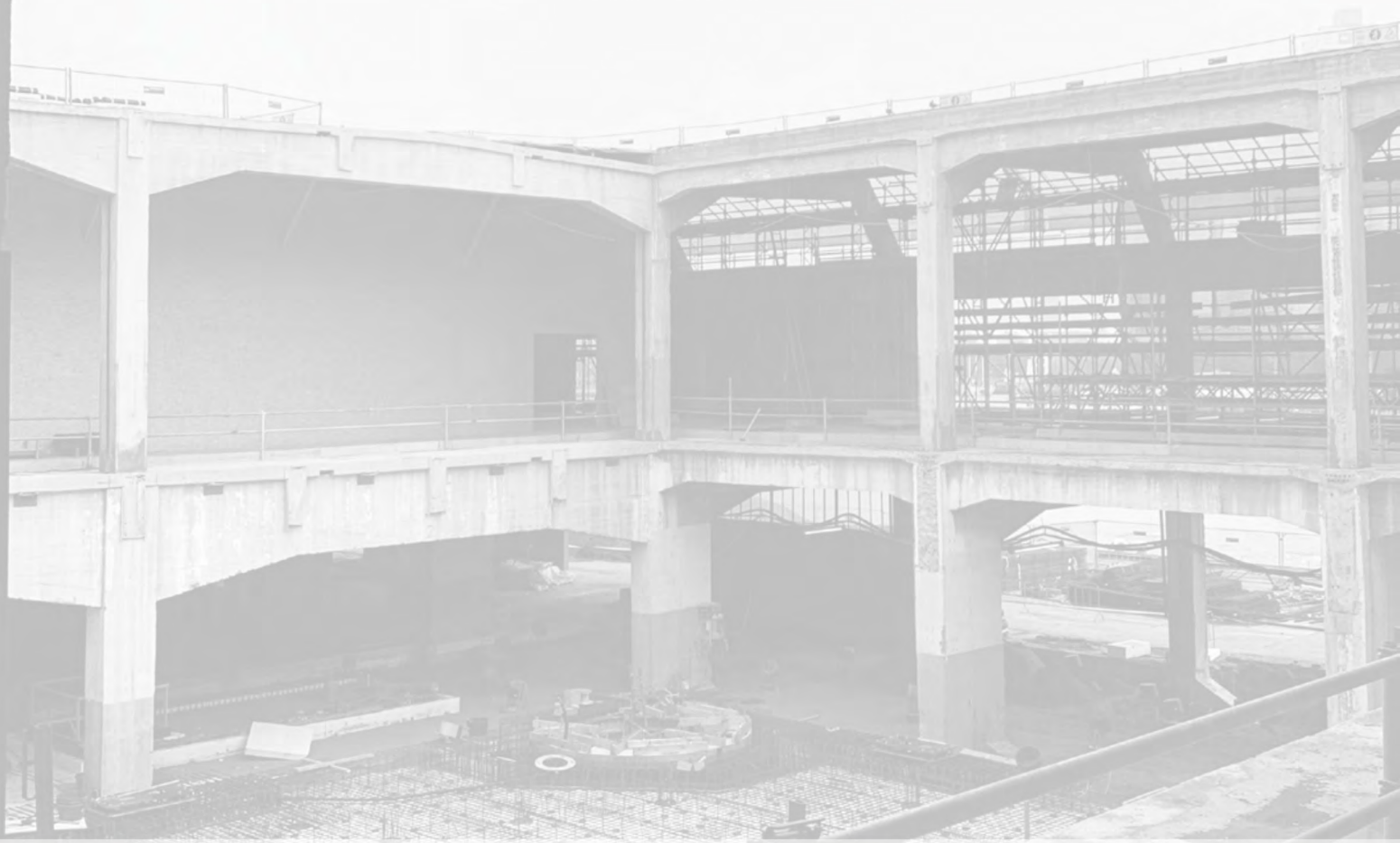
Adaptive Re-use of Industrial Heritage in Dutch Post-industrial Urban Area Development

The relation of the adaptive reuse and the added value in regards to the economic, social, and environmental sustainability



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ABSTRACT

Urbanization, modernization, and the growth of the population put severe pressure on the current Dutch building stock. Inner-city developments in Dutch cities are limited due to the high density of the urban fabric. Therefore, the focus of urban transformation gradually moved from the inner-city developments to the periphery of the city. These boundary zones are often former industrial sites that are currently derelict and underused, due to the rapid de-industrialization in Europe that took place. These areas offer a unique opportunity to address the demand for housing and the space for new economic sectors. The Dutch urban areas are more than abandoned industrial sites that need to be regenerated. The presence of industrial legacy in the form of industrial heritage is a source of added value for these redevelopments. The reappraisal of industrial heritage is a catalyst effect that ensures further urban revitalization due to its societal, historical, architectural, and technological importance. This type of development is a kickstarter for further redevelopment and upgrading deprived areas.

Furthermore, the reappraisal of industrial heritage by adaptive reuse has a positive effect on the triple bottom line of sustainability. Capturing the value that is linked to the triple bottom line of sustainability is challenging due to the various components that define them. To reach sustainable development on the basis of the triple bottom line of sustainability, linkages and an equilibrium of all components should be reached. The sustainability of adaptive reuse in industrial heritage is an interplay between coping with challenges and emphasizing on benefits. Developments are always reaching for the maximum, and try to achieve sustainable development. Despite the identifiable benefits, the revitalization of Dutch urban areas also faces a myriad of challenges. Challenges and barriers encountered make it futile and hard to obtain. The financing of complex urban development, with the adaptive reuse of industrial heritage, is a major challenge. Due to the challenges and uncertainties this development faces, the cost rises with it. The main challenge is finding implementation methods and feasible and appropriate financial instruments that maximize the benefits on economic, social, and environmental sustainability of regenerating these areas.

Adaptive reuse of industrial heritage greatly improves social and environmental sustainability. The degree to which this sustainability is improved is dependent on the perceived sustainability benefits on sustainability. This research begins to understand the factors that impact the degree of added value. Understanding these factors, the process of adaptive reuse of industrial heritage can be optimized to ensure more sustainable and successful end-products.

Adaptive reuse of industrial heritage has clear benefits, it is important that industrial heritage is continuously being transformed to preserve the industrial legacy and to cope with the pressure on the current building stock.

PREFACE

The master thesis “Adaptive Re-use of Industrial Heritage in Dutch Post-industrial Urban Area Development” is written from the perspective of urban area development. The thesis is written at Delft University of Technology at the faculty of architecture in the built environment in the master track management in the built environment (MBE).

When I started my bachelor’s “Bouwkunde” at Delft University of Technology, I discovered the complexity associated with urban area development. This is one of the reasons why I started my masters in management in the built environment (MBE). The complexity of urban area development and the need for development within the urban fabric, was always to my interest and became the starting point of this research.

Walking through cities and witnessing the deterioration of post-industrial areas sparked an interest in the need for urban area development. Regenerating these areas to add value to the urban fabric is a process that has various opportunities but at the same time faces several challenges, uncertainties and risks due to the complexity of it.

Simultaneously, there is a mounting urgency to partake in sustainable development. With my research, I want to contribute to the growing demand for sustainable development. I strongly believe we as individuals, and the (extremely) polluting construction sector, must take responsibility for our carbon footprint and ensure future generations inherit a livable planet.

The deteriorating post-industrial urban areas contain many industrial heritage buildings. This industrial heritage stems from an industrial, historical legacy that has always interested me. I think we can learn from our past, but to ensure we can learn and admire the encumbrances we overcame in the past we should preserve these assets that carry this rich history. By re-adapting the use of these derelicted industrial heritage buildings we make sure that this rich history is not getting lost.

I am looking to uncover how to optimize the existing building stock in urban areas. By reusing the existing industrial building stock the sustainability accompanied with it will benefit, simultaneously several other challenges will arise. As limited research is conducted in the way these post-industrial urban area developments are financed, implemented and adding value to the economic, social, and environmental sustainability, I endeavor to contribute to work on how implementation methods and financial instruments in adaptive reuse of industrial heritage correlate to the triple bottom line of sustainability.

I appreciate your attention and interest in this work.

Corné de Broekert

4571231

Delft, April 7th, 2022

“PRESERVATION IS SIMPLY HAVING THE GOOD SENSE TO HOLD ON TO THINGS THAT ARE WELL DESIGNED, THAT LINK US WITH OUR PAST IN A MEANINGFUL WAY, AND THAT HAVE PLENTY OF GOOD USE LEFT IN THEM.”

- Richard Moe, National Trust For Historic preservation -

EXECUTIVE SUMMARY

The executive summary is a brief summary of the complete report that highlights the most important parts of the whole research. The executive summary reflects the main points of the research setup, literature study and the findings in the empirical case studies. The conclusion and recommendations presented show the outcome of the research and next step.

Introduction

The pressure on the current building stock is rapidly increasing. In order to halt the depletion of the natural environment, innovative solutions to meet the demand for housing and new economic centers are necessary. Making use of existing industrial heritage, that is currently vacant due to the rapid deindustrialization and move to the periphery of the city, is an innovative solution that can begin to address the demand. Adaptive reuse in industrial heritage can be challenging in regards to using successful implementation methods and fitting financial instruments. Although adaptive reuse is a potentially sustainable development method, the implementation method and financial instruments are key factors in the redevelopment process and contribute to the success of the adaptive reuse and the degree of sustainability of the development. Sustainability in adaptive reuse may be defined in many ways, but in this research it is defined as;

"Sustainability in adaptive reuse highlights the importance of the redevelopment that satisfies present consumption without compromising future needs on economic, social., and environmental sustainability."

The municipality of Rotterdam, located in the Netherlands, is the focus area where all case studies are located. The industrial past of the city presents great potential for many adaptive reuse developments. The scope of the research is on the building level, however, the building must always be seen in its context of a neighborhood, city, and country as shown in Figure I.

Figure I: Scope definition of the research (own figure)

Central question of this research

How does the adaptive reuse of industrial heritage, in post- industrial Dutch urban area development, relate to the added value, in regards to the economic, social, and environmental sustainability?

Through addressing this research question, this research works within a gap in the existing literature. Addressing implementation methods and financial instruments in adaptive reuse of industrial heritage and looking at economic, social, and environmental sustainability works on filling the knowledge gap to achieve

scientific relevance. Additionally, this research can help inform industry leaders on the value of pursuing adaptive reuse, specifically in regards to sustainably addressing the demand for housing and new economic centers.

Literature study

Urbanization, modernization, and population growth put severe pressure on the building stock (Buhaug & Urdal, 2013). Due to these factors, the demand for real estate within cities is substantial. Research by Oliver et al. (2005) shows the diminishing number of available greenfield development areas in western Europe. They stated that, due to the high population density and consequent lack of available new greenfields, regenerating brownfields (previously developed land) is a key priority. Therefore, investors and developers have to explore the more segregated industrial areas of the city. Often these places are at peripheral and unfavorable locations in the city. Some challenges these locations face are pollution, high costs, and isolation from the rich city fabric (Chen, 2020).

Research conducted by Canevaro et al. (2019) identifies the rapid de-industrialization of Western economies as the cause of vacancy in inner-city industrial areas (brownfields). In addition to this de-industrialization, the technology growth in the maritime sector ensured that harbor functions moved to the periphery of the city (Hein & van de Laar, 2020). These areas contain many industrial heritage sites that are important to the industrial legacy of the city. Re-establishing this industrial heritage by adaptive re-use, preserves and enhances the character of the industrial past within the city fabric (Canevaro et al., 2019). The intervention should always focus on the demand the building industry faces. This strategy can be used as a value-adding strategy for urban city development. Transforming industrial heritage but preserving the industrial character and legacy of the area accelerates urban area development. This can effectuate the catalyst effect causing the direct surroundings to become more valuable (Tam et al., 2016; Fitch, 1990). The catalyst effect affects its direct surroundings but disperse when the distance from the redevelopment increases (de Vor & de Groot, 2011).

By reusing the desolated industrial areas and breathing new life into them, these areas become more valuable (Yung & Chan, 2012). The added value can be assessed by the actual sustainability of the development that is divided into economic, social, and environmental sustainability (Parkin et al., 2003). The consolidation of the three is the actual sustainability of the development. All seperate pillars of sustainability can be evaluated on the basis of sustainability benefits that are enhanced in adaptive reuse of industrial heritage (Conejos et al., 2016).

There are a myriad of reasons to adapt industrial heritage to better fitting functions. Yet there are also numerous barriers and challenges associated with transforming industrial heritage. Key challenges are related to the sustainability pillars. To effectuate the redevelopment it is an interplay between coping with the challenges and emphasizing on the benefits associated with the adaptive reuse of industrial heritage. In addition to the interplay between challenges and benefits to achieve sustainable development, stakeholder management and the financial instruments are essential to actually redevelop industrial heritage (Franzen et al., 2011). All stakeholders in the project have the same goal to create a successful project, only their definition of a successful project can differ (Shenhar et al., 1997). Adaptive reuse of industrial heritage can be seen as a pioneer where it is the first in urban area renewal, and where it attracts other developments. Likewise it can be seen as the crown of urban area renewal where it is not dependent on the inflow of people and companies to the area.

Methodology

The implementation methods and financial instruments in adaptive reuse in industrial heritage and their correlation with sustainability are researched on the basis of three case studies. As this

research focuses primarily on the process and the outcome of adaptive reuse in industrial heritage, the data related to the case studies are obtained from qualitative interviews and review of documentation of the plans. The data obtained from interviews and literature review is the initial build block for the assessment of the cases. All cases are assessed on the basis of the challenges and benefits related to the three pillars of sustainable development. These sustainability challenges and benefits related to the adaptive reuse of industrial heritage are substantiated by data gathered in interviews and literature. These interviews are analyzed using AtlasTi and a deductive coding system. After coding all interviews the data is examined to draw conclusions. The case assessment is the basis to cross examine the cases and synthesize the results to draw a conclusion on how the adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value of sustainability.

Empirical research

For all cases a history timeline and an in depth description on their background information and design is established. The involved stakeholders are mapped in a stakeholder diagram that shows the relation of the stakeholders to the case and each other and the sustainability goals of them. Next the financing of adaptive reuse in industrial heritage is established. Finally on the basis of qualitative data from the conducted interviews all cases are in depth evaluated on the sustainability challenges and benefits divided over the three pillars of sustainability. This data from the cases is summarized, reduced and excluded to the main findings. The cases are eventually cross examined to find correlation between the characteristics of the cases and the added value, in terms of sustainability of the project. Besides the sustainability benefits it is important to determine how the adaptive reuse of industrial heritage copes with the challenges and barriers associated with it.

Synthesis

The synthesis and cross examination is where the data from the empirical research is summarized and reduced to the main findings. In addition to the main findings from the cases, the foundation for the conclusion is established. The analysis is based on a methodological implementation of the concepts and themes to the transcripts (Mayring, 2000). The occurrence of the codes per sustainability theme allows for an understanding of each case's sustainability benefits and challenges. It establishes relations between the actual sustainability and the redevelopment methods of the cases. It also gives an idea of how sustainability is integrated into the design and the decision-making process. The synopsis is the blueprint for the development of the conclusion.

Conclusion

In conclusion, it is difficult to give an unambiguous answer on the question how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social, and environmental sustainability. Adaptive reuse of industrial heritage greatly improves the social and environmental sustainability. The degree to which this sustainability is improved is dependent on the occurrence of the sustainability challenges and benefits. There are signals that some benefits including the program, the initiation or the nature of the investment impact the degree of added value in terms of sustainability in these three case studies. Although some of these signals are substantiated in literature, other findings cannot be generalized to other cases.

This thesis begins to understand the factors that impact the degree of added value. By understanding these factors, the process of adaptive reuse of industrial heritage can be optimized to ensure more sustainable and successful end-products. Some factors may add more value delivering more sustainable projects than other factors. Adaptive reuse of industrial heritage has clear benefits, furthering the research presented in this

thesis ensures that these benefits are optimized; thereby further highlighting the opportunity of adapting and reusing industrial heritage in post-industrial Dutch urban area.

Epilog

The epilog discusses the process, steps, and decisions made during the research. These steps define the research, and are the reasoning why data is missing or why it cannot be used for scientific purposes. If these limitations were prevented the research would have been more univocal.

- Context of the cases limits the credibility of framework and conclusion.
- The number of case studies limits the validity and significance of the conclusion.
- The different characteristics of the cases limits the validity and significance of the conclusion.
- Old cases limit the possibility to find proper unambiguously data.
- Limited qualitative data makes the assessment biased and multi-interpretable.
- Interview protocol is heading in a certain direction.

In addition to the limitations that counter the success of the research, recommendations that give future research possibilities that were either not touched upon or unclear within the scope of the research are established. There are some tools to capture the potential adaptive reuse in industrial heritage, although there are no tools that actually assess the incorporation of the adaptive reuse plan. If there would be an assessment potential framework prior to the redevelopment there is an extra juncture to revise the design and improve the plan. The creation of a holistic assessment framework potential tool can be incorporated within practice of the decision-making process of adaptive reuse in industrial heritage. Incorporating the tool within practice can make the actual sustainability of redevelopment projects more sophisticated. In addition to making the redevelopment projects becoming actually more sustainable, the holistic assessment framework potential tool for adaptive reuse in industrial heritage can exclude or diminish uncertainties and risks that would normally appear at the end of the redevelopment.

"The charm of industrial heritage is how unique and incomparable the objects are."

(translated from dutch)

- Research participant EvH(04) -

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READERS GUIDE

The report adaptive reuse of industrial heritage in dutch post-industrial urban area development is divided into 5 parts that give an overview of the content of the report. Every step is one step closer to the answer to the question of how adaptive reuse of industrial heritage relates to the added value of the three pillars of sustainability.

The context consists of the introduction and the methodology. In this part of the report the problem, the scope and the steps of the research are established.

The literature establishes the theoretical framework upon where the case studies are assessed. The literature study provides answers on the sub questions of the research.

The empirical part of the research consists of three case studies. The case studies are substantiated with interviews and case documents related to the cases.

The synthesis is the part where cases are combined and cross examined to find correlation between the adaptive reuse projects and the outcome on the sustainability benefits.

The conclusion gives an answer on the question if adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social, and environmental sustainability.

INTRODUCTION

This chapter introduces background information on the thesis. There are several reasons why this research is important and why it should be conducted. In this chapter the problem, the scope, the expected result, and the societal, and scientific gap is highlighted. In addition, the research questions that are the guideline of this research on which the structure and content is based are presented.

Problem analysis

The rising demand of housing and new economic sectors due to the urbanization, modernization, and population growth of real estate (Buhaug & Urdal, 2013), forces cities to translocate their developments to the periphery of the urban fabric. These brownfields are complex in stakeholder management, have a high cost of regeneration, and are isolated from the city fabric (Chen, 2020). These areas house numerous industrial heritage buildings (Canevaro et al., 2019). Preserving these assets can have a significant impact on the liveability, profitability, and sustainability of the area. It is therefore of high importance that the industrial heritage in these areas is preserved and given a new function by adaptive reuse (Canevaro et al., 2019). Adaptive reuse of the industrial heritage can have a drastic positive impact on urban area development (Tam et al., 2016). Despite the complexity, transforming vacant industrial heritage has many clear and tangible benefits. However, it is unclear how the reappraisal of industrial heritage affects the economic, social, and environmental sustainability of the industrial site. There are various assessment criteria and variables on these three different pillars of sustainability, but there is no framework that combines these criteria and variables to assess the actual sustainability of the redevelopment. Many things are unclear before starting the transformation of industrial heritage. This ambiguity increases the cost of research prior to the actual development. Coupled with the high cost of revitalizing urban areas and the adaptive reuse of industrial heritage, it is hard to find proper and fitting financial instruments to finance these projects. Another problem that occurs is the differences between the public and private stakeholders. They both want to develop urban areas that are attractive and inclusive, but the resources they have and the way they reach that goal is different. Despite the fact that their resources and methods are different they are still dependent on each other. The public wants to preserve the industrial heritage and increase the livability of the area, but private parties are mainly focused on magnifying their portfolio and the profitability of the project. This also gives private developers eventuality of receiving funds to make their business case feasible. Financing, implementing and adding value with these kinds of developments requires a lot of commitment and cooperation between different parties.

Scope definition

This research focuses on how adaptive reuse is implemented and which financing instruments have been adopted in the adaptive reuse of industrial heritage in post-industrial areas in the Netherlands. On the basis of a theoretical framework, relations between the implementation methods, financial instruments and the sustainability of the redevelopment are established (if present). Adaptive reuse takes place on different scale levels, ranging from a solitary object, a complex, a district/area to complete regions (Nijhoff, 1994). The scope of this research focuses on the adaptive reuse of industrial heritage in Rotterdam. Rotterdam is located next to the Maas and has a rich history associated with the industrial revolution. The associated industrial buildings became vacant and derelict due to the rapid de-industrialization that took place in Europe. Having all cases in the same country as well as the same city, the findings are easier to assess and draw conclusions upon. This is due to the fact that the majority of the context of the redevelopment is the same for all cases. The actual assessment of the sustainability output is focussed on the building context of industrial heritage. The sequence of scope definition can also be approached in reverse. The impact of the adaptive reuse on its direct context and beyond can be evaluated. Figure 1 gives an schematic overview of the scope definition of the research. The focus gradually moves from the national context all the way to the building context of the industrial heritage.

Aim

It is the aim of this research to discover how adaptive reuse of industrial heritage in Dutch post industrial urban areas is financed, implemented and how these developments are adding value to economic, social, and environmental sustainability. Another aim is to evaluate how these projects are feasible and how the challenges associated with urban area developments are faced. The main aim is to find how adaptive reuse in industrial heritage succeeds on sustainability and relates to the implementation methods, and financial instruments used. On the basis of the literature study that provides the impetus for the framework for this research, case studies are examined. Assessing case studies and their outcome presents better understanding and a blueprint to future redevelopment projects. Further, the aim of this research is to create a theoretical framework that assesses the sustainability of the adaptive reuse of the redevelopment on the various factors, criteria and variables that are associated with the three pillars of the triple bottom line of sustainability. This theoretical framework is used for the cases that are covered in this research.

Research question

The following research question is established to set a clear boundary for the research. This question is the guideline for this research. Due to the comprehensive nature of the main research question, sub-questions are established to underpin the structure of the thesis. The sub-questions are a bifurcation of the main research question. By splitting the main question into sub questions it becomes more attainable. The main question can be answered by synthesizing the sub-questions, and data gathered from the empirical case studies.

Figure 1: Scope definition of the research (own figure)

Central question of this research

How does the adaptive reuse of industrial heritage, in post- industrial Dutch urban area development, relate to the added value, in regards to the economic, social, and environmental sustainability?

Sub questions of this research

SQ1 *What challenges or barriers are faced by the industrial heritage transformation if the aim of adaptive reuse is to achieve sustainable results?*

SQ2 *Which implementation methods have been adopted and what financial instruments have been explored if the aim of adaptive reuse is to achieve sustainable results?*

SQ3 *To what extent have adaptive reuse methods and financial instruments led to sustainable outcomes?*

Expected result

It is expected that the revitalization of Dutch urban areas and the adaptive reuse of industrial heritage positively contributes to the triple bottom line of sustainability. It is difficult to estimate to what extent adaptive reuse in industrial heritage is fully sustainable. If all pillars of the triple bottom line of sustainability are evenly distributed or one is way more present then the other depends on the cases. Also, the revitalization of Dutch urban areas and the adaptive reuse of industrial heritage within the city fabric addresses the problems that come with urbanization, modernization, and population growth. The financing and implementation of adaptive reuse in industrial heritage is the main topic that is clarified throughout this research. There are multiple financial instruments to revitalize urban areas, which are used for a single adaptive reuse development in industrial heritage and the relation with the surroundings is rather unclear. Due to the complexity of adaptive reuse in industrial heritage and urban area development, there is not one best outcome.

Relevance

The growing urbanization, modernization, and population growth engenders the need to think about implementing new ways to develop within the city fabric. If more knowledge is being collected on how adaptive reuse is financed, implemented, and how it adds value on economic, social, and environmental sustainability, it is more likely that industrial legacy is preserved. The relevance is divided in societal and scientific relevance. Societal relevance mainly focuses on the need for this research within the boundaries of normal life, whereas scientific relevance focuses on the gap in scientific literature.

Societal

How implementation methods and financial instruments in adaptive reuse in industrial heritage is related or is adding value, is of high societal relevance. The urbanization, modernization, and population growth that put severe pressure on the building stock (Buhaug & Urdal, 2013), requires more development within the boundaries of the city. Dutch cities become congested due to the density of development. The movement of harbor and port activities to the periphery of the city resulted in new development space. The transformation and redevelopment of the former industrial sites are an upgrade for the city and can have a positive effect on the industrial site. Since the 1980s, a new development has taken place with regard to industrial heritage. By the demolition of the industrial heritage the authentic factory chimney has become much rarer than a church tower. The growing awareness of industrial heritage as references to industrial use and as landmarks is fueling actions aimed at their adaptive reuse (Nijhoff, 1994).

With the availability of more research on the implementation methods and financial instruments and their correlation with sustainability it is more likely that a considerable number of stakeholders broadens their perspective on brownfield (re)development. If there is more knowledge on adaptive reuse in industrial heritage it is more likely that these projects have the

chance to be furthered. With the adaptive reuse of industrial heritage, the demand for housing and space for new economic sectors can be met in an economic, social, and environmentally sustainable way. If the industrial heritage is sustainable then this has a positive effect on its direct and indirect surroundings. More knowledge ensures more development for these derelict and deprived areas within the city fabric. Additionally, more development means that more less favorable areas are upgraded. Upgrading of city regions ensures people move towards these new centers, which diminishes the deplorable image of those areas.

Scientific

The existing research on adaptive reuse in industrial heritage focuses primarily on the need and the result of these developments. The existing research gives a step-by-step approach on how to regenerate post-industrial areas that contain industrial heritage and the added value of this redevelopment. In the available literature, there is limited evidence-based research on how implementation methods and financial instruments relate or have the highest leverage on the sustainability of the adaptive reuse of the industrial heritage.

Research conducted by Halbert & Attuyer (2016) indicates that there is a dearth of exploration on how the finance of urban development is established. It is unclear how financing adaptive reuse of industrial heritage between private financiers and public bodies, collectively or individually, shapes a new urban context. By going beyond the simplistic financing patterns and scrutinizing potential innovative financial forms, a better understanding for these types of projects can be established. More knowledge is available regarding how adaptive re-use of industrial heritage has leverage on sustainability. There is no unambiguous framework that combines the criteria that are associated with adaptive reuse and the triple bottom line of sustainability. This research can contribute by establishing a theoretical framework that shows the correlation between the implementation methods and financial instruments and the success of the adaptive reuse on its sustainability.

LITERATURE STUDY

Conducting a literature study is the start of answering the question on how adaptive reuse of industrial heritage, in post industrial Dutch urban area development, relates to the added value in regards to the economic, social, and environmental sustainability. Although sustainability in adaptive reuse is becoming increasingly more important, the concept is vague and hard to define. One interpretation is that:

"Sustainability in adaptive reuse highlights the importance of the redevelopment that satisfies present consumption without compromising future needs on economic, social, and environmental sustainability."

This chapter presents the underlying reasoning, which discusses what adaptive reuse is and why it has to be incorporated (part 1). The challenges and the benefits of sustainability related to adaptive reuse in industrial heritage (part 2). After this is established the stakeholder management and financial instrument are discussed (part 3 & 4). And finally how adaptive reuse in industrial heritage is adding value to its surrounding is concluded (part 5). The literature study provides background information to establish a framework that is used to assess the cases. After conducting the case studies and gathering all data that is associated with the cases, the literature study is used to link and appraise this data. The literature parts are structured in this order to link the information and to build knowledge about the adaptive reuse in industrial heritage reasoning, implementation and means. The structure of the literature study is displayed in figure 2.

Figure 2: Structure of the literature study to build knowledge and to establish a theoretical framework.

Adaptive reuse of industrial heritage in post-industrial urban areas.

Adaptive reuse of industrial heritage is a process that can take place within the bandwidth from changes to the interior and exterior to the integral preservation of structures. The shift in function of the asset is essential, modifying the current structure the building is revitalized (Nijhoff, 1994). Adaptive reuse takes the original structure as a base to create new and better fitting functions; one can see it as a form of sustainable urban regeneration (Yung & Chan, 2012). Adaptive reuse of industrial heritage is a worldwide phenomenon. Since the 1960s, every industrialized country has struggled with the effects of the factors leading to vacant industrial buildings. Scaling-up and changing location factors resulted from the de-industrialization of the post-industrial society (Nijhoff, 1994). From the mid 1980s policy in North America and Europe has shifted and the emphasis is on cultivating the quality of life around the post-industrial urban area (De Sousa, 2003; Nijhoff, 1994). There are three main causes why the revitalization of urban areas is an emerging concept. One of the main takeaways for this type of inner city development is urbanization, modernization and population growth (Buhaug & Urdal, 2013). Many Dutch cities are reaching their boundaries with regard to their developing possibilities and expanding power (Brooks, 1975). If developers keep building on available greenfields in the city fabric the degree of urbanization becomes higher, which results in a city with little to no green space (Abdulameer & Abbas, 2020). The amount of inner city greenfield areas diminishes due to the tremendous need for development. This means the current approach is not sustainable and becomes impossible to develop within the city. Oliver et al. (2005) states that the available greenfields in Europe diminishes and that we have to develop in the more segregated industrial areas at the peripheral and less favorable locations. These areas are often forgotten and deserted with the presence of former industrial sites that look deteriorated and fors public squalor. On the contrary with new construction these areas have a context to work with and which cannot be lost (J. Semijn, personal communication, 12 November 2021).

"The difference between repurposing industrial heritage and new construction is having an analytical approach in the beginning to avoid further conflicts. You have to be able to explain the things you do. "

(Translated from Dutch)
- Research participant JS (06) -

To cope with the demand for housing we have to develop less favorable locations at the periphery of the city. Research by Claassens et al. (2020) discusses the shift from the creation of housing in greenfields to the development of brownfield developments. Their study shows that between 2000 and 2005 the share urban/non-urban was respectively 42% and 58% and this shifted to 69% and 31% between 2012 and 2017. Developing within an urban context does not contribute to the urban sprawl where cities agglomerate (Claassens et al., 2020). Heritage preservation is nowadays linked to urban development, the heritage forms an integral part of the redevelopment strategy (Murzyn-Kupisz & Działek, 2013). Developing segregated locations brings numerous challenges. Segregated industrial sites at the peripheral or less favorable locations within the city are in any quantity, underused and deteriorated industrial sites. The industrial revolution came to a halt and the harbor and port activities moved from the inner city to separated maritime industrial development areas (Hoyle, 1998). This movement of activities left the industrial heritage vacant and deteriorated. The presence of vacant and deteriorated industrial heritage in post-industrial urban areas often leads towards an urban ghetto at the periphery of the city fabric. These urban ghettos face problems such as out-migration, social isolation, drug use and lack of services (Green, 2020). Developing these areas with industrial heritage, and incorporating them into the city fabric is essential for the city as its whole and its people within.

"In a cyclical economy, our work (adaptive reuse of heritage) can expand in times of adversity and diminish in times of prosperity. "

(Translated from Dutch)
- Research participant AB (10) -

The evolution of the port city is moving at a tremendous pace. Hoyle (1998) made a distinction in how port cities developed over time. Before the 19th century till the early 20th century ports were primarily focused on break-bulk industries, the port severely changed with the upcoming industrial revolution. During this period the port and harbor activities exploded. A tremendous amount of buildings that housed an industrial harbor activity were commissioned by the companies. This period of industrialization in the 19th- till mid 20th century was short lived as a result of the deindustrialization (Canevaro et al., 2019). In the late 20th century the ports were redeveloped in an urban renewal effort of the original cores. Nowadays, the urban redevelopment of the port/city enhances the integration of both parts. The port and harbor function are still linked to the city but the harbor or port activities are moved out of the city due to globalization and rapidly increasing port activities. As the perspective on old industrial sites shifts, there is an ever growing emphasis on linking the traditional city with new maritime industrial areas. Figure 3 shows this development and the interrelation between the city and the port.

The different stages show the evolution of the city and port functions. We have already been through stage I to IV and currently find ourselves in stage V and VI where we revitalize the industrial sites with industrial heritage and enhance the link between the port and the city. This stage is highly important to not further deteriorate the vacant and segregated harbor/port function-related assets. And to incorporate these areas within the city again (Hoyle, 1998).

In addition to the deindustrialization of the ports, the port activities became bigger. This slowly pushed the port activities to the periphery of the city and beyond (Hein & van de Laar, 2020). The waterways of the former ports became too small for the ever increasing size of the container vessels (de Gijt et al., 2010). If the container vessels nowadays are compared with container vessels from the 1960s it is obvious that the existing inner city waterways are too small for these enormous vessels. Expanding the waterways at the inner city port was not possible due to the already existing developments at the quay. In addition to the increasing size of the container vessels, there has been an increase in the throughput of containers in the port of Rotterdam (de Gijt et al., 2010). It becomes clear that due to the rapid development the port that was made before 1960 became insufficient for the current harbor and port activities. This expanding industry necessitated a separate maritime industrial development area.

STAGE	SYMBOL ○ City ● Port	PERIOD	CHARACTERISTICS
I Primitive port/city		Ancient/medieval to 19th century	Close spatial and functional association between city and port.
II Expanding port/city		19th - early 20th century	Rapid commercial/industrial growth forces port to develop beyond city confines, with linear quays and break-bulk industries.
III Modern industrial port/city		mid - 20th century	Industrial growth (especially oil refining) and introduction of containers/ro-ro require separation/space.
IV Retreat from the waterfront		1960 s - 1980 s	Changes in maritime technology induce growth of separate maritime industrial development areas.
V Redevelopment of waterfront		1970 s - 1990 s	Large-scale modern port consumes large areas of land/water space; urban renewal of original core.
VI Renewal of port/city links		1980 s - 2000+	Globalization and intermodalism transform port roles; port-city associations renewed; urban redevelopment enhances port-city integration.

Figure 3: The different stages in the traditional port-city interface that are defined by characteristics that are known for the type of development during that stage (Hoyle, 1998).

The transformation of industrial heritage in post-industrial urban areas has various reasons. The process can be seen as a chain reaction of causes that result in the need for revitalizing the industrial sites. This revitalization faces challenges but also opens up numerous possibilities for regenerating these derelict industrial sites.

Sustainability benefits and challenges in adaptive reuse of industrial heritage.

As the need for cities to expand increases, cities began to develop their post-industrial urban areas, which became central to urban regeneration (Davidson, 2012). Martinovic & Kofl (2018) mention that heritage buildings hold great potential for adaptive reuse and are the perfect place to incorporate sustainability concepts. Prior to the adaptive reuse of the industrial heritage, sustainability is practically not included in the post-industrial site. Most areas are vacant which is an obstacle for economic growth (Kaufman & Cloutier, 2006), social sustainability is an upcoming concept which has less been enhanced when these areas were created (Ikiz Kaya et al., 2021), and during the industrial revolution, there were little to no regulations on environmental sustainability (Wrenn et al., 1983). Chen (2020) mentioned preserving the industrial legacy of the historical industrial heritage as a major benefit. The sustainability challenges and benefits of adaptive reuse in industrial heritage can be categorized in economic, social and environmental sustainability (Parkin et al., 2003). The sustainability challenges and benefits related to the adaptive reuse of industrial heritage are an interplay between coping and emphasizing to safeguard sustainability. Adaptive reuse in industrial heritage has a positive effect and can be seen as a catalyst for further development (Bazelmans, 2013). Scholars and institutions within the field have different views on which and what value industrial heritage contains (Cristina Heras et al., 2013; Carter & Bramley, 2002). If the industrial heritage loses its function and becomes vacant, an evaluation on the preservation is conducted (Bazelmans, 2013; Conejos et al., 2014; Langston, 2012). This evaluation includes the technical state that determines the potential of adaptive reuse in industrial heritage. A strategy to conserve this built heritage is adaptive reuse.

"The complexity is actually very simple. If buildings are empty, there is a reason. The reason is mainly that they are no longer in demand, the demand no longer fits the building's function. "

(Translated from Dutch)
- Research participant AB (10) -

If one wishes to examine the outcome of the adaptive reuse on industrial heritage, It is unclear what sustainability indicators should be used when measuring sustainable development (Tanguay et al., 2014). The sustainable development diagram is a good and sufficient indicator that assesses actual sustainable development. Sustainable development is defined by the equilibrium of economic, social and environmental sustainability (Parkin et al., 2003; Guo et al., 2021; Kahn, 1995). Figure 4 is a representation of dependence of the three pillars. Kahn (1995) calls the connection between economic, social and environmental sustainability inevitable, but their methodological articulation is still tentative.

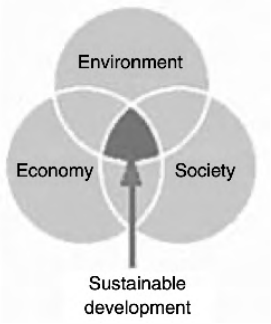


Figure 4: Venn diagram of sustainable development. The three sustainability pillars that comprise sustainable development. (Parkin et al., 2003).

The three dimensions of sustainability can be divided into benefits and challenges to assess the impact of an urban (re) development project (Cooper, 2001; Guo et al., 2021). These variables give the blueprint for a substantiated assessment of a project's impact or success based on sustainability. When a (re)development

is not fully sustainable it does not mean that no sustainability factors are taken into account. This means that there might not be a balance between all three pillars but that the (re)development is more shifted towards one or two of the pillars (Tanguay et al., 2014). Sustainability factors within the three pillars of sustainability related to adaptive reuse in industrial heritage are deductively established from findings in literature to capture the sustainability of adaptive reuse in industrial heritage. Besides the benefits related to adaptive reuse of industrial heritage there are several challenges accompanied. In order to adopt adaptive reuse and the sustainability-related to it, one should cope with the challenges related to this type of development. The main challenges of urban renewal in industrial heritage are tangible and easy to define. Challenges are factors that negatively affect adaptive reuse; it encompasses constraints, obstacles, or hurdles that impede adaptive reuse (Eisenack et al., 2014). The tangible challenges are linked to the sustainability goals of urban renewal and adaptive reuse in industrial heritage. The challenges that adaptive reuse faces to become sustainable are the key points to address to actually obtain sustainable development. As barriers and challenges are common in new situations it is important to identify them to enhance the benefits of adaptive reuse (Conejos et al., 2016).

Economic sustainability

Challenges

Innercity, derelict, former industrial sites are a result of a maturing city, these areas originate when flourishing industrial areas become vacant and environmental polluted assets remain. The industrial sites are obstacles for economic growth for the city fabric (Kaufman & Cloutier, 2006). The redevelopment of these derelict sites are important to ensure these areas become economically vital contributors for the rest of the city. Basiago (1998) defines economic sustainability as: "The economic sustainability implies a system of production that satisfies present consumption levels without compromising future needs. The 'sustainability' that 'economic sustainability' seeks is the 'sustainability' of the economic system itself." There are several challenges linked to the economic sustainability of adaptive reuse in industrial heritage. A key challenge is the financial and technical perception/ notion that adaptive reuse is expensive and demolition is the only profitable way of redevelopment (Conejos et al., 2016). Besides these challenges Conejos et al., (2016) state the economic considerations (direct and indirect) costs that are associated with conservation as a main barrier of adaptive reuse. The economic sustainability challenges are mainly focused on the enhancement of the positive economic impact in the financing of the regeneration of Dutch urban areas. Without financial instruments no development will ever take place (Heurkens et al., 2020). Next to these financial instruments it is important that there is a feasible business case. Adaptive reuse faces several risks and uncertainties which makes it hard to create a feasible business case. These projects are likely to be lengthy and difficult, which often leads to reduced profits (Conejos et al., 2016). Upgrading the old industrial heritage to the technological standard of modern days requirements is costly. Conejos et al. (2016) also states that the contamination caused by hazardous materials in the heritage buildings results in high remediation costs and construction delays, which affects the economic sustainability of the project. All stakeholders have different perspectives on a business case's feasibility (Franzen et al., 2011). The project's financing can satisfy certain sustainability goals within the project and so the goals of certain stakeholders. Financing can determine the project outcome which makes it a powerful tool within the adaptive reuse of industrial heritage. Financing adaptive reuse and reaching economic sustainability is difficult and complex, there is no blueprint which financial instruments should be used for these developments or how to deal with the challenges associated with it. The embodiment of economic sustainability in adaptive reuse of industrial heritage is a wicked problem that presents indeterminate solutions.

Benefits

Besides challenges there are several factors that positively affect the economic sustainability of adaptive reuse in industrial heritage. The economic sustainability benefits can be divided in use value and non-use values. The non-use values indirectly benefit from the preservation of the industrial heritage, these values cannot be captured by the market and are non-excludable in consumption (Navrud & Ready, 2002). The economic sustainability benefits are deductively drawn from the literature and give a general picture of economic sustainability. The most frequent and representative sustainability benefits give a substantiated representation of the redevelopment.

The economic benefit of adaptive reuse in industrial heritage may occur in the external effect on the adjacent property value of the redevelopment (Kaufman & Cloutier, 2006; Duijn et al., 2014). If vacant industrial heritage is redeveloped it is likely that the prices surrounding this development will rise with it. To some extent this includes the intrinsic value of industrial heritage that is determined by the willingness of people to pay more for the industrial asset (Remøy, 2014). There are numerous factors that determine the price of housing where location and surrounding is one of.

"The value of real estate directly surrounded by the adaptive reuse of the industrial heritage receives an upgrade. I think it has to do with the fact that industrial heritage has a strong identity which often contains functions that make the area more lively."

(translated from dutch)
- Research participant EvH (04) -

The cost benefits related to the materials and time that are used in the redevelopment, are part of the economic sustainability of a project (Abulameer & Abbas, 2020; Tan et al., 2018). Using less materials and less time has a positive effect on the costs involved with the redevelopment. If the implementation of adaptive reuse ensures that the time and materials involved with the redevelopment are less than with a "normal" development the implementation of adaptive reuse has a positive effect on the economic sustainable pillar.

"The costs of a development are roughly divided in, 25% structure, 25% facade, 25% installations, and 25% process"

(Translated from Dutch)
- Research participant RW (01) -

Bullen & Love, (2011) did research on the factors that added value in adaptive reuse in industrial heritage. Economic viability is a factor that they identified as a benefit of adaptive reuse of industrial heritage. They state that the economic viability after adaptive reuse would improve and have a positive impact on the sustainability objectives. The economic viability measures the economic benefit of the redevelopment project to the society. This benefit simultaneously focuses on the generation of local employment and new activities in the surrounding. Abdulameer & Abbas (2020) state that the job creation together with the business opportunities or either the economic impulses that are given by new companies are benefits of the economic sustainability of adaptive reuse. Remøy (2014) highlights the impact a monument has on cultural tourism, it can create a twofold multiplier process, where people spend money on accommodation, food and other activities that are related to the monument. If the adaptive reuse of industrial heritage incorporates these functions it enhances economic sustainability. In order to determine the economic sustainability of the redevelopment of industrial heritage, the actual financial feasibility says something about the continuity of the project and the parties involved in the project. Adams & Watkins, (2002) state that it becomes more essential to assess the financial feasibility of the redevelopment of industrial heritage due to the various challenges involved with it. If adaptive reuse in industrial heritage is financially feasible is a main value capturing mechanism that enhances economic sustainability.

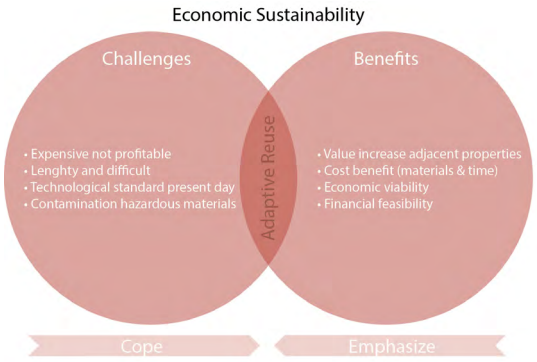


Figure 5: Challenges and benefits related to economic sustainability and adaptive reuse.

Social sustainability

Challenges

The concept of social sustainability in urban area development is upcoming and is rarely used in old city designs. Social sustainability in adaptive reuse stands for the combination of social principles for basic societal needs and social justice with concepts associated with wellbeing (Ikiz Kaya et al., 2021). Social sustainability is an important contributor to the continuity of the city, a city where people are happy and feel safe is more likely to grow. (Lami & Mecca, 2020) state that social sustainability is the place where people want to live and work, now and in the future. It is not only about meeting the needs of the people now, but being flexible enough to meet the social needs of future generations. Basiago (1998) defines social sustainability as: 'social sustainability' implies a system of social organization that alleviates poverty. In a more fundamental sense, however, 'social sustainability' establishes the nexus between social conditions (such as poverty) and environmental decay. Social sustainability is all about the people within the area, it is the community that feels included or not. Adaptive reuse in industrial heritage faces several challenges or barriers that are linked to the social sustainability of the project. Conejos et al., (2016) mentioned the social consideration which pertains to the intangible non-economic values considered to maintain the community's daily life as one of the main barriers that are linked to social sustainability. There are several other social sustainability challenges related to the adaptive reuse of industrial heritage. Chen (2020) mentioned urban development as development that is less accessible on peripheral areas of the urban fabric. These areas were increasingly more segregated from the city due to the growing rail yards and warehouses (Wrenn et al. 1983). It is not only a challenge to revitalize the area, but also to integrate this urban development into the existing city fabric. Barriers must be overcome to reestablish the relationship with the inner-city. Revitalizing urban with adaptive reuse of industrial heritage can connect parts of the city that were previously segregated within city boundaries.These areas are less developed and have less services. The adaptation of industrial heritage works as a catalyst effect for developments and upgrades in an area (Tam et al., 2016; Fitch, 1990). Also the reappraisal of industrial heritage gives more character to the area which makes the area more valuable.

Benefits

The adaptive reuse of old derelict industrial sites entails social benefits. Making an assessment on social sustainability is difficult because social sustainability is primarily focussed on how people feel within an area, or feel attached or related to physical surroundings. Social sustainability is all about the inclusion of groups in the community. Including groups in the community is possible by creating places that enhance the social interaction and social networks within the community. Dempsey et al., (2011) calls these places of social interaction that enhance the inclusion of groups in the community, community places. These places that enhance social cohesion contribute to societies for presenting future communities (Lister, 2000). Creating these community places within the adapted industrial heritage will enhance the social interaction/ social networks between the community members. As Lami & Mecca, (2020) stated, social sustainability is all about the place where people want to live and work, now and in the future. This also includes the safety and security within the area. Old derelict industrial building sites often attract illegal activities (Green, 2020). By

readapting the industrial heritage the area can be upgraded and the unfavorable area can become reappraised. Hence, the safety and security of the direct surroundings after the completion of the adaptive reuse enhance the social sustainability (Schilling, 2002). Safety and security contains the following factors; satisfaction with living in the area, avoidance behaviors, and the extent to which residents believe that they or someone else in the household is at risk of becoming a victim of burglary, pickpocketing, mugging or assault.

Chen, (2020) gave the inaccessibility of the industrial sites to the city fabric as one of the challenges related to the revitalization of post-industrial urban area development. Dempsey et al., (2011) already mentioned the creation of community space as a key assessment factor for social sustainability. To make the creation of community spaces accessible it is important to lift the barrier that most industrial sites separate from the city fabric. Increasing the accessibility within the redevelopment plan is essential for the success of the outcome of the redevelopment of the industrial heritage. Lifting barriers can be achieved by making the formerly closed asset more open and using materials that connect outside with inside (Wren et al. 1983). In certain cases, pre-investments in public infrastructure are necessary, such as connections, in order to ultimately arrive at a context in which you can really re-develop industrial heritage at a high level (W. de Vries, personal communication, 09 February 2022). Innovations naturally thrive on crossovers and encounters. If everyone locks themselves in their personal domain, this has negative consequences for their innovative capacity. On the one hand, you have to look for users that want to contribute to such a movement. Further, arranging coincidences and creating a place where these users have room for exchange and meeting. Arranging coincidences, industrial heritage could in principle lend itself very well as places for exchange and meeting (W. de Vries, personal communication, 09 february 2022).

Old derelict buildings affect the identity of the surroundings. Dempsey et al., (2011) describes pride and sense of place as one of the social sustainability factors that define the success of the redevelopment project. Lami & Mecca, (2020) already stated that social sustainability is about the place where people want to live and work. Nash and Christie, (2003) state that pride and sense of place is related to the integral component of residents' enjoyment of the place they live in. The pride and sense of place can be seen as the general living experience of people within a certain area. The assessment of the pride and sense of place give a general picture of living in a certain neighborhood. Satisfaction with the living situation indicates how pleasantly people live in the neighborhood and determines to a large extent whether people have plans to move. The assessment of pride and sense of place contains the following factors; housing satisfaction, and inclination to move.

"People feel that the building is aged, all footsteps set by others before resonate. It is a subconscious enthusiasm that cannot always be defined by people."

(Translated from Dutch)
- Research participant AB (10) -

Social participation based on the ladder of participation by (Wilcox, 1994) is one of the assessment criteria to assess social sustainability. The sequence of social participation is; information, consultation, deciding together, acting together, and supporting. To enhance social participation between stakeholders within a project it is important to at least reach the level of deciding together, in other words substantial participation. If users and other stakeholders of the asset are closely associated with the project from the start it contributes to the attachment of the place and asset. With substantial participation among stakeholders one can say that this enhances the social sustainability of the adaptive reuse of industrial heritage. Participation and establishing connections with involved parties in the process are essential. The perception that there is one theory of continuity which is the

continuity of change is changing. It is important to have a focused process with the stakeholders involved (R. Geelhoed, personal communication, 18 February 2022).

"I think it's really good for a place if buyers are involved early and become ambassadors for your development. Sometimes that is difficult, but it normally does contribute to the quality of a place."

(Translated from Dutch)
- Research participant GvH (15) -

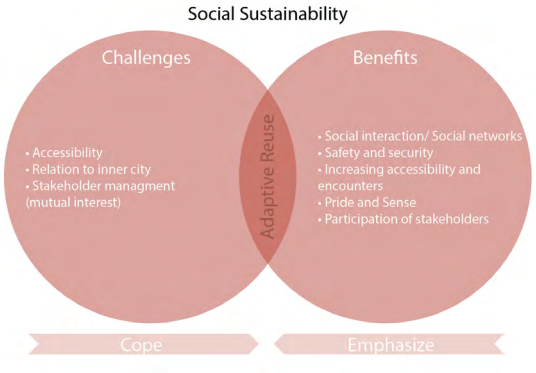


Figure 6: The challenges and benefits related to social sustainability and adaptive reuse.

Environmental sustainability

Challenges

Environmental sustainability relates mainly to safekeeping the environment and natural assets. Goodland (1995) defines environmental sustainability as the ability to maintain the physical environment by protecting the resources in an effective way that the limits of humans and environment are not exceeded. Environmental sustainability is becoming increasingly important, the building industry is a huge accumulator of natural and finite resources and is a major emitter of CO2 emissions. This is why environmental sustainability is more incorporated in the current designs. There are several challenges that can be linked to the environmental sustainability of the project. The former post-industrial practices in areas and the weak environmental standards of that time led to heavy metal soil pollution that affected the overall health of the area (Canevaro et al., 2019; Sousa, 2001). The heritage is often contaminated due to the hazardous materials that were formerly used in the buildings (Conejos et al., 2016). The degradation of industrial areas became a serious problem. Pollution control was nugatory, meaning there were no regulations on waste processing. This resulted in waste discharged in the ground, soil, and water (Wrenn et al., 1983). The industrial revolution valued the industrial areas for their important economic value, unfortunately the nefarious aspects of industrial practices only became apparent years later. Contamination of the soil is often a large cost item that puts severe pressure on the financial feasibility. Due to various factors most harbor activities moved, but some activities stayed and are still present in those areas. The maximum emissions they can emit is regulated by the EU and national governmental authorities, but can still obstruct new development. The peaks of pollution concentration that the industries are able to emit, together with the large scale background and the urban scale background can ensure the concentration of pollution to exceed the health risk threshold of 40 µg/m3 (Milieu -en Natuurplanbureau, 2007). Pollution and industrial sites are undeniably connected to one another, with the redevelopment of these sites regenerating the soil and assessing the quality of the air is undoubtedly needed. Beside the health risks that are associated with the pollution and affect the environmental sustainability of the project Conejos et al., (2016) mentioned that there is often limited support from building owners and commercial property markets in updating buildings to sustainability standards. This reduces the likelihood of reaching the environmental sustainable goals.

Benefits

The main natural assets are soil, water, and air. Chen, (2020) mentions pollution as one of the challenges old derelict industrial sites face. It is likely that these areas still house industrial functions that emit and pollute the area to a certain extent. In the past there were no regulations on waste discharging, which resulted in companies discharging waste in ground, soil, and water (Wrenn et al., 1983). Nowadays

there are regulations on waste discharging and on current levels of thresholds related to health risks. Whenever developments take place the area has to be remediated. Foster & Kreinin, (2020) state the diminishing of health risks by hazardous contamination in the threefold of natural assets, a key environmental indicator of direct environmental improvements due to implementation of adaptive reuse (Sousa, 2001). Adaptive reuse of industrial heritage contributes and is a benefit to environmental sustainability.

Foster & Kreinin, (2020) state that the reduction of construction and demolition waste to the landfill, through the recovery and the reuse of the asset by adaptive reuse, which then results in the increase of land use efficiency as a key environmental sustainability factor. Preserving the industrial heritage results in mining less natural and finite resources than related to new constructions. Bahl, (2005) mentioned that 85% of the embodied energy of materials is in their production and transportation. Adaptive reuse enhances the embodied energy and will ensure that less waste is created.

Public infrastructure as environmental sustainability benefit is an important observed impact of adaptive reuse (Dane et al., 2019), The building/ area should have adequate infrastructure which minimizes negative environmental impact. The incorporation of public infrastructure enhances environmental sustainability. Enhancing the environment is an environmental sustainability benefit for the adaptive reuse in industrial heritage buildings (Abdulameer & Abbas, 2020). This enhancement of the environment in adaptive reuse is mainly about the quality of the space on an environmental level. The quality of the space contains the following factors; clean, pavements, parks, road safety. Greenspaces give room for flora and fauna and reduce the urban heat effect which results in a better climate and so environmental sustainability. If adaptive reuse in industrial heritage incorporates these design solutions the environmental sustainability is amplified.

The energy performance of adaptive reuse enhances environmental sustainability. If the gas consumption, CO2 emission and primary energy use of the adaptive reuse is low the building has a high energy label. The energy label for buildings is a mark that classifies the comfort and energy use of the asset. Currently the energy labels for redevelopment run from G (very high energy consumption) to A (very low energy consumption). Dane et al., (2019) give energy performance as one of the main success factors of the outcome of adaptive reuse of industrial heritage. If the energy label is high, the redevelopment is very energy sufficient and has little to no impact in its use phase. In the past, buildings were primarily based on function. Comfort was often slightly subordinated and not included in this.

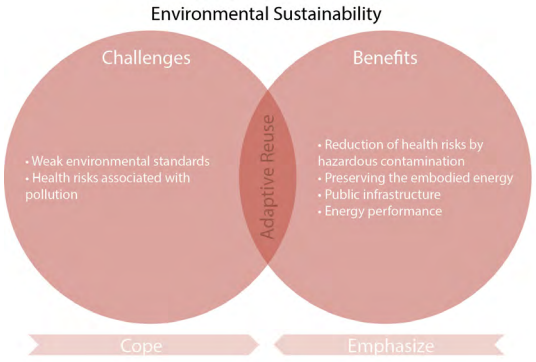


Figure 7: Challenges and benefits related to environmental sustainability and adaptive reuse.

Stakeholder management

Revitalizing urban areas and the adaptive reuse of industrial heritage is a complex and unique problem where numerous stakeholders are involved. Stakeholders are all the parties and persons that are affected by, or affect the project themself (Nutt and Backoff, 1992) or those individuals or groups who depend on the organization to fulfill their own goals and on whom the organization depends (Johnson and Scholes, 2005). All stakeholders have different demands and perspectives on the project. Parmar et al. (2010) states that in stakeholder management one should focus on the mutual interest rather than focussing on the trade-offs. By focussing on mutual interest it is more likely that value is created for all parties. The high complexity of urban development necessitates

the cooperation and collaboration of various stakeholders. It is the goal of the municipality to meet the demand for housing, the creation of new economic sectors, and safeguard public values. Meanwhile, it is the objective of market parties to magnify their portfolio and make profit on the development (Franzen et al., 2011). On the other hand, the end-user and the community around the redevelopment should be satisfied. All stakeholders have different wishes and needs which makes it hard to coordinate all these perspectives. Stakeholder management is of high priority to establish a well designed process. It should be clear what the typology of the stakeholder is (attitude-power-interest). Successful stakeholder management ensures potential problems to become foreseeable and easily addressed (Bryson, 2004). Public and private parties have to find a common goal and common ground to care for urban space that is designated for the community (BenDor et al., 2011). It is therefore important for stakeholders to find mutual interests, and to satisfy the community in the revitalization of the industrial area. Safeguarding participation with the community will ensure the success of the project. Talking with them and ensuring the wishes and needs of the community will help for a successful outcome of the redevelopment project. In an office park, the neighbors have a much greater economic importance by the redevelopment than a residential area. They are different stakeholders with whom you have to speak and make different agreements. In an urban or residential area there are more people who are associated with the development. With a large number of people, the importance is somewhat smaller. Adjacent companies or residents to the redevelopment should be included in the plan as early as possible. “Let them be part of the redevelopment plans and let them feel connected to them” (E. van Holland, 07 October 2021).

In order to create an overview of the stakeholder involved in a project, an extensive stakeholder mapping must take place. Identifying stakeholders is the first step, subsequently it is important to conduct a proper stakeholder network analysis and display how stakeholders are interrelated (Bryson, 2004). The network analysis prioritizes the influence of the stakeholders on the basis of their possession of certain attributes such as power, interest, and stance towards the project. In addition the dependency and potential issues of stakeholders are identified.. The decision about how to define stakeholders is consequential, as it affects who and what counts (Mitchell et al. 1997). There is no blueprint for which stakeholders are involved in the process of revitalizing urban areas. Per project the number and the sort of stakeholder can differ. Due to interruptions, variations or either uncertainties the stakeholder can change or the network how stakeholders are related can shift.

The adaptive reuse of industrial heritage processes consist of an iteration of multiple phases defined by the value chain. When buildings are derelicted and underused the phases of the value chain are seen as repeating process where buildings are used again (see figure 8). In order to go through the process of redeveloping industrial heritage, stakeholders have to work together. Every phase of the adaptive reuse process comes with different stakeholders. Some stakeholders are present in multiple phases and some only in one.

Stakeholders are divided into three different groups. For further clarification in this research, the stakeholders are divided into private stakeholder, public stakeholders, and community stakeholders. All stakeholders have the main goal to create or effectuate a successful redevelopment, only their definition of a successful project can differ. In general, the success factors for all public stakeholders are fairly overlapping, the same applies to private stakeholders, and community stakeholders (Franzen et al., 2011). In general the goal of private parties is to enlarge their portfolio and make profit on the (re)development, whereas public parties do focus more on the social impact of projects (Franzen et al., 2011). Public and private stakeholders must find

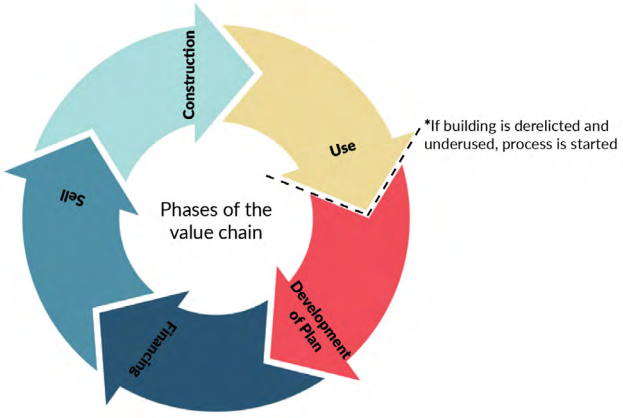


Figure 8: Phases of the value chain, with the adaptive reuse of industrial heritage the value chain becomes a repeating process of steps (own figure)

common goals and common ground to care for urban space (BenDor et al., 2011). It is at the end the community stakeholder that uses the redevelopment, and those wishes should be included in the redevelopment plan. All stakeholders can influence the decision-making process of urban redevelopment projects due to their interrelationship. They are all linked to each other which makes them able to exert force to the project team throughout different levels. The stakeholders in the center form the project team and make decisions on the outcome of the project. The stakeholders at the periphery of the diagram are less involved but can indirectly, through other stakeholders, exert force on the project team (Yang, 2014). Figure 9 gives an schematic overview on how the relationships between different stakeholders work within an urban development project.

Adaptive reuse in industrial heritage has a great abundance of stakeholders, all these stakeholders adopt different approaches to sustainability, based on diverse definitions and perceptions, and the means to achieve this. These differences affect the decision making in the design process (Herazo & Lizarralde, 2016). The abundance of stakeholders for adaptive reuse does not severely differ from other development projects. Stakeholder management is focussed on finding mutual interest and common ground to reach the goals and create value for all involved parties. Stakeholder management is different for each project and can differ substantially per project (Hörisch et al., 2014). There are criticized views where they argue that the trade-off always exists. In the context of sustainability management it is important to overcome the trade-offs. The gravity of sustainability asks for trade-offs between stakeholders' perceptions to deal with the sustainability issues. Schaltegger & Synnestvedt, (2002) mention that the ideas of profit-making go hand in hand with the consideration of social and ecological issues. One should create synergies between different interests of stakeholders. Applying sustainability management, sustainability should be the core value around which stakeholders cooperate (Hörisch et al., 2014). The core challenges are;

- Anchoring sustainability in the mindset of all stakeholders.
- Creating mutual sustainability interests based on the particular sustainability interests of single stakeholders.

If one translates the perspectives of stakeholders to the sustainability pillars, one can identify different views on the pillars of sustainability. To achieve sustainable development there will always be a trade-off between several factors. All stakeholders strive to achieve economic sustainability, public parties focus on how the adaptation of the asset will enhance the surrounding and have an indirect economic impact, whereas the private parties will focus on the direct economic impact of the redevelopment. Generally all stakeholders enhance social sustainability and community stability to ensure project success (BenDor et al., 2011).

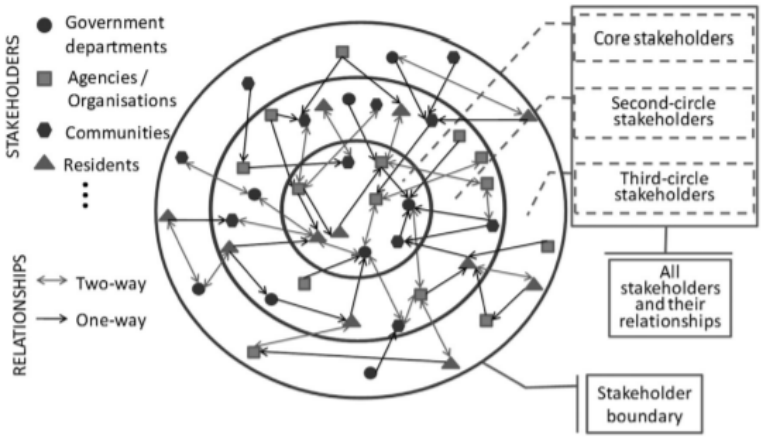


Figure 9: Schematic model on stakeholder relation within urban development. Closer to the center means more power than closer to the periphery of the stakeholder boundary (Yang, 2014).

Research participant JDK(03) works as a monument inspector at the municipality of Rotterdam, when heritage or monuments are being initiated for adaptive reuse he is the one that assesses the plans to protect the industrial legacy. Because he works at the municipality of Rotterdam, and is part of an advisory body of the "college of B&W", he also takes into account the housing issues within the city. In his job he has to make many trade-offs between preserving the heritage and the demands that the municipality faces. If he is not there, there is no one to represent the interests of the heritage. This example shows the complexity of the stakeholders within the redevelopment.

"I see myself primarily as a monument steward, that you almost speak on behalf of the monument and represent the importance of the monument, because the monument itself can't talk."

(translated from dutch)
- Research participant JDK (03) -

Financing adaptive reuse in industrial heritage.

Heurkens et al. (2020) state that it is essential for complex urban transformation projects to make a financially feasible business case. This is a case where at least all the incurred costs should be recovered from the yield, and that there are adequate safeguards against risks (Franzen et al., 2011). Preservation of industrial heritage can only be assured if it has an economic, profitable, or socially acceptable purpose. Many industrial monuments do not meet the generally experienced notion of 'beauty' and therefore still lack broad support among the population (Nijhoff, 1994). Adaptive reuse in industrial heritage is often less attractive for investment due to the challenges and uncertainties that these areas face (Chen, 2020; Conejos et al., 2016). The costs in adaptive reuse have two different aspects; acquisition cost and construction costs. The costs for acquisition represent the price of the land and the building. The construction costs represent the costs for redevelopment. The construction costs can be divided into "hard" and "soft" costs. Where the "hard" costs are the contractors responsibility and the "soft" costs comprise costs complementary to the construction. Industrial heritage without monument status has more freedom in adapting the building to accommodate new functions. However, the object will have to withstand the exploitation with new construction. These less desirable locations have the advantage of lower acquisition costs. Adaptive reuse of industrial heritage is therefore highly dependent on a new function that guarantees anchored exploitation (Nijhoff, 1994).

"If the actual residual value after transformation does not come close to the purchase amount, you have to start puzzling and therefore you have to search longer for alternative options"

(translated from dutch)
- Research participant RG (14) -

Austin et al., (1988) mentioned that normally the construction costs in adaptive reuse are lower than new constructions,

although the process of adaptive reuse is more labor intensive. When adaptive reuse tends to cost more than new constructions there is still an added value, considering the catalyst effect for revitalization (Tam et al., 2016; Fitch, 1990). Urban revitalization is a long-term project that involves large and unforeseeable risks (Franzen et al., 2011). A useful tool for not exceeding cost is the risk management process within a project by G.M. Winch, (2010). First the risks that are accompanied to the redevelopment are identified, then they are assessed, then you respond to them, and after you respond to them you control the risks. The risk management process reduces unforeseeable costs and makes the business case more attractive.

Financing adaptive reuse and the development of urban areas has great impact on the interrelationship of the myriad of stakeholders, especially the interrelationship of the public and private. The definition and perspective of a successful project can differ between various stakeholders (Shenhar et al., 1997). Public parties are more likely to take greater risks if social benefits are noteworthy. Private parties are primarily focussed on making profit and reducing and managing risks (Franzen et al., 2011). It is likely that stakeholders increase the amount of square meters or add more valuable functions in the industrial heritage to create a financially feasible business case. Enhancing sustainability contributes to the success of the redevelopment but comes with major expenses. Incorporating sustainability factors is an interplay between cost and revenues, and will depend on the technical state of the asset and the stakeholders stance towards this.

Due to the complexity of urban development and the adaptive reuse of industrial heritage in inner cities, these projects need serious and long-term investments. Adams & Watkins, (2002) state that it becomes more essential to assess the revitalization of urban areas with industrial heritage on financial feasibility. The development of brownfield locations comes with a lower financial feasibility, which makes it less attractive for market parties to develop (Chen, 2020; Conejos et al., 2016).

As stated adaptive reuse in industrial heritage has several challenges that put severe pressure on the financial feasibility of the project. These challenges and uncertainties make investors and developers less eager to develop the case due to the lower profit margin (Verheul et al., 2017). There are financial barriers that have to be overcome to make the project economically sustainable (Conejos et al., 2016). Gaps within the land expropriation necesitate major pre-investment to ensure the continuity of the project. If land expropriation costs, due to the complexity and the former use of the project, become higher there will be a lower profit margin. In order to increase the financial feasibility of inner city urban developments it is important to reduce costs or increase the revenue of a redevelopment project. This interplay between the costs and the revenue is called the optimization potential (Heurkens et al., 2020). Derived from de Zeeuw (2018) table 1 gives an overview of examples on reducing cost or increasing the revenue in urban development. These optimization potentials are tools to make the adaptive reuse in industrial heritage financially feasible or magnify the profit margin. When optimization potentials are taken into account, it can still occur that cases are not financially feasible. Since the 70s, there has been financial support from the government for inner city developments. This financial support was made available by the government to ensure continuity of inner city development by reducing the land expropriation costs for private parties, and to tackle the problem of unprofitable development. Without governmental incentives it is challenging to create financially feasible business cases. Incentives are needed in order to develop sufficiently within the city fabric. In addition to the subsidies and public funds there are private financial instruments that are used in the revitalizing of urban and industrial heritage. Investors in sustainable developments have the possibility to make use of tax and interest incentives. This tax incentive makes borrowing money

Table 1: Optimization potential to increase the financial feasibility of urban transformations (Heurkens et al., 2020).

Reduce costs	Increase revenues
• Reduce parking standards and smarter (bundled) organizing parking. • Avoid expensive technical environmental and quality facilities/requirements that are not substantially contributing to environmental quality. • Maintain existing infrastructure, giving no costs for shifting cables and pipes. • Prioritize in archeological research, excavations and preservation. • Cheaper and more function-oriented soil pollution remediation. • Inventive mixing of demolition, conservation/preservation and transformation.	• Reduce the share of social rental properties. • Make the program more competitive (wishes of end users) in terms of function mix, urban design, housing typology, design public space and parking. • Inventive dealing with water storage can lead to value creation and more efficient use of space. • Income from temporary or continued use can affect exploitation and contribute to value creation by positioning areas. • Research land use and programs critically, and search for the optimal balance between compaction (expanding real estate program), high-rise and dilution.

more favorably, and makes the return on investment better for the investors. With the regulation the government encourages "green" investments in the development of sustainable and innovative (construction) projects. As a result, green funds (banks) can offer loans at a lower interest rate than the market interest rate. Investors in green projects benefit from this (Belastingvoordelen bij groenfondsen | RVO.nl | Rijksdienst, 2021).

Due to the high complexity and long-term investments of revitalizing urban and industrial heritage, it can be less attractive to initiate and invest in these developments. Creating a financially feasible business case for adaptive reuse in industrial heritage is hard. Hence there are various different forms of funding sources. The most common funding sources in adaptive reuse are the; private equity, bank, investors, subsidies and crowdfunding (Gelinck & Strolenberg, 2014). Heurkens et al. (2020) emphasizes that to start urban area transformation development, organizing sufficient amounts of financing is one of the main conditions that have to be met.

Private equity

It is possible that the initiator of adaptive reuse uses their private equity as venture capital. Using private equity comes with many risks but can be a powerful tool for groups to reach a common goal and generate economic and societal value. Private equity can come from the initiator or project partners in the project.

Bonds or Loans

A bond is a loan in the long term. The bond has a fixed interest and is paid back at the end of the duration of the debt certificate. With the debt certificate the lender can collect the interest of the bond at any time. Chen, (2014) states that the use of bond financing is justified by the rationale of spreading out the costs of public investments through the period of bond repayments. Another benefit of bonds is that the revenue of bonds is normally exempt from governmental taxes. A loan is when a bank lends money to developers for a certain time period. The developer will pay monthly or yearly interest over the amount that is lent from the bank. For sustainable developments there are regulations in place that reduce the interest rate of the loan. A lower interest rate on a loan results in a higher return on investment for the investor. The government encourages these developments by tax incentives that compensate for the normally lower return on investment (Belastingvoordelen bij groenfondsen | RVO.nl | Rijksdienst, 2021).

Investors

By sharing the investment between stakeholders the risk will also be shared. This gives more financial security and security on the project's continuity. Financing by project partners is a common form of financing. The project partners become more involved in the content of the project. The success of the project also becomes their importance, delays and loss of rent as a result of improper renovation also become their problem. In May 2014, major insurers, pension funds and pension

providers announced that they would invest billions of euros in the Dutch economy by participating in the National Investment Institution NII (Gelinck & Strolenberg, 2014).

Subsidies

Subsidies can be the solution to safeguard the continuity and the feasibility of the complexity of revitalizing urban and industrial heritage. It is the artery of inner city development. Subsidies are tax money that will only be used for urban renewal if the subsidy is equivalent to the social benefits of the project (Nourse, 1966). The goal of subsidies is to make an inclusive city where social and public values are safeguarded (Franzen et al., 2011). These goals of governmental authorities weigh seriously when incentives are granted. A private initiative normally yields more money. But it is also difficult to profitably exploit adaptive reuse in industrial heritage. Subsidy is a tool to get these developments off the ground. Besides subsidies, governmental authorities can give other incentives such as the possibility to add square meters to make the business case financially feasible (W. de Vries, personal communication, 9 February 2022).

Crowdfunding

Crowdfunding is a relatively new way of funding the revitalization of urban areas. Crowdfunding in urban renewal is the collection of social money. This financial instrument is only used for financing (smaller) real estate and urban development (Verheul et al., 2017). This financial instrument is used primarily in developments with a strong social-cultural character. It can be used as a financial instrument for place-making and give an impulse for urban renewal.

Due to the unique and complex character of revitalizing urban and industrial heritage, there is no single best solution for the implementation of a certain financial instrument. A decision must be made on which financial instrument is best suitable and which parties see a profitable and feasible business case.

Added value of adaptive reuse in industrial heritage.

Buildings are designed and constructed with particular functions in mind. With most industrial heritage, the function is linked to the industrial era wherein the building is commissioned. Due to the changing economy it is likely for buildings to deteriorate and their functions to change. Hereby the function of the building becomes meaningless and the building becomes vacant, due to the de-industrialization and the move of functions to another part of the city or other countries within Europe (Canevaro et al., 2019; Pike, 2009). The industrial heritage became useless for their original function. Wilkinson & Remøy (2015) state this deterioration and the vacancy of the assets is a result of distribution of functions. The urge and the interest for adaptive reuse is rising. Society realizes the ecological waste associated with new development, and simultaneously witnesses the loss of industrial and historical heritage (Cramer & Breitling, 2007). Preserving this heritage means less ecological waste and an extension of the building's life which means no loss of industrial and historical legacy. Furthermore, Yung & Chan (2012) mention that adaptive reuse encourages the reappraisal of the embodied energy in materials and the social and economic benefits to the society.

"All these buildings are collapsing, but in fact, the population is collapsing simultaneously. What used to be a source of income, what they were proud of, what they identified with, evaporated. One should not underestimate the effect on the self-image of people and a community."

(Translated from Dutch)
- Research participant WdV (09) -

Plevoets & Van Cleempoel (2013) give three reasons why we should reuse the vacant existing building stock: there is a need for sustainable development patterns, we should create less costly physical architecture and we should be aware of the benefits of retaining architectural heritage.

Modifying the existing building stock and housing new functions in it, is a strategy to conserve the heritage that we created over the years (Jessen & Schneider, 2003). Transforming industrial heritage through adaptive reuse can be seen as an injection for the local community and the surrounding area. The revitalization of an area with the presence of industrial heritage can create a positive impact by bringing new economic or cultural activities within the area. It attracts a new inflow of people that ensures vitality to the depreciated areas (Tam et al., 2016). The reappraisal of industrial heritage can often be seen as a catalyst for further development (Bazelmans, 2013). The juncture of redeveloping industrial heritage is an important factor. This affects the financial return and the continuity of the revitalization of the area. The sooner you redevelop, the more money you probably have to put into the project. The longer you wait for other developments and the upgrade of the area, the more it can yield. The yield of the redevelopment has to be seen on a larger scale than the industrial heritage (W. de Vries, personal communication, 09 February 2022).

Figure 10 is a visualization on the two different phases adaptive reuse of industrial heritage can take place. Industrial heritage becomes vacant and underused due to various reasons which negatively effect its surroundings. Adaptive reuse in industrial heritage can take place as a pioneer or as a climax. If the adaptive reuse of the industrial heritage takes place as a pioneer, the assets are repurposed and redeveloped which can result in a catalyst effect for the revitalization of the urban area. If the redevelopment took place, it is likely that new development follows and the area will be restored to its original value but with a different function. Besides the adaptive reuse of industrial heritage as a pioneer it can take place as a climax. In this case the area is being revitalized and slowly becoming more accessible by development that takes place. The adaptive reuse of the industrial area can then be seen as the climax of the revitalization of the area. This method is not dependent on people or companies to move to the area but can be seen as a crown on urban area development (W. de Vries, personal communication, 09 February 2022).

Martinović & Ifko (2018) states that the adaptive reuse of industrial heritage is a great basis to incorporate sustainability. The reappraisal of these sites are a catalyst for further urban revitalization due to their societal, historical, architectural and technological importance. Transformation of industrial heritage can act as a catalyst to transform entire areas. Industrial buildings and monuments nevertheless have a certain appearance. People make use of the building or sit near to the building because it is a good and nice place. The presence of people attracts social and economic value, which results in not only the building to increase in value but also the image of the area (J. Semijn, personal communication, 12 November 2021).

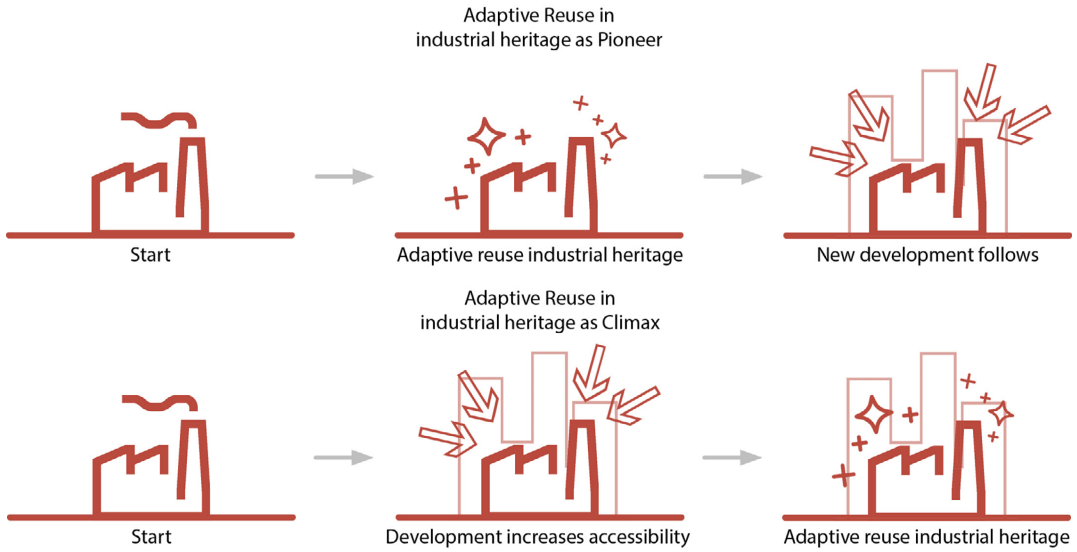


Figure 10: Visualization of adaptive reuse in industrial heritage as pioneer and as a climax (own image).

Figure 11 shows the concept of the catalyst effect, where the industrial heritage is adapted and the direct surroundings of the redevelopment of the industrial heritage will become more valuable. It is widely accepted that redeveloped industrial heritage adds value to the surroundings (Domingo, 2015). The urban catalysts promote developments in adjacent urban areas which lead to economic, social, and environmental revitalisation of the area (Sun et al., 2019; Sternberg, 2002). The added value that is created by the industrial heritage is an intrinsic value that is caused by the appearance of the asset itself. This intrinsic value or non-use values are indirectly related to the industrial heritage as a public good; it is non-excludable and nonrival in consumption (Choi et al., 2010; Greffe, 1999; Navrud & Ready, 2002).

Figure 11: Reappraisal of industrial heritage and the catalyst effect (Persoon, 2019).

Li & Brown (1980) show a relation between heritage and the added value that decreases when the distance from the center of the industrial heritage increases. When adjacent properties are close to the center of the non-residential activity, the increase in value is more as when the distance to the industrial heritage increases (see figure 12). This accounts for industrial heritage that is good accessible and has a positive effect on its surroundings. The exact opposite effect is seen if the asset is not well accessible, underused, and in decay. Then the industrial heritage has a negative effect on the value dispersion around the asset, equivalent to the industrial heritage with a positive effect, when this distance increases the negative effect on the value decreases (Bazelmans, 2013; Li & Brown, 1980). They state that these negative effects decrease more rapidly than the positive effects. Sites that are abandoned and are in decay, result in lower property values for neighboring properties. The lowering of the neighboring property value results in the vacancy of these assets. The vacancy of assets is again lowering the property value together with other negative effects (Greenberg, 1998). This result is a vicious circle that an area can suffer dearly from if there is no incentive in the form of (re)development. This displays that adaptive reuse in industrial heritage can have a huge impact on the value distribution and dispersion. In this research the value distribution as in what are the factors that add value to the industrial site will be more central than the dispersion of added value.

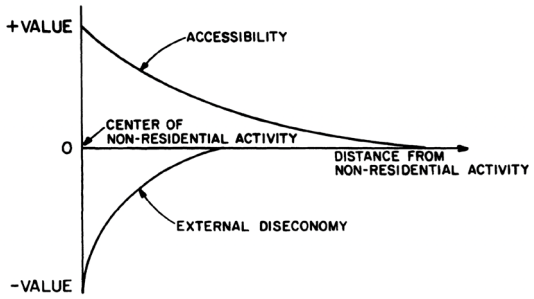


Figure 12: Value dispersion of heritage buildings on its surroundings (Li & Brown, 1980).

The direct surrounding of a new (re) development is arbitrary and hard to define. The dispersion of value can be different for various different projects and is related to the scope of the transformation (de Vor & de Groot, 2011). Kaufman & Cloutier (2006) state, as the distance from the development increases, its impact decreases. The closer to the vacant and derelict industrial sites, the more negative effect it has on the value of residential assets (de Vor & de Vor, 2011). This devaluation of assets which are near brownfields are normally less problematic within a dense urban context. The former industrial sites are often seen as ghettos where out-migration, social isolation, drug use and lack of services are everyday problems (Green, 2020). The problems have the opposite effect and are worse closer to the vacant and derelict asset. These problem areas are completely secluded from the services that the city fabric provides. Previously health status was assessed by environmental factors, especially hygienic conditions and housing standards (de Hollander &

Staatsen, 2003). Because these factors became more regulated, the health status assessment shifted towards more socio-economic, spatial and environmental factors. These ghettos that are described by Green (2020) are sufficient if you look at the socio-economic, spatial and environmental assessment stated by de Hollander & Staatsen (2003). Especially the more socially disadvantaged groups are situated in these old industrial sites where their (social) health status is lower (Pearce et al., 2006).

Due to the growing obsolete building stock the emphasis is more on adaptive reuse. Bullen & Love (2011) state that environmental, economic and social sustainability are important but are not the main driver for why adaptive reuse is the best solution to incorporate. These factors are seen as output instead of input for the redevelopment. So why developers choose for adaptive reuse is largely because of the capital investment and the creation of a feasible and viable business case. Regeneration of industrial sites can often lead to an increase in economic, social and environmental value (Guo et al., 2021). The new function of the building may have a much higher value to the ground. Although considerable costs have to be incurred, there is often a net value increase in the area directly surrounding the redevelopment. Research shows that after incentivizing urban area (re)development there will be an increase in value in the area (Gielen, 2011). The farther from the source of the adapted industrial heritage the more the value is dispersed. In other words, this is the catalyst effect previously explained. By redeveloping industrial heritage the direct surrounding of it profits from the development. The reappraisal of these industrial sites ensure the inclusion to city fabric again, redeveloping abandoned and derelict industrial sites diminishes the negative effect on value dispersion (Gielen, 2011; Guo et al., 2021). Adaptive reuse in industrial heritage has a positive effect on the value of the properties adjacent to the industrial heritage (Li & Brown, 1980). In addition, the reappraisal of the old derelict industrial sites has a positive effect on the (social) health status of the area and the people within.

The results of the catalyst effect on the heritage value can be seen in three pillars of sustainability. If industrial heritage is transformed, added value becomes notable in economic, social and environmental, sustainability (Cooper, 2001; Guo et al., 2021). Mısırlısoy & Günçe (2016) say that adaptive reuse strategies promote sustainable development, that the preservation and the reappraisal of industrial heritage ensures economic, cultural and social benefits in the urban community. Sustainable development is defined by the equilibrium of the three pillars of the triple bottom line of sustainability (Parkin et al., 2003). These pillars are the criteria to capture the success and output of the redevelopment. Parkin et al. (2003) says that over the years the perspective changed from preserving our industrial legacy to making this industrial legacy part of our urban area developments.

Building on what is there instead of demolishing and starting over saves sociologically seen from mistakes. It is easier to add layers to the city to diminish the likelihood of mistakes. New developments come entirely from the people of today. That is why it is better to continue building on what is already there (W. de Vries, personal communication, 09 February 2022). By preserving industrial heritage within the concept of adaptive reuse the function is replaced which reduces the energy, waste, and building resources. Figure 13 shows the streams of environmental loads that are related to the different ways of redeveloping old building stock. If the building stock is suitable for adaptive reuse and one enhances this there is much less environmental load associated with the redevelopment of the industrial heritage (Sanchez & Haas, 2018). By revitalizing this industrial heritage and preserving landmarks the street scene creates social benefits for the surrounding (Conejos, Langston, & Smith, 2011). It is therefore extremely important to embrace this development method.

"I see a positive influence of adaptive reuse of industrial heritage both on the social component, but also in the economic value increase of everything that surrounds it."

(Translated from Dutch)
- Research participant EvH (04) -

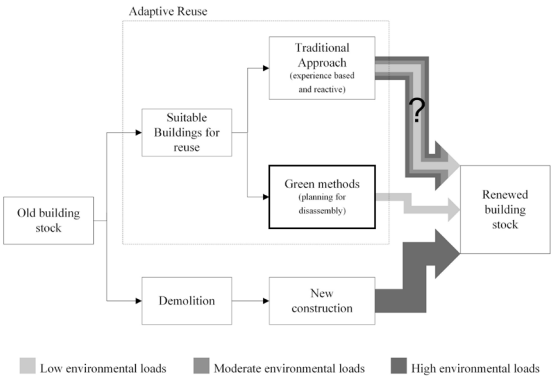


Figure 13: Adaptive reuse and the reduction of environmental burdens (Sanchez & Haas, 2018).

Related to the asset condition that is given as a key criteria to examine adaptive reuse decision making by Bullen & Love (2011), Brand (1995) came up with the famous "shearing layers of change" in this concept he explains how the different layers of a building work and how long they should last. The structure should normally last 30-300 years but few buildings make it past 60 years. If we look at our industrial heritage, in most cases it became obsolete after less than 100 years. Research participant RW(01) emphasized the importance of preserving old buildings due to the rough cost distribution of (re)developments. With preserving the old structure one can save 25% on the budget that can be spent on different factors. With adjustments we can preserve the structure that we created years ago. Adaptive reuse is a unique and complex problem. Due to the unique structures of the industrial heritage there is not a single best solution for adaptive reuse. Some of the assets need minor adjustments to house a new and better function. Whereas other buildings need major modifications. Despite this uncertainty most industrial heritage has great potential for adaptive reuse. With adjustments in industrial heritage the environmental footprint can be reduced, new economic sectors can be added and it can cope with the rising housing demand. The existence of models to assess the potential of adaptive reuse confirms the complexity of the adaptation of adaptive reuse in industrial heritage. A framework to assess the potential of adaptive reuse does not limit opportunities but rather reveals what projects can be most viable. Available frameworks consider the current status of heritage and its potential for adaptive reuse but do not take into account the output and success of the redevelopment.

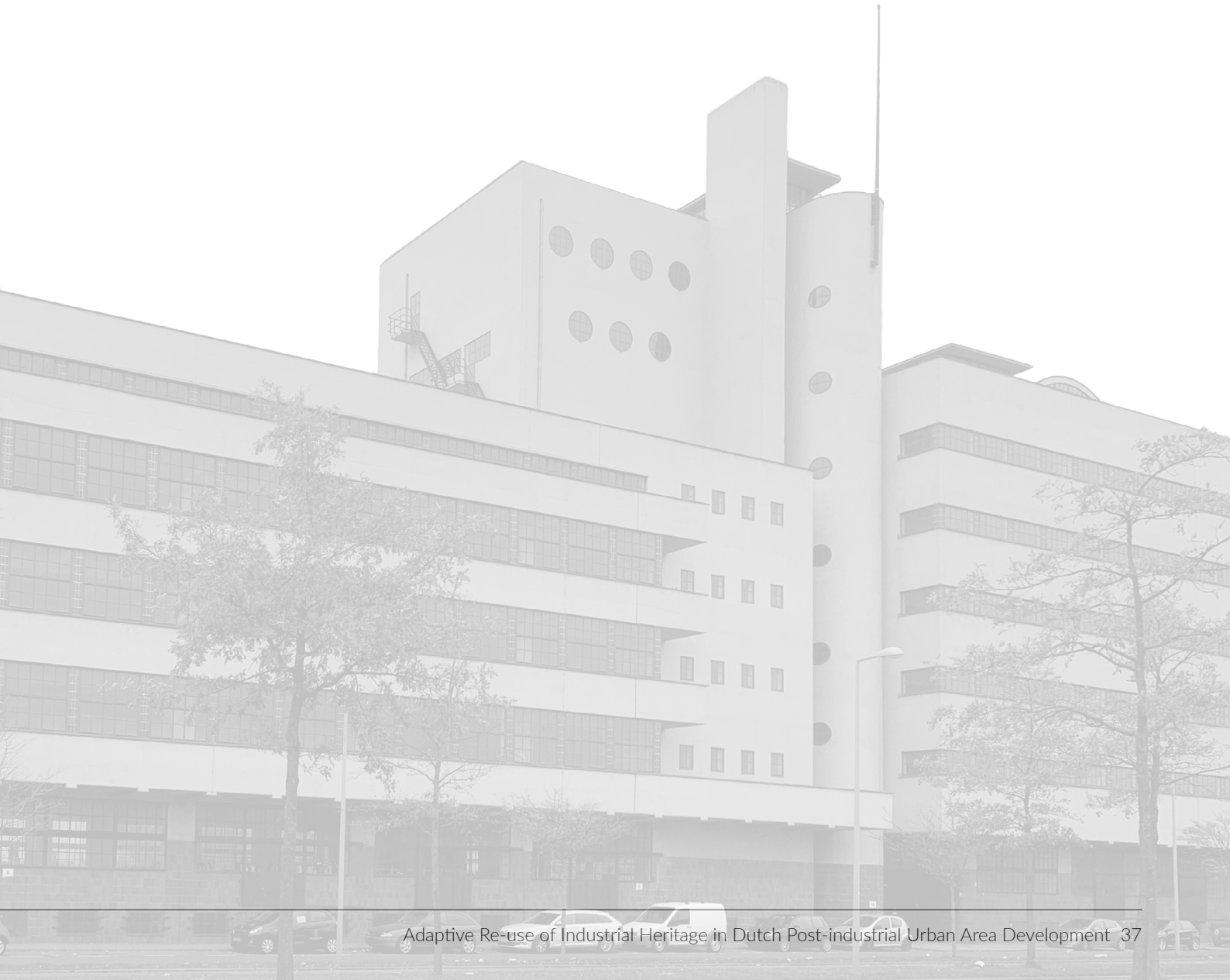
Main findings literature study

The main findings that relate to the adaptive reuse of industrial heritage in post-industrial urban areas are supported by literature. It presents knowledge on facilitating factors and inhibiting factors that affect the process of adaptive reuse in industrial heritage. Urbanization, modernization, and population growth, together with the vacancy of the industrial sites and the expanding power of the city that has been reached are the facilitating factors that effectuate adaptive reuse in industrial heritage. In addition to the facilitating factors there are inhibiting factors that thwart the redevelopment. The main inhibiting factors are related to the sustainability pillars of sustainable redevelopment and are defined as challenges and barriers. If the development is done well, the sustainability benefits outweigh the challenges and barriers. Sustainability in adaptive reuse in industrial heritage is an interplay between the sustainability benefits and challenges. If one copes with the challenges and emphasizes on the benefits, sustainability in adaptive reuse of industrial heritage is likely to be achieved. The combination of the facilitating factors and inhibiting factors is the approach for revitalizing post-industrial areas. The adaptive reuse of industrial heritage is complex but enhancing adaptive reuse of industrial heritage has a positive impact on the surrounding and the three sustainability pillars; economic, social and environmental sustainability.

The added value that is related to the adaptive reuse of industrial heritage is higher closer to the redevelopment and

disperse if the distance increases. Although the adaptive reuse of industrial heritage has a positive effect on its surroundings, the success on sustainability of the project is dependent on different factors. Due to the one of a kind structures all adaptive reuse projects differ, which means that the design, decision-making process, stakeholders involved and the financial instruments used differ as well. This can have a significant impact on the added value of adaptive reuse in industrial heritage. Subsequently the moment of initiation is important to the success of the revitalization of the urban area. Adaptive reuse of industrial heritage can be performed as a pioneer project or as a climax project in the revitalization of urban area development.

The success of the adaptive reuse of industrial heritage on its sustainability is dependent on how the sustainability benefits in the adaptive reuse of industrial heritage are perceived. The sustainability benefits are supported by literature and are all-encompassing, substantiated instruments to display the success of sustainability. Adaptive reuse in industrial heritage should be embraced to cope with the demand of housing and new economic sectors. Simultaneously the inhibiting factors should be overcome to actually redevelop these assets. If adaptive reuse in industrial heritage is actually performed, the benefits related to it and the way they are perceived can display the actual sustainability of the project. The sustainability that the industrial heritage itself comprehends disperse and influence the industrial site.



METHODOLOGY

To answer the research question and to achieve the goals and objectives set for this research, evidence-based empirical research is conducted. The research consists of literature- and practice-based research. The literature-based research establishes the theoretical frameworks on which the practice-based research is synthesized and cross examined. The practice-based empirical research consists of case studies substantiated with interviews within the field of urban area development and adaptive reuse in industrial heritage. The case studies and interviews are examined to test the economic, social, and environmental sustainability and feasibility of the adaptive re-use of industrial heritage. In this section, the conceptual framework that works as a guideline for the thesis and the research design/method are presented.

Conceptual framework

The conceptual model of the research is displayed in figure 14. The model is a blueprint for the research and shows the context factors for the revitalization of post-industrial urban areas. These drivers and show the urge for the redevelopment. In addition to the context factors the revitalization of post-industrial urban areas comes with the challenges and barriers that inhibit sustainability. The inhibiting factors are linked to the sustainability factors and make the redevelopment difficult to perform. Revitalization of post- industrial urban areas is an interplay between the two types of factors. If the development actually takes place it comes with the adaptive reuse of industrial heritage that is still present in these areas. Here the main research is composed, how do implementation methods and financial instruments in adaptive reuse of industrial heritage, in post-industrial urban area development relate or add value to the redeveloped industrial site, in regards to economic, social, and environmental sustainability. These three sustainability factors are together the assessment of the actual sustainability of redevelopment projects and are called the triple bottom line of sustainability.

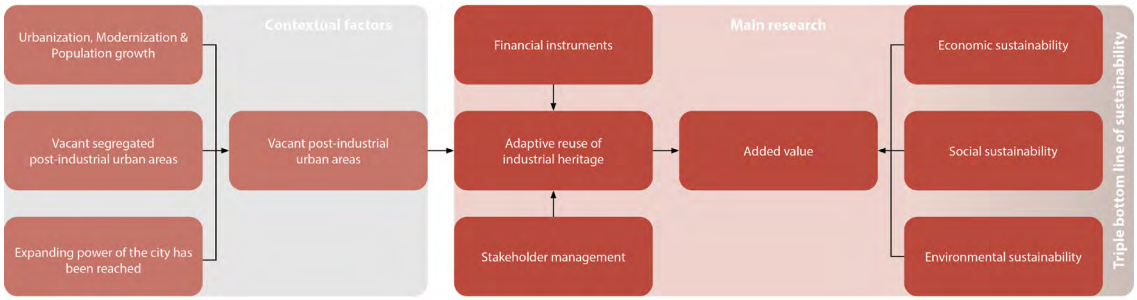


Figure 14: Conceptual framework and the main structure of the research. How stakeholder management and financial instruments are incorporated in adaptive reuse and the added value that is defined by the triple bottom line of sustainability is the core of the thesis (own illustration).

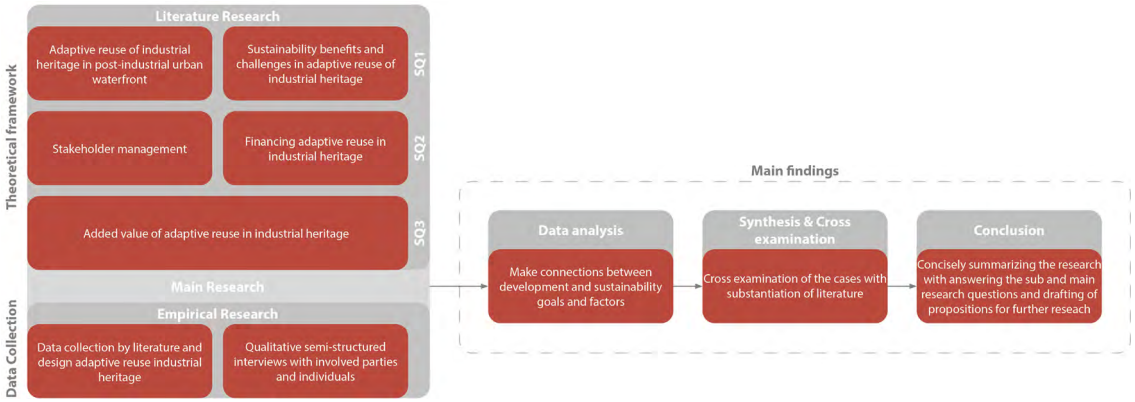


Figure 15: Research design/methods model that works as a guideline and a step by step approach to answer the main research question (own illustration).

Research design/method

The conceptual framework is the primitive of this research and shows the main structure and context of the research. Figure 15 displays the structure and steps on how to answer the research question. Table 2 is a more in depth description of the methodology. On the basis of a preliminary literature review the problem and scope of the research are defined. The literature study is focussed on answering the subquestion that establish the framework for the further research. The framework that has been established by the literature is used to conduct the empirical research. In these case studies there are four focus areas which are answered by case documents and semi-structured interviews with involved parties and individuals. After the interviews have been conducted the transcripts are analyzed on the basis of connections between the redevelopment and sustainability with a deductive coding scheme in AtlasTi. This information is synthesized and the assessment of the cases is cross examined to find links between the implementation of sustainability in the adaptive reuse of industrial heritage. Examining and interpreting the outcome and success of the redevelopments on sustainability with the various variables of adaptive reuse of industrial heritage, can establish a substantive answer on the research question. The main idea of the synthesis and cross examination is that the qualitative background of the research is interpreted with the advantages of quantitative content analysis (Mayring, 2000). Subsequently the synthesized information together with the cross examination sets out to answer the main question. These are the main findings that are supported by literature and case studies.

Table 2: Methodology of the research with the related focus, research method and data collection.

	Focus	Research method	Data collection
Problem analysis	• Problem and scope definition	Preliminary literature review	Scientific sources
Literature study	• Challenges or barriers faced by industrial heritage transformation if the aim of adaptive reuse is to achieve sustainable resutlt • Implementation strategies and financial instruments that have been adopted to achieve adaptive reuse in industrial heritage • Adaptive reuse strategies and the financial instruments lead to sustainable outcomes?	Literature review	Scientific sources and semi -structured interviews
Empirical research case studies	• Background information • Stakeholder management and sustainability goals • Financing • Sustainability	Case studies	Case documents and semi-structured interviews
Data analysis	• Connections between redevelopment and sustainability	Coding transcipts AtlasTi	-
Synthesis & cross examination	• Adaptive reuse of industrial heritage, in post-industrial Dutch urban waterfront area development, related to the added value, in regards to the economic, social and environmental sustainability	Synthesis and cross examination of coding	-
Conclude	• Concisely summarizing the research with answering the sub- and the main research question and drafting of propositions for further research	Validate findings with research participant	Consolidation of literature and empirical

Table 3: Criteria case study selection

Criteria	Description
Location	All cases should be located in the same area, this results that all cases have the same context.
Industrial heritage	All cases should have a relation to the industrial era and contain industrial legacy.
Adaptive reuse	The underused function of the building should be changed to a better fitting function on the basis of adaptive reuse.

Literature study

The literature study provides the theoretical framework for this research. The literature study is the basis whereupon the assessment of the case studies are established. By studying and exploring literature, more insight on implementation methods and financing instruments in revitalization Dutch post-industrial urban area development, by adaptive reuse in industrial heritage is collected. The literature study is divided into five parts. The first two parts that focus on adaptive reuse in industrial heritage and the barriers and challenges of it, substantiate the answer to sub-question 1. The stakeholder management and the financial instruments in adaptive reuse of industrial heritage substantiate the answer to sub-question 2. Additionally, capturing the sustainability of adaptive reuse in industrial heritage is constructed on the basis of literature and substantiates the answer to sub-question 3.

Empirical research

For the case studies two types of data sources are used. First, project related documents or reports are analyzed to get a better understanding of the cases. Besides the project related documentation, Semi-structured interviews with parties or individuals that are related to the project are conducted. The theoretical framework on which a framework is established is the starting point for the practice. There is no statistical data on the nature and extent of the repurposing of industrial heritage in the Netherlands. Although adaptive reuse cannot be quantified, a qualitative typology along various perspectives is possible (Nijhoff, 1994). On the basis of insights gathered in the theory section, qualitative case studies in unison with qualitative interviews are conducted. To establish evidence-based research, three case studies are conducted. Qualitative embedded case studies examine different adaptive reuse in industrial heritage with diversity of implementation methods and financing instruments, whereby the industrial heritage is revitalized. Multiple case studies allow for a broader understanding of financing this type of development. Embedded case studies focus on the different salient aspects of a case (Scholz & Tietje, 2002). The case studies mainly focus on the implementation methods and financial instruments in adaptive reuse of industrial heritage and the added value of the redevelopment in regards to economic, social, and environmental sustainability.

The logic behind the choice of multiple case studies is the replication of cases. It is the goal to find contrasting outcomes, but with foreseeable reasoning (Garner et al., 2016). The cases are selected on the basis of several criteria. It is vital that the case is considered in relation to its context. Rotterdam has a large number of present industrial heritage which makes it the ideal context for this research. By linking adaptive reuse of industrial heritage to the area development, the perspective on the quality and the added value of this development is extrapolated to a macro level.

For the selection of the cases, the region of Rotterdam is taken as a point of departure. Besides the location of the cases, they have been selected upon the 3 criteria that have been described in table 3. The selected cases with their background information are displayed in table 4. Both de Fabriek van Delfshaven and Fenix 1 are already developed, they function as a comparison between the cases and can be used as a cross-examination to identify any correlation between the outcome of the projects on the sustainability pillars.

Table 4: Selected case studies with background information.

	de Fabriek van Delfshaven	Fenix 1	HAKA
Location	Mathenesserdijk 410, 3026 GV Rotterdam	Veerlaan | Rijnhaven, 3072 ZP, Rotterdam	Vierhavenstraat 38, 3029 BE, Rotterdam
Monument type	Municipal monument	No monument	National monument
Old function	Factory	Warehouse	Warehouse, factory, and office
Year of construction	1892	1922	1932
Year of transformation	2013	2019	2023 (future)
Surface	3.560 m²	40.500m²	10.500m²
Programme new function	Multi-company office building	Commercial, cultural, parking, apartments	Multi-company office building, catering
Development costs	€4.000.000	€48.000.000	€22.000.000
Owner	Stichting Havensteder (HA)	Heijmans (D&C)	Dudok Projectontwikkeling (D&I)

These cases are assessed separately but are combined to test the outcome of them. The HAKA case functions as an interpretation of the possible outcome of the project. This case is never compared with the cases that have been completed. Despite the fact that this case does not show the sustainability outcome it gives a glimpse on how sustainability is enhanced in the design and the decision-making process. This synthesis does not intend to predicate the outcomes on sustainability in the HAKA case, but rather investigates and establishes a synopsis on how sustainability is distributed in the design and decision-making process in the adaptive reuse of industrial heritage. Meanwhile the other cases focus on the sustainability outcome.

Case study set up

Conducting numerous case studies with a diversity of functions, implementation methods and financial instruments is a time-consuming process. It is critical to have a clear and unambiguous case setup. The sequence of steps is linked to the research design described in table 2. This step by step approach gives a clear overview of the case and a framework to cross examine and synthesize the results of the involved cases. Data for the case studies is obtained through case documents and semi- structured interviews with involved parties and individuals.

The first step in the case studies is to acquire background information on the adaptive reuse of industrial heritage developments, such as the context of the project and the design. After defining the context of the development it is important to outline the financing of the project and map all the resources that are used within the project. In addition to these resources the stakeholders are identified on the basis of a stakeholder organization chart which shows the importance, interdependence, and interrelationship of the stakeholders. The final step is to assess what effect the adaptive reuse of industrial heritage has on the triple bottom line of sustainability. The success of the case studies on economic, social and environmental is assessed on the basis of sustainability benefits that were found in the literature. The sustainability assessment of adaptive reuse in industrial heritage is supported by qualitative interviews taken with parties or individuals that are involved in the cases. Qualitative interviews give a better understanding of the implementation methods and financial instruments used and the relation or added value of adaptive reuse in industrial heritage.

Qualitative interviews (semi-structured)

The qualitative semi-structured interviews are an important part of the case studies. These interviews give better understanding on the implementation methods and financial instruments in the redevelopment. In addition to this the interviews give substantiated data on the sustainability assessment of the adaptive reuse of industrial heritage. The stakeholder analysis is used as a list for potential interviewees to gain insight in the cases. For each case, interviews are conducted with directly and indirectly involved stakeholders from different perspectives. Conducting these interviews gives an unprejudiced answer on the success of the development. For every case different involved parties or individuals are interviewed, besides the interviews with the case related stakeholders, five interviews with experts are conducted to examine the expected outcome and the incorporation of sustainability in an adaptive reuse project (see figure 16). An additional ten interviews are conducted with other case related interviewees. All interviews are semi- structured, which allow for more in depth data on the feelings and beliefs of the interview participants on the case (De Jonckheere & Vaughn, 2019). The main goal of the interviews is to assess the redevelopment of the economic, social, and environmental sustainability. An interview protocol that outlines the main structure of the interview is established (see appendix III). The interview protocol can be deviated from during the interview when needed. The interviews are the main source to assess the success of the development. The interviews are recorded to assess the data in a later stage.

Data analysis

The data analysis is about financing, implementing and the justification of sustainability in adaptive reuse in industrial heritage. On the basis of data retrieved from semi-structured interviews from different perspectives with developers, experts, and users, supplemented with documentation of the cases, a clear overview of the cases is established (Ayres et al., 2003). Based on these different perspectives, a deductive coding scheme is identified that shows the relevant codes to make a statement about the general sustainability and the individual sustainability pillars of the adaptive reuse projects. The assessment on sustainability of adaptive reuse in industrial heritage is based on sustainability benefits and challenges divided over the three pillars of sustainable development. Besides the sustainability benefits it is important to determine if the adaptive reuse in industrial heritage copes with the challenges and barriers associated with it. The actual sustainability of the cases is analyzed on the basis of semi-structured interviews. The case studies are based on in depth research to explore causation. In order to find underlying principles all interviews are analyzed on the basis of the deductive coding scheme in Atlas Ti that is shown in table 5. The preliminary code book can be developed based on a conceptual model that is substantiated by the literature review (Crabtree & Miller, 1992). The research starts with the deductive approach where concepts are derived from literature and the associated conceptual framework. It is likely that during the analysis inductively new codes that are relevant to the sustainability of adaptive reuse in industrial heritage are drawn up. The codes are applied to the conducted semi-structured interviews which encompass linking the codes to the transcribed interviews (Boyatzis, 1998). It is important to link codes to identify patterns in the data, these patterns are called themes (Fereday & Muir-Cochrane, 2006). The main codes are the sustainability pillars positive and negative (benefits and challenges). Besides these sustainability codes the interviews are coded on financing, stakeholder management and trends in adaptive reuse to get a structured overview on the cases.

Figure 16: Visualization of the number of stakeholders and their relation to the research (own image).

Tabel 5: Deductive coding scheme for the data analysis on the sustainability of the cases.

Codes	Descriptive
Economic sustainability Benefits & Challenges	Value increase adjacent properties
	Cost benefit (materials & time)
	Economic viability
	Financial feasibility
Social sustainability Benefits & Challenges	Social interaction/ Social networks
	Safety and security
	Increasing accessibility and encounters
	Pride and sense
	Participation of stakeholders
Environmental sustainability Benefits & Challenges	Reduction of health risks by hazardous contamination
	Preserving the embodied energy
	Public infrastructure
	Energy performance

Coding the qualitative data gives a clear overview on the perception of sustainability of the case studies by the interviewees. The deductive coding, structures the statements of different interviewees about the sustainability of the project and gives an overview on how conclusive the actual sustainability is. Deductive analysis works with the previously formulated concepts and themes that are theoretically derived from literature. This deductive analysis is brought into connection with the transcripts of the semi- structured interviews. The analysis is based on a methodological implementation of the concepts and themes to the transcripts (Mayring, 2000). Figure 17 gives an schematic overview of the process for deductive qualitative case study research. After conducting the semi-structured interviews and analyzing them by the process diagram in AtlasTi, the next step is the interpretation of the data to give a substantive answer on the research question. The interpretation of the data is the synthesis that combines the data to give a substantiated answer to the research questions established.

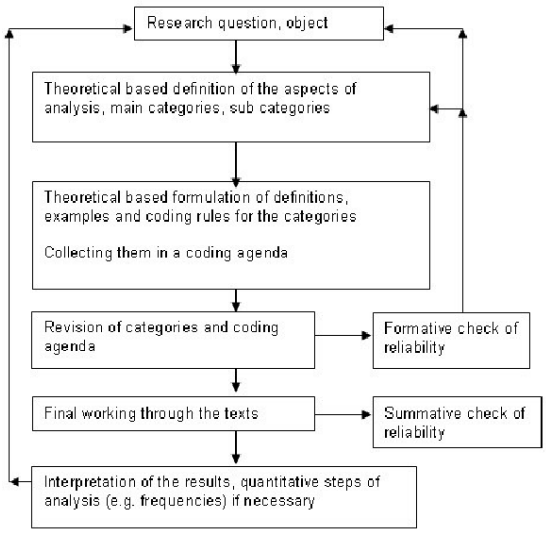


Figure 17: Process diagram for deductive qualitative case study research (Mayring, 2000).

"The assessment framework that tests the added value of adaptive reuse is a complex mix of all kinds of considerations."

(Translated from Dutch)
- Research participant EvH (04) -

Synthesis

After analyzing, the data is synthesized and cross-examined. Synthesizing the data is based on the triangulation principle, where different forms of research are conducted to strengthen the findings and credibility of the research (Sarvimäki, 2018). The synthesized data addresses the sub-questions and the outcome of the cross-examination of the case studies. Combining

the data to answer the questions raised is the main idea of the synthesis. There might be a correlation between the implementation methods, financial instruments, and the added value of the project on sustainability. The literature study gives the blueprint for the theoretical framework upon which the case studies are being evaluated. The data that has been gathered from the semi-structured interviews is synthesized on the basis of a code-document table in AtlasTi. In this table, the statistics of the codes are displayed per document group (case). This table shows the occurrence of the codes per case. The occurrence of the codes gives a brief or condensed statement on the case sustainability. If the coding of the cases is normalized one can make a statement about the synopsis on how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social, and environmental sustainability (ATLAS.ti Scientific Software Development GmbH, 2020).

Conclude

The last step is to reach a conclusion through the resolution of the main research question. Using the synthesized information derived from the case assessment, the cross examination, and the theoretical and practical research the main research question can be answered. By answering the central question of the research more insight is gained in how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social and environmental sustainability. Another takeaway that might be found in this research, is how real estate development connects with urban area development. The final step is to validate the conclusions drawn from the cross examination of the case studies with the literature study. This step is a valuable part that enhances the validity of the research (Hartley, 2004).

Ethical considerations

Due to the qualitative nature of the research where case studies and interviews are conducted, it is important to think about ethical considerations. In this thesis, implementation methods and financial instruments in developed and ongoing projects are researched. This financial information in developments is most likely to be confidential. Therefore the information gathered in this research is only used for research purposes. The case studies and interviews will not harm the concerned companies or employees. As researchers it is important to guarantee and respect the privacy and dignity of the research participants. Before an interview is conducted or data is obtained from a company, an informed consent is sent to the research participants. This informed consent states that the research participant can always withdraw from any information given. The informed consent states that obtained data is primarily and exclusively used for this research and is not shared with third parties. If the research participants sign the informed consent the information that they give can be used in this research, but exclusively in this research.

In addition to the confidentiality of research participants within the interviews there are various rules stated by the university according to writing a master dissertation. At all costs these rules should be embraced and not be violated. The rules primarily focus on the trustworthiness of the research and the plagiarism related to it. As a researcher you cannot make assumptions that are not founded, the research is validated and verified by literature to enhance the credibility of the research.

Central question of this research

How does the adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relate to the added value, in regards to the economic, social, and environmental sustainability?

EMPIRICAL RESEARCH

The literature study established the theoretical framework to examine the embedded case studies to compare the various implementation methods and financial instruments in practice and the (possible) outcomes of these types of development. This chapter gives the main findings of the cases that are selected for the research on how the adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to economic, social and environmental sustainability. This chapter presents background information on the focus area, the history and development goals of the various cases, data on financing, feasibility, implementation, and the added value in regard the economic, social, and environmental sustainability. The data on the added value is the starting point to assess the success and the sustainability of the redevelopment project.

Focus area

Rotterdam is the context where all embedded case studies are located. Previously mentioned the city of Rotterdam has a rich history in harbor activities. The activities gradually moved from the inner city towards the periphery of the city fabric (Hein & van de Laar, 2020). Due to this, Rotterdam has a large number of present industrial heritage which makes it a great context to perform this research. A theoretical and visual representation of the context of the research area is presented which gives substantiation to the separate cases that are discussed further on.

Rotterdam is after Amsteram, the second largest city of the Netherlands and is one of the precursors in the European harbor industry. Rotterdam is Europe's main cargo junction; due to the geographical location of the city, the central location in Europe and open access to the North Sea, making it perfect for harbor activities (van Gils & Klijn, 2007). Rotterdam has always been a key player in the distribution of goods in Europe. The port of Rotterdam is Europe's largest logistic and industrial hub (Port of Rotterdam, z.d.). The deindustrialization of the port, and the ever growing container vessels (de Gijt et al., 2010), causing the activities to move to the periphery of the city (Hein & van de Laar, 2020). Rotterdam wants to remain a key player in the distribution of goods, the harbor of Rotterdam steadily expanded westward towards the North Sea, with during the 60s Maasvlakte 1 as a major port development to cope with the rising demand of the harbor activities (van Gils & Klijn, 2007). The port started to grow exponentially, and after the major intervention of building Maasvlakte 1 there was a need for another expansion of the port. The Port Authority of Rotterdam and the Dutch Ministry of Public Works introduced the creation of Maasvlakte 2 in 1993 and the optimization of the current harbor activities (van Gils & Klijn, 2007). Sixteen years after the initiation, the creation of new land began. From 2009 until 2014, 1000ha of new land

that shifted the harbor functions more to the North Sea was realized to extend and modernize the current port of Rotterdam. This move facilitated the (re)development of the associated former harbor buildings into new urban areas (Loeper & Ott, 2017; Hoyle, 1998).

The number of inhabitants in Rotterdam has been increasing every year since 2008 (CBS, 2020). The total number of inhabitants in 2019 was 651.168 and the prognosis for 2040 is that the number of inhabitants will only rise. To house the influx of inhabitants, new inner city developments are essential. Redeveloping vacant, derelict, and underused industrial heritage creates opportunities for this demand (Claassens et al., 2020).

Figure 18 is a 2D representation of the city of Rotterdam and its direct surroundings. On the right is the inner city with its old harbor areas, and on the left are the current harbor activities that gradually moved over time. In addition, the three case studies are shown on the map. The cases are located in the area where the old harbor functions took place. Due to the expanding power of the harbor activities and the expanding power of the city fabric, these derelict industrial assets should be repurposed or redeveloped.

The city of Rotterdam is known for its modern architecture. Yet the city has a rich industrial past and therefore also many different monumental buildings.

The municipality of Rotterdam has a specific policy; maintain, unless. No demolishing of old structures, but try to show the time layers. Reading the time layers of the city is of architecture-historical importance. Besides that it is important from an urban planning viewpoint. It adds quality, atmosphere and layering to a city. It is an objective quality that shows the historical stratification of the city (G. van Heest, personal communication, 22 February 2022).

The monuments are often iconic and important for the city and its immediate surroundings (Gemeente Rotterdam, 2016). The buildings are defined as national monuments, municipal monuments, UNESCO world heritage, landmark buildings, and protected cityscape. The heritage policy is laid down in the Erfgoedagenda 2017 - 2020. At the end of 2016, the Municipal Executive drew up this erfgoed agenda in which the conservation of heritage is pursued and stimulated. The erfgoed agenda has been drawn up to conduct a dialogue about cultural-historical awareness in the city (Gemeente Rotterdam, 2016).

"The intrinsic value, the challenge is that you affect the building as little as possible and that you keep that rawness and originality as much as possible in keeping with that new destination. That's the art"

(Translated from Dutch)
- Research participant JDK (03) -

Figure 18: Map of Rotterdam with the location of the case studies (own image).

DE FABRIEK VAN DELFSHAVEN

Location	Mathenesserdijk 410, 3026 GV, Rotterdam
Monument type	Municipal monument
Old function	Factory
Year of construction	1892
Year of transformation	2013
Surface	3.560m2
Programme new function	Multi-tenant office building
Development costs	€4.000.000
Owner	Stichting Havensteder (Housing Association)

History de Fabriek van Delfshaven

"de Fabriek van Delfshaven" is a building with a rich history, this history is shown in a timeline in figure 19. The factory complex was originally owned by "Roeloff" steaming facility, steam dyeing and chemical laundry NV. The factory that is situated at the Mathenesserdijk in Delfshaven was realized in separate construction phases. The company established themself at the site in 1892. Over the years the company expanded, in 1905 they bought the warehouse and built the now so familiar chimney. 5 years later in 1910 they expanded their building, after which in 1926 they duplicated the asset and the amount of square meters. The expansion came to a halt but in 1948 they made major adjustments internally and externally. Over time the factory became derelict, underused and vacant. In 1987 squatters moved into the building and stayed there for over 20 years (P. Boel, personal communication, 15 February 2022). There were plans to demolish the building but this became difficult when in 1991 the chimney of "de Fabriek van Delfshaven" was declared a protected cityscape by the municipality of Rotterdam. The building has a prominent presence in the city landscape. The large chimney is the defining element that can be seen throughout the whole Delfshaven.

Prior to the redevelopment of "de Fabriek van Delfshaven" the whole building was dilapidated and detracted from the look of the Delfshaven district. The owner Havensteder that is the outcome of a merger between "com.wonen" and "PWS" tried to make a feasible business plan. PWS bought the asset in 2005 with the idea to demolish the asset and build a new structure (R. Geelhoed, personal communication, 18 February 2022). In 2008 PWS made the first contact with the developer Lingotto to redevelop the asset. This year the technical state of the building was at such a low point that the squatters had to move out of the building for their own safety (R. Geelhoed, personal communication, 18 February 2022). In 2011 the transformation of de Fabriek van Delfshaven started, after which in 2013 3560m^2 multi-tenant office building that houses over 30 different companies was delivered.

Design adaptive reuse de Fabriek van Delfshaven (Mei architects and planners, 2021).

The old factory is transformed into a 3.560m^2 multi-tenant office building with 36 office units and an atrium which enhances encounters and where routing takes place. In addition to the offices, neighborhood-oriented functions have been added, such as a restaurant, a yoga studio, and an after-school care. The exterior of the former steam laundry has two distinctive faces. On the street side a series of traditional dike houses, and on the Schie side a factory view including a large chimney pipe.

Havensteder together with Lingotto decided to transform de Fabriek into a multi-tenant building for small and creative entrepreneurs. During the transformation process much was designed in real-time, because during the renovation, surprises appeared when layers were uncovered. The design was based on the aesthetic, cultural-historical and constructive quality that was still present. These historical elements have been consolidated and reinforced. They were then incorporated into the plan for the renovation into 36 office units.

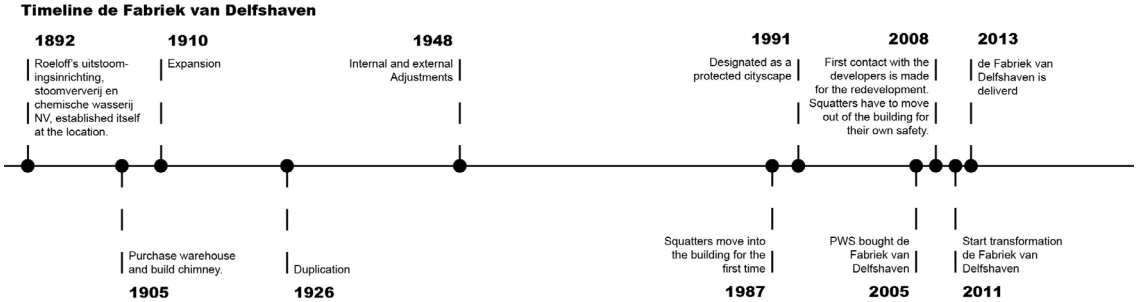


Figure 19: Timeline of major events during the lifespan of de Fabriek van Delfshaven (own image).

Figure 20: Exterior of de Fabriek van Delfshaven (Mei architects and planners, 2021).

The office units are flexible in design and can be interconnected so companies can grow in size within the building. The atrium has been realized in the collapsed middle section which became a place for encounters and routing. The atrium functions as: routing (including stairs and an elevator), meeting space with collective facilities and as daylight supply. The glass fronts between the business spaces and the atrium create an openness and transparency that allows synergy and encourages collaboration with the companies housed in de Fabriek van Delfshaven.

The ground floor of the atrium makes use of the characteristic facade openings that have been preserved all around. The additions that have been made, such as the steel construction in the atrium, are minimalistic. An industrial greenhouse roof has been applied above the atrium, which can be opened in the summer. The additions of materials that have been made are sustainable materials.

Stakeholders involved adaptive reuse de Fabriek van Delfshaven

In the process of adaptive reuse numerous stakeholders are involved with all different demands and perspectives on the project. Herazo & Lizarralde, (2016) mentioned the different approach of the abundance of stakeholders on sustainability, which affects the decision making process. In order to create sustainable projects there should be clarity on the sustainability ambitions of each stakeholder (Hörisch et al., 2014). If stakeholders aspire to reach the same sustainability standard it is likely that this goal will be met. Figure 21 displays the stakeholder relation diagram for de Fabriek van Delfshaven. This diagram shows the main stakeholders involved in the project and their primary sustainable goals. Due to the size of the project and the fact that the owner of the building invested and exploited their own redevelopment, fewer stakeholders are involved within the redevelopment of de Fabriek van Delfshaven. At the time of initiation Havensteder (PWS) had no actual sustainability goals (R. Geelhoed, personal communication, 18 February 2022). PWS contacted the developer lingotto to devise and implement a concept design for de Fabriek van Delfshaven. Lingotto has come up with a concept based on a vision of the local market and economy to apply an internal transformation that has resulted in a responsible repurposing (R. Geelhoed, personal communication, 18 February 2022). Mei Architects and Planners was enlisted to make the design together with the developer. The main takeaway in the design was the circulation and interaction between the offices. The Delfshaven Factory is a certain segment in the market where the identity is not determined by the building, but by the service it provides and the people within it (R. Geelhoed, personal communication, 18 February 2022). The main contractor on this project was BAM woningbouw, which had a few subcontractors and advisors. The main sustainability goal of BAM woningbouw was to develop the building within budget and time. Due to the success of the concept the tenants that rented one of the offices were involved from an early stage of the redevelopment. De Fabriek van Delfshaven is located in a densely populated area. This involves more stakeholders to the redevelopment. PWS at that time was closely in contact with the residents that lived next or close to the asset to discuss the development with them (R. Geelhoed, personal communication, 18 February 2022). These residents were involved and defended themselves and the area against demolition and new construction. Even when it became clear that de Fabriek van Delfshaven was not to be demolished they stayed very much in contact with the project team (P. Boel, personal communication, 15 February 2022). The

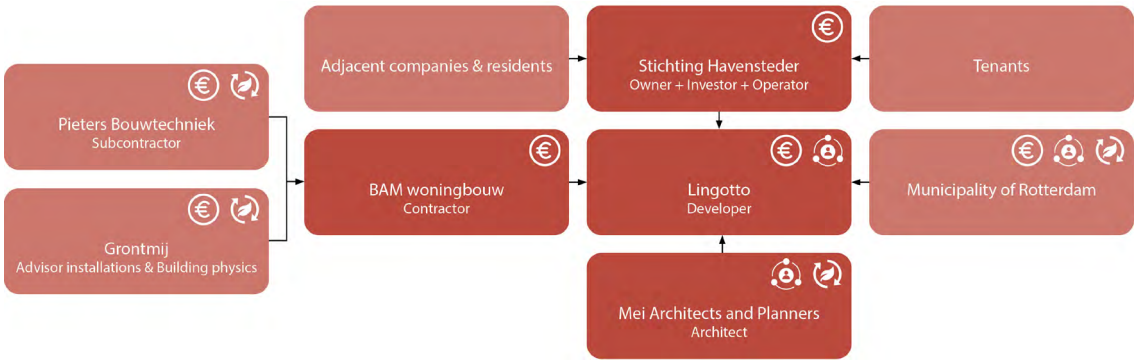


Figure 21: Stakeholder relation diagram within the adaptive reuse of de Fabriek van Delfshaven and their sustainability goals. The dark red boxes are the stakeholders that are identified as key stakeholders that are part of the project team.

project team actively focuses on enhancing all pillars of sustainable development within their core business strategy. Where some stakeholders are more focused on one or two sustainability goals, all pillars of sustainable development are represented in the development of the case.

Financing adaptive reuse de Fabriek van Delfshaven

The housing association Stichting Havensteder carried out the restructuring of the factory with the developer Lingotto to develop a concept that can be implemented and exploited by Havensteder themself. At the time of the initiation Stichting Havensteder was owner of the asset. In the past many concepts were created that were financially not feasible. With the complexity of the available investment they project team created the sustainable concept with future value for the building and the neighborhood. Together with Mei Architecten and BAM Woningbouw an efficient redevelopment concept is created that Havensteder can implement and exploit themself.

Creating professional business units for independent entrepreneurs and small businesses is in accordance with the market demand of Delfshaven. The redevelopment optimally responds to the needs of local, young entrepreneurs through the functional and flexible rental units. The supply lacked the perception of the target group; flexible contracts, acceptable rent, and no unnecessary services. Besides that the concept is not dependent on subsidies by the local government. In the past several applications for subsidies have been rejected. “If the actual residual value after transformation does not come close to the purchase amount, you have to start puzzling and therefore you have to search longer for alternative options” (R. Geelhoed, personal communication, 18 february, 2022).

The redevelopment of de Fabriek van Delfshaven did not receive any subsidies which meant that the financing of the adaptive reuse of de Fabriek van Delfshaven was completely done by Havensteder. The total redevelopment costs are estimated at €4.000.000,-. It was clear from the start that this was the budget from Havensteder. Developer, building team and the architect had to work with this and committed themself to it (De Fabriek van Delfshaven - Gulden Feniks, n.d.).

To ensure the continuity of the project Havensteder did put the offices on the market before the actual start of the redevelopment. Promptly 100% occupation was guaranteed because the factory responds to the shortage of the market supply. There is even a waiting list for new tenants. When the project was delivered the costs of a standard unit, dependent on the situation, was approximately between € 400,- en € 430,- per month. For the tenants an additional € 100,- has to be paid for service costs (NRP gulden fenix, 2013). A standard office nowadays cost between € 712,- en € 748,- per month without any service costs (De Fabriek van Delfshaven, 2022). Besides the 36 office units a space that was intended as a dance hall is redeveloped to a 250m^2 office loft. Presuming that the price per square meter is the same as the standard office units a calculation has been made.

After exploiting the assets for 6 years Havensteder repelled the asset and put the multi-tenant office building on the market. Havensteder sold de Fabriek van Delfshaven for €4.100.000, to Zappoffice, the owner of various flex workplaces in Rotterdam (Roggeveen, 2019). This displayed the success and the financial feasibility of the adaptive reuse of de Fabriek van Delfshaven. Transforming and exploiting the asset for 6 years gave Stichting Havensteder an Internal rate of return of 6,2% (See Appendix II). (This calculation excludes the purchase of the property.)

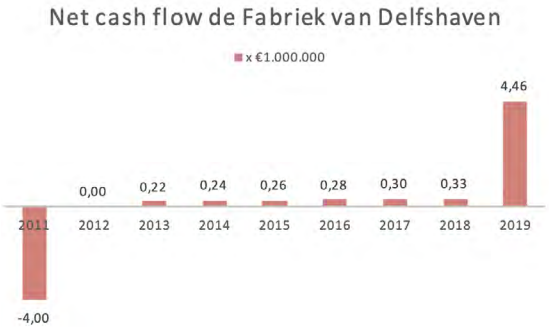


Figure 22: Net cash flow de Fabriek van Delfshaven from start development to disposal of the asset (own image).

Sustainability de Fabriek van Delfshaven

Establishing an objective and substantiated assessment of the sustainability of de Fabriek van Delfshaven it is important to assess the sustainability factors of adaptive reuse in industrial heritage that define sustainability. The sustainability coding scheme has been drawn up from the literature and forms the basis that determines the sustainability outcome of the redevelopment project. The assessment of the factors is substantiated by data that is gathered in extensive literature research, case documents and conducted semi-structured interviews with involved parties or individuals. The assessment of the sustainability and the outcome of the sustainability are justified further on.

Economic sustainability

Value increase adjacent properties

The rising house prices of adjacent properties go hand in hand with the redevelopment of vacant industrial heritage (Kaufman & Cloutier, 2006; Duijn et al., 2014). Research participant 12 bought the adjacent factory director's house in 1997 and is still the owner of the property to this day. For a long time the WOZ value of the building stayed around the purchase price. In the 10 years, since the dilapidated building was renovated the WOZ has been rising. It was clear that the WOZ value was reduced due to the vacant asset (P. Boel, personal communication, 15 february, 2022). However research participant 14 thinks this value increase of the adjacent properties is indirect. "It is more of a sectoral aspect from the primary supply and demand perspective. The impact on the scale area is too small for that" (R. Geelhoed, personal communication, 18 february, 2022). The relative property value change around the redevelopment of de Fabriek van Delfshaven together with the property value change of the Netherlands and Rotterdam is shown in appendix II. De Fabriek van Delfshaven was delivered in 2013 which means that a quantitative relation with the residential property value change of the surrounding is hard to establish. Although no quantitative connections can be made, the qualitative interviews show the relation between the adaptive reuse and the benefit of the value increase of adjacent properties.

Cost benefit (materials & time)

The cost effectiveness is based on materials and time used within the redevelopment. If one looks at the cost efficiency of the redevelopment of de Fabriek van Delfshaven not much new materials or extra time is used. The whole outside structure is kept and only renovated from the inside. Figure 23 shows the inside of the redevelopment, here it is seen that only the essential materials are used to house the functions the asset is housing. For the adaptive reuse of de Fabriek van Delfshaven they used a design as it goes approach. They started with a basic design and made adjustments if they were needed. This approach ensured that less materials and time were used for the redevelopment of the asset (Mei architects and planners, 2021a). The cost benefit is

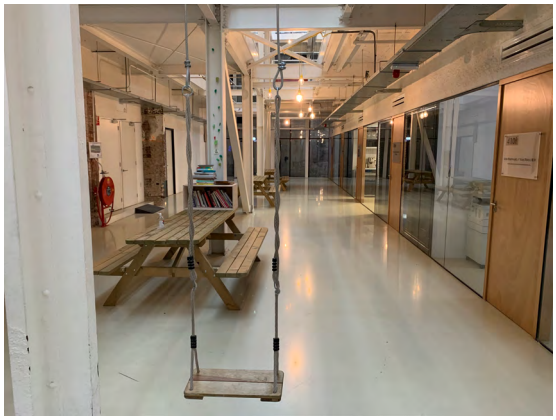



Figure 23: Inside of de Fabriek van Delfshaven, with the gathering space for the companies that are housed in the building and the routing (stairs and elevator) (own picture)

maximally enhanced in the project due to the fact that the life of the materials and the building is extended (R. Geelhoed, personal communication, 18 february, 2022).

Economic viability

The redevelopment of de Fabriek van Delfshaven has significance for the "power district" Delfshaven because an important, growing economic sector is provided with suitable housing and, together with the catering and educational activities also located in the complex, the solidarity of all residents is strengthened (de Fabriek van Delfshaven, 2013). The economic viability is determined by the (in)direct economic impact the adaptive reuse has on its surrounding. The multi-tenant office building has an (in)direct impact on the surrounding area (I. Janmaat, personal communication, 30 september 2021). The companies and the employees of them indirectly give economic impetus to the area. They make use of the restaurants, bars, and other amenities adjacent to de Fabriek van Delfshaven. The people that work there give back to the neighborhood and community (I. Janmaat, personal communication, 30 september 2021). After the redevelopment young local entrepreneurs moved into the building to execute their businesses. The presence of these new interesting local companies enhanced the generation of local employment. In addition to the offices, the design of de Fabriek incorporates neighborhood-oriented functions such as a restaurant, a yoga studio, and an after-school care.

Financial feasibility

The housing association Havensteder bought the asset in 2005 (R. Geelhoed, personal communication, 18 February 2022). Earlier development concepts did not get off the ground because a financially feasible business case could not be made. The situation became so dramatic that they had to look at a new function fundamentally differently (R. Geelhoed, personal communication, 18 february, 2022). At the start of the redevelopment they responded to the high demand for flexible work units to create a feasible business case. Even to this day there is hardly any vacancy, which is very special in these times, it is ofcourse a special market that they do fulfill (R. Geelhoed, personal communication, 18 february, 2022). Many costs have been incurred prior to the redevelopment. If one only looks at its redevelopment and its exploitation, there is an approximate internal rate of return of 6,2%. Havensteder invested 4 million euros to transform the dilapidated old industrial heritage into a multi-tenant office building. Before the redevelopment started, de Fabriek van Delfshaven already rented full occupation (De Fabriek van Delfshaven, 2013). This displayed the success of the project. After six years of exploiting the asset Havensteder decided to repel the asset for 4.1 million euros. As appendix II shows the internal rate of return on the adaptive reuse of de Fabriek van Delfshaven is 6,2%. This means that the actual redevelopment project has been financially feasible. This excludes the purchase of the building which is unknown.

Social sustainability

Social interaction/ social networks

The appearance is a beautiful pearl within the area where the soul of the place and its history is confirmed. And what is even more important in the context of liveability and entrepreneurship is of course a different type of local economy has emerged (R. Geelhoed, personal communication, 18 february, 2022). The redevelopment of de Fabriek van Delfshaven is a multi-tenant office building that is only accessible for the people that work there. In addition to the offices the asset also houses neighborhood oriented functions that are open for the community. The creation of the neighborhood-oriented functions characterize the strong local anchoring in Delfshaven (Mei architects and planners, 2021). These functions that are incorporated within the design enhance the social interaction/ social networks in the community. Due to the character of the design concept there is more interaction with the users of the asset. Research participant 02 mentions that with their current office renovation they search for collaboration and in house knowledge (I. Janmaat, personal communication, 30 september, 2021).

Safety and security

De Fabriek van Delfshaven has been dilapidated for a long time prior to the redevelopment. The vacancy of the asset attracts unfavorable people, and has a negative influence on the sense of safety and security. At the lowest point, not only the factory was vacant, but also quite a few houses on the other side of the street. They started making a movie about the squatters' riots in Amsterdam, in the Vondelstraat because it looked like such natural decor (P. Boel, personal communication, 15 february, 2022). When de Fabriek van Delfshaven and the houses across the street had been renovated and people were living and working, and there was light behind all the windows, there was a lot more vibrancy which contributed to the sense of safety and security in the street (P. Boel, personal communication, 15 february, 2022). The redevelopment simply created a stable factor and increased the sense of safety and security. The fact that there is light, the fact that there is liveliness, the fact that there is movement on the street contribute to this feeling (R. Geelhoed, personal communication, 18 february, 2022). Perhaps it is because there are always eyes in this type of building and from the ground, you are never alone which effectuates and strengthens social security (I. Janmaat, personal communication, 30 september, 2021).

"I did not see it anymore but when people came to visit, they asked if I could park my car safely outside. They did not dare to walk on the street alone, because it looked so lugubrious and boarded up."

(Translated from Dutch)
- Research participant PB (12) -

Increasing accessibility and encounters

The accessibility and exchange and meeting of an area contributes to the innovative capacity. If adaptive reuse becomes more accessible and encounters are arranged it can contribute to social sustainability. The area of de Fabriek van Delfshaven was already well accessible for the people of the community. The whole concept of de Fabriek van Delfshaven is aimed at arranging encounters between different companies. The adaptive reuse did not contribute to the accessibility of the area. The multi-tenant office building is only accessible for the people that work there.

Pride and sense; attachment to place

The aesthetic appearance to the built environment has not changed much. The building is primarily redeveloped on the inside to house the small businesses and neighborhood-oriented functions. "The factory is a defining element which holds onto the identity. In addition, the factory is no longer vacant which makes the appeal of the building better (R. Geelhoed, personal communication, 18 February, 2022)". The design of the adaptive reuse enhances the characteristic, but also the differentiated

facade. It preserves the bifurcation of facades, whereas from the Schie (waterside) the asset still looks like an old factory, and from the street side the asset looks like old historical dike houses. The appearance of the industrial heritage still cultivates the surrounding. The assets cultivate the historical legacy of the building (P. Boel, personal communication, 15 February, 2022). When research participant 12 bought his house next to de Fabriek van Delfshaven he wanted to stay, after the redevelopment his perception changed to here I want to grow old. “I feel very at home in the area, don’t touch Delfshaven so to speak. I first live in Delfshaven, and then in Rotterdam.” (P. Boel, personal communication, 15 February, 2022).

Participation of groups and networks in redevelopment

At the initiation phase of the redevelopment of de Fabriek van Delfshaven the developer was in close contact with someone that was an important anchor to bring back history. They talked with interest holders, with authority in the area (R. Geelhoed, personal communication, 18 february, 2022). The residents of the neighborhood around the Factory of Delfshaven have defended themselves against the demolition of the building and have interfered in the redevelopment of the multi-tenant office building (P. Boel, personal communication, 15 February 2022). Before the redevelopment of the multi-tenant office de Fabriek van Delfshaven all stakeholders that signed an initial contract were involved in the redevelopment process. Future tenants together with developers were creating the offices and decided together over the outcome of the building. Also the design of the multi-tenant office contributes to the participation of various companies. The routing and gathering places situated on the inside enhances social interaction of the companies housed within the asset.

Environmental sustainability

Reduction of health risks by hazardous contamination

The contamination of the surroundings of the redevelopment is defined by the soil and air pollution. The soil and air pollution can have a relation with the former function of the area or the asset of the redevelopment. The urban background gives a high concentration of air pollution, by the location specific measures this concentration can get over the threshold of hazardous contamination (Milieu -en Natuurplanbureau, 2007). There are no design solutions incorporated to enhance the reduction of health risks by hazardous contamination (I. Janmaat, personal communication, 30 September 2021).

Preserving the embodied energy

With the adaptive reuse of de Fabriek van Delfshaven only the essential elements for the concept are demolished and turned into waste to house the multi-tenant office building. A major part of the building collapsed prior to the adaptive reuse and was no longer suitable for circularity. Besides the waste related to the collapsing of the building no more waste was created. Only the inside of the building is being redeveloped and the structure and facades are kept in their original status. In addition to the waste involved in the redevelopment process the minimum amount of materials are used to create the offices. The life span of the building has been extended including the embodied energy involved (R. Geelhoed, personal communication, 18 February, 2022).

Public infrastructure

The fabriek van Delfshaven is located in a dense area of the city. The redevelopment of de Fabriek van Delfshaven is focussed on the transformation into a multi-tenant office building with the addition of some neighborhood-oriented functions and does not incorporate any alteration on the public space. Enhancing the environment is making decisions in the design that will contribute to the general quality of the space around the redevelopment. Due to

the density of the area where de Fabriek van Delfshaven is located no greenery or other environmentally enhancing design solutions were added. The redevelopment project is allocated in a dense area where already various sustainable mobility in the form of public transport is situated. Besides that the concept of the multi-tenant office building has a positive ecological effect. This effect is seen in terms of commuting which is a combination of social and ecological sustainability. The design concept ensures the users live near the building, which reduces emissions by commuting. "De fabriek van Delfshaven can be seen as a home office when it is not your home (R. Geelhoed, personal communication, 18 February, 2022)."

Energy performance

De Fabriek van Delfshaven is an old building which has its pros and cons. The advantage is that the ceilings are very high which results in a lot of light, which makes the working environment very pleasant. On the other hand, you have to do a lot in terms of climate to keep it nice. In the summer it can be really hot due to the light that is coming in. Research participant 02 mentioned that they had to hang awnings and put fans on their desks to keep the climate pleasant. After several years they finally have the underfloor heating under control (I. Janmaat, personal communication, 30 September, 2021). At the time of initiation the sustainability of the project was not an agenda item with the owner and investor of the redevelopment (R. Geelhoed, personal communication, 18 February, 2022). This energy performance is based on experiences by users, if one looks at the actual energy label that displays the amount of energy the building uses and the comfort, the offices within de Fabriek van Delfshaven score energy label A. This means that the building has a very low energy consumption and the comfort level is high.

Consolidation sustainability de Fabriek van Delfshaven

The sustainability of de Fabriek van Delfshaven is seen in figure 24 and is based on the consolidation of the three sustainability pillars that comprise sustainable development (Parkin et al., 2003; Guo et al., 2021; Kahn, 1995). Based on the coding of the interviews related to de Fabriek van Delfshaven one can see the ratio between the different sustainability factors. The figure displays which factors were mentioned most frequently during the interviews and whether they relate to each other or whether one of the factors stands out. When sustainability benefits are enhanced more than the sustainability challenges occur, the development tends to include that pillar of sustainability. If one sustainability pillar is coded more absolutely than another sustainability pillar the interviewees mentioned these sustainability pillars more. This can mean that the particular sustainability pillar tends to be more included in the adaptive reuse of this case. The coding yields an overview of the sustainability benefits and challenges mentioned but partly neglects the quality of the data and forgets to highlight the different interpretations of connotations in the data, meanwhile it gives a clear synopsis of the case (Glaser & Laudel, 2004).

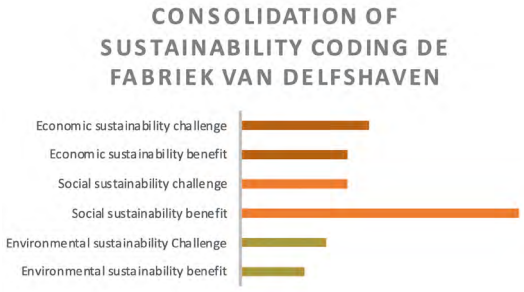


Figure 24: Sustainability of de Fabriek van Delfshaven as a consolidation of coding the three sustainability pillars that comprise sustainable development.

FENIX 1

Location	Veerlaan | Rijnhaven, 3072 ZP, Rotterdam
Monument type	No monument
Old function	Warehouse
Year of construction	1922
Year of transformation	2019
Surface	40.500m2
Programme new function	Commercial, cultural, public parking, loft apartments
Development costs	€48.000.000
Owner	Heijmans (Developer & Constructor)

History Fenix 1

The history of the Fenixloodsen is shown in the timeline in figure 25. The Fenixloodsen originally called San Francisco loods are located at the Veerlaan in Katendrecht. These warehouses were built by Holland America line in 1922 when the company was vastly expanding. The warehouse was 360 meters long and was the longest warehouse at that time. The Fenixloodsen are characterized by concrete facades and large loading decks. The warehouse had two railroads running through the building. During World War II part of the warehouse was destroyed. Directly following the war, a fire destroyed more of the complex leading to a decision to create a square in the middle and rebuild both sides. Both sides were respectively called Fenix I and Fenix II.

The Fenix warehouses are being developed in two phases. Proper stok that has been taken over by Heijmans started planning the redevelopment of Fenix 1 in 2009. In 2013 Mei architects and planners was selected as the architect for the redevelopment of Fenix 1. The design of Fenix 1 includes ca. 8.500m^2 commercial and cultural, ca. 9.000 m^2 public parking and 212 apartments. The redevelopment started in December 2015 and the development was delivered in November 2019.

Fenix II which is the other side of the old warehouse will be redeveloped into a 15.000 m^2 museum initiated by a philanthropic arts institution

Design adaptive reuse Fenix 1
(Mei architects and planners, 2021)

Fenix 1 is 140 meters long, 40 meters deep, and 2 floors with 6 meters free height. The warehouse is reused and restored for a mixed program. On top of the old warehouse 212 loft apartments have been realized in a one million kilo steel table construction. The warehouse could be largely preserved by keeping the steel construction separate from the warehouse. The first three floors of the steel construction contain 78 rental homes that have limited variation. The floors above contain 134 unique loft apartments with a high degree of flexibility in size (40 - 300 m2) and layout. All apartments per floor are connected with a gallery which ensures people meet each other and not step anonymously in the elevator The gallery of the apartments connects via four elevators and stairwells to a public passage on the ground floor. The Fenix passage is a 40 meters inner street that connects both sides of the building and runs right through the building.

The warehouse consists of a mixed program. The warehouse is partly rebuilt for a public parking garage with 227 parking spots. At the quay there are 5 houses. Fenix Docks houses three cultural institutions that form the Culture Cluster. Besides the cultural cluster there is the Fenix Food Factory and some other companies.

The original warehouse is characterized by raw concrete, the presence of large loading doors, an elongated heavy loading deck and an elongated strip window. On top of this the 8-storey residential building is built. The new building is adaptable due to the extra storey height and can be flexibly subdivided due to the supporting construction of columns. The windows are made of high-efficiency solar control glazing which enhances the energy efficiency. The roof gardens and vertical green inner facades encourage a healthy, comfortable and nature-inclusive living environment.

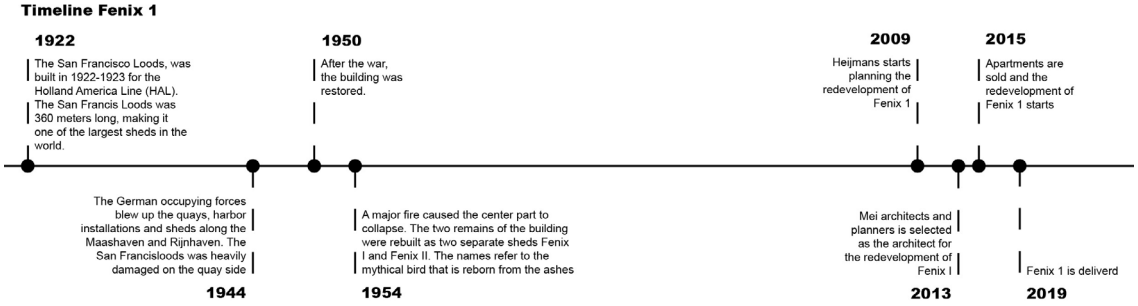


Figure 25: Timeline of major events during the lifespan of Fenix 1 (own image).

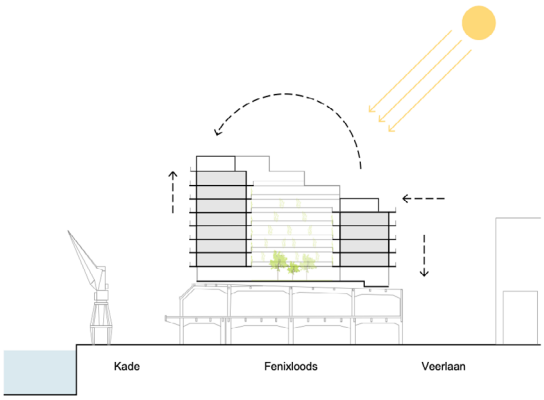


Figure 26: Concept design of Fenix 1 with the relation to its surroundings (Mei architects and planners, 2021a)

Stakeholders involved adaptive reuse Fenix 1

In the process of adaptive reuse numerous stakeholders are involved with all different demands and perspectives on the project. Herazo & Lizarralde, (2016) mentioned the different approach of the abundance of stakeholders on sustainability, which affects the decision-making process. In order to create sustainable projects there should be clarity on the sustainability ambitions of each stakeholder (Hörisch et al., 2014). If stakeholders aspire to reach the same sustainability standard it is likely that this goal will be met. Figure 27 displays the stakeholder relation diagram for Fenix 1. This diagram shows the main stakeholders involved in the project and their primary sustainable goals. Fenix 1 is the largest case in this research based on the size, budget, and number of stakeholders.

Heijmans Vastgoed, which is the developer and owner of the building, bought the warehouses from the municipality of Rotterdam that wants to develop Katendrecht. Because Heijmans has no track record with redeveloping or repurposing industrial heritage they hired Mei Architects and Planners that is an architect who focuses on transformation and repurposing (G. van Heest, personal communication, 22 February 2022). Heijmans is a developing builder, the construction branch within Heijmans carried out the development together with various subcontractors and advisers. The development of Fenix 1 must be seen in its own time, the development started in 2008 at the start of the crisis, and the sales started in 2013. In 2013 it was actually the cheapest time to buy a house. Heijmans started to build in a low and bad economy. The development branch can be seen as the commercial department of the company. They had to keep building to keep the business going (G. van Heest, personal communication, 22 February 2022). Besides their main goal to generate money, the redevelopment enhanced the social and environmental sustainability. To start the development you have to reach a certain sales percentage. The only reason the development could start was because investors had bought a share. Syntrus Achmea bought 78 rental homes, which provided a buffer to start the redevelopment. The same applies to the parking garage that has been sold to Holland Immo Group, which in turn leases the parking garage to Q-park the operator. Another major investment has been made by APF International that bought the commercial and cultural cluster, which are rented to the municipality of Rotterdam. APF saw the value of the redevelopment and contributed to the redevelopment of Fenix 1 and met the needs of the market and users. They see the importance, and opportunity in this complex real estate issue. Without these upfront investments, the project is less likely to get other financing to start the project (G. van Heest, personal communication, 22 February 2022).

Syntrus Achmea has outsourced the property management to MVGM, who are the contact party for the tenants of the apartments. MVGM is besides the contact party for the tenants of the apartment, also the property management of the cultural cluster and the Fenix food factory (R. Rietveld, personal communication, 8 February 2022). The main goal of the investors is the economic durability and continuity of their investment. The cultural cluster consists of three parties, all with their own interests. During the design they were visionary that they could do everything together. This is when an seperate project leader had been hired by the cultural parties to improve and safeguard their

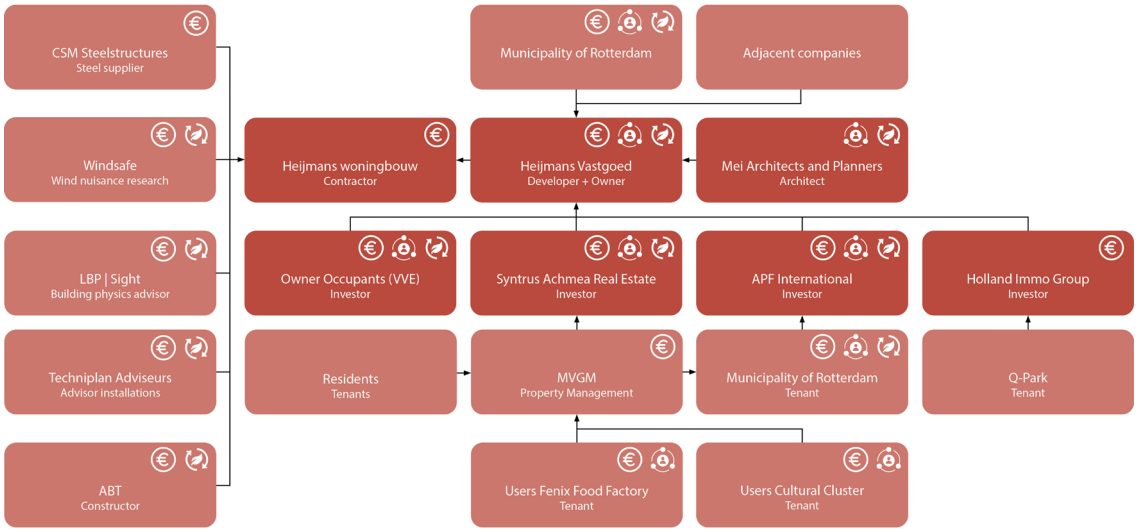


Figure 27: Stakeholders within the adaptive reuse of Fenix 1 and their sustainability goals. The dark red boxes are the stakeholders that are identified as key stakeholders that are part of the project team.

program of requirements. The many intermediaries made it difficult to change the preconditions (K. Thielen, personal communication, 17 February 2022). Besides all the investment companies there are the owner occupied residents. On their own initiative, the residents united themself before the start of the redevelopment in an owners association (H. van Langerak, personal communication, 7 February 2022). The involvement of owners benefits the redevelopment, they become part of the plan and feel like ambassadors of the project. Besides the benefits there are also several conflicts (G. van Heest, personal communication, 22 February 2022). The project team actively focuses on enhancing all pillars of sustainable development within their core business strategy. Where some stakeholders are more focused on one or two sustainability goals, all pillars of sustainable development are represented in the development of the case.

Financing adaptive reuse Fenix 1

Fenix 1 is bought by Heijmans from the municipality, it is unclear how much money is involved with the purchase of the asset. As stated the total cost of the construction of Fenix 1 is estimated at €48.000.000,-. Heijmans is developer and contractor of the project, the 48 million that are involved with the redevelopment are for the account of Heijmans. Heijmans spreads their risks by letting other parties invest in their projects. The investment for the redevelopment of Fenix 1 can be divided in four parts. Fenix 1 consists of Fenix docks, the parking garage and the steel topping that consist of 78 rental properties and 134 owner occupied properties. All parts of the development are financed by either different parties or different financing methods.

Fenix Docks

The old concrete structure that after the redevelopment consists of 6,041 m^2 lettable floor area was bought by the investor APF International, the investment fund is called Vastgoed CV APF XIX. APF International investment management in collaboration with Adviesgroep Reyersen van Buuren have successfully initiated a new investment fund for its investors. The lettable floor area is divided into a 4.049m^2 cultural cluster that is rented to the municipality of Rotterdam for 15 years, which is now rented to the users of the cultural cluster. The other 1,992m^2 is designated for horeca and offices. The total investment amounted to €11.700.000,-. The investment fund is a collective fund that represents the interest from numerous investors that is managed by APF International. The investment fund is divided in part by investment capital €4.600.000,- (39,3%) and mortgage €7.100.000,-(69,7%)(Vastgoed CV APF XIX, 2018). As a result of the "groenverklaring" which was requested by APF International. With a "groenverklaring" it is easier to borrow money more favorably. APF International got a 0,5% interest discount at the Tridosbank which is a quarter of the interest rate of the total loan. The

return on investment becomes better for the investors. ("Hergebruik is de ultieme vorm van duurzaamheid," 2021). With the regulation of "groenverklaring", the government encourages green investments in developments in environmental technology, the circular economy and sustainable and innovative (construction) projects. The tax benefits compensate for the lower return of a green fund. As a result, green funds (banks) can offer loans at a lower interest rate than the market interest rate. Investors in green projects benefit from this (Belastingvoordelen bij groenfondsen | RVO.nl | Rijksdienst, 2021).

Parking garage

The integrated parking garage in Fenix 1 that consists of 227 parking spots is sold to Holland Immo Group in collaboration with Adviesgroep Reyersen van Buuren. The investment fund that is being managed by Holland Immo Group is called Parking Fund Nederland V and consists of 3 different holdings. The holdings are parking garage Amstel Station Amsterdam, parking garage Fenix 1 Rotterdam, and parkeergarage Malieveld the Hague. The total investment fund Parking Fund Nederland V consists of €22.610.000,- of which €12.110.000,- is investment capital and €10.500.000,- is mortgage. The investment was issued on 27th of June 2016. The Fenix 1 parking garage was purchased for €4.119.552,- by the investment fund that is a collective fund that represents the interest from numerous investors. After the delivery the parking garage is rented to Q-park that will operate the parking garage (Parking Fund Nederland V, 2021).

Leased dwellings

Heijmans gave Syntrus Achmea Real estate & Finance, a real estate investor, the possibility to buy the 78 rental properties of Fenix 1. The 78 rental apartments were almost identical, which is fairly cheap to build and easier in the stakeholder management because fewer people are involved (H. van Langerak, personal communication, 07 february 2022). One of the reasons the redevelopment could start was because Syntrus Achmea had purchased 78 rental homes. It is necessary to have a certain sales percentage in order to start. Selling real estate to investors is in bulk. Especially during a crisis it is important to have a financial buffer (G. van Heest, personal communication, 22 February 2022). The redevelopment was in the middle of the crisis and Katendrecht was not as vibrant as it is right now. This is why Syntrus Achmea was skeptical at the time of initiation (Heijmans, 2019). Syntrus Achmea saw Rotterdam south increasingly becoming part of the city center and the offering of interesting investments projects. Fenix 1 is one of those projects that is a valuable addition to Syntrus Achmea client's investment portfolio. Consequently Syntrus Achmea Real estate & Finance accepted the offer and bought all 78 rental properties with capital of the BPL (pension fund agriculture). Syntrus Achmea represents the interests of the pension fund of agriculture. The pension fund made Syntrus Achmea able to invest in various properties. Syntrus Achmea as previously mentioned has the goal to invest in sustainable inclusive real estate. If it is assumed that the prices per square meter that are given in the sales brochure are in accordance with the prices paid by Syntrus Achmea Real estate and finance. The investors get a discount if they buy real estate in bulk. The total investment of Syntrus Achmea is approximately € 15.000.000,-. The average price per apartment is then estimated at € 192.308,-

Owner occupied apartments

The other 134 loft apartments were sold to private investors/ new residents. The first apartments were sold at the initiation of the project in 2014. The presale percentage to be achieved was quickly reached, this was partly due to the fact that new residents could participate in the decision making process about the apartments (Heijmans, 2019). The total income on the apartments are calculated on the basis of the sales brochure (see appendix II). The total income is calculated at € 37.182.942,- This is by far the largest share of the project. The average price per square meter for an apartment is €3.231,-.

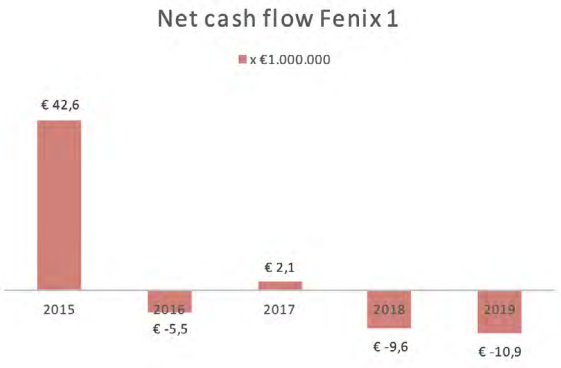


Figure 28: Net cash flow Fenix 1 from start development to delivery (own image).

Sustainability Fenix 1

Establishing an objective and substantiated assessment of the sustainability of Fenix 1 it is important to assess the sustainability factors of adaptive reuse in industrial heritage that define sustainability. The sustainability coding scheme has been drawn up from the literature and forms the basis that determines the sustainability outcome of the redevelopment project. The assessment of the factors is substantiated by data that is gathered in extensive literature research, case documents and conducted semi-structured interviews with involved parties or individuals. The assessment of the sustainability and the outcome of the sustainability are justified further on.

Economic sustainability

Value increase adjacent properties

Research participant 07 is owner of one of the loft apartments in Fenix 1. They bought the apartment in 2015 and currently the price of the apartment is 100 to 150% higher than they paid for (H. van Langerak, personal communication, 07 february 2022). The prices of houses in Katendrecht have risen enormously. The houses have a considerable increase in the value of their neighborhood due to the arrival of all catering and cultural institutions. In the past you only had the Walhalla theater and the rest was wasteland. Nowadays there is more movement in the area (R. Rietveld, personal communication, 08 February 2022). The relative property value change around the redevelopment of Fenix 1 together with the property value change of the Netherlands and Rotterdam is shown in appendix II. 2015 is the moment the development started and in 2019 the former industrial warehouse was transformed to residential and mixed use. After the development there is a clear increase in the relative property value change around the redevelopment of Fenix 1. One year after the redevelopment was delivered the increase in a radius of 100m from Fenix 1 was 44% compared with the 15,6% average increase in Rotterdam. The residential property values adjacent to the redevelopment are directly related to the redevelopment of Fenix 1.

Cost benefit (materials & time)

Redeveloping old structures comes with various challenges and setbacks. During the adaptive reuse of Fenix 1 they found huge mysterious concrete blocks during excavations, this had quite some consequences. It is unclear what the function of the concrete blocks was and where they originate from but the design had to be revised which resulted in considerable delays (Heijmans, 2019; Liukku, 2017). In addition to the delay that was related to the excavations there was also a considerable amount of materials added to the old concrete structure of the warehouse. The adaptive reuse of the industrial heritage used the old structure of the warehouse but also added almost 1 million kilos of steel to realize the superstructure to create the loft apartments (G. van Heest, personal communication, 22 February 2022). This addition to the old warehouse was possible due to the monumental status. There was significant extra time and materials involved with the adaptive reuse of Fenix 1.

Economic viability

Fenix 1 is one of the major redevelopments of Katendrecht. Before the redevelopment of Fenix 1 there were some place making functions that made the area more of interest. There is an obvious economic development taking place in Katendrecht (K. Thielen, personal communication, 17 February, 2022). Nowadays Fenix 1 houses various different functions. The creation of these functions generate employment

for local residents and new activities, which result in a multiplier process where money flow is generated and job creation is established. The economic viability is determined by the indirect economic impact the adaptive reuse of the industrial heritage has on its surrounding. The adaptive reuse of Fenix 1 contributed to the general upgrade of the neighborhood (E. van Holland, personal communication, 7 October 2021). The adaptive reuse of Fenix 1 has a (in)direct positive economic impact.

Financial feasibility

The redevelopment of Fenix 1 did cost more time and money than originally intended. The construction of Fenix 1 had to deal with major setbacks that had to be overcome. The construction took longer because dozens of concrete blocks measuring 4 by 2 by 2 meters were found in the ground of the old warehouse when the foundation was laid. This resulted in considerable delays, where the patience of future residents was put to the test. These setbacks and delays had a great impact on the financial feasibility of the case (Heijmans, 2019; Liukku, 2017). Due to the delay all 134 apartment owners received money based on the number of square meters they had bought. On average all owners received €10.000 as compensation for the delays (H. van Langerak, personal communication, 07 february 2022). All components of the redevelopment of the old warehouse have been sold in the depth of the 2008 financial crisis. Thenceforth the construction took place when the economy picked up and prices rose (K. Thielen, personal communication, 17 February 2022). This resulted in that no extra money could be generated while the project was being executed. No more income could be generated but more costs were generated which means that the profit margin was diminishing.

Social sustainability

Social interaction/ social networks

Fenix 1 is transformed into a mixed use program. The so-called Fenix docks include various different programs which enhance the social interaction/ social network stability of the community. One of the functions is the cultural cluster where “Codarts”, “Circus Rotjeknor” and “Conny Janssen” are housed. The social connection between these parties of the cultural cluster are strengthened by this building. The reason is that the parties are more logistically intertwined (R. Rietveld, personal communication, 08 February 2022). Another function that contributes to social interaction is the Fenix Food Factory. The Fenix Food Factory is a place where people from all over Rotterdam come to have a drink and meet people. The passage to the quay is a connection to the commercial spaces, this connection and these functions contribute to social interactions. The building has gallery access. Those galleries with a number of landing points ensure that people meet each other and do not enter the elevator anonymously and do not see each other (G. van Heest, personal communication, 22 February 2022). The social interaction among the buyers is of a very high level. In addition to the Fenix Food Factory, on the ninth floor there is a Fenix Fit Factory. Every

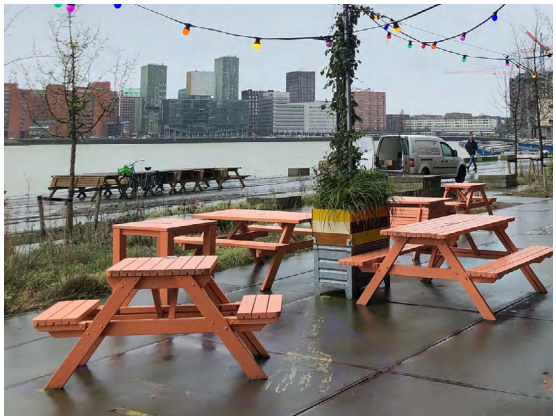


Figure 29: Functions that enhance the social interaction/ social networks (own pictures).

Saturday morning all people from the 9th floor go out for a walk together, this shows the interaction among apartment owners (H. van Langerak, personal communication, 07 February 2022). The idea of creating your own loft attracts a certain type of people. "A group of residents is established that is daring and not attributing housing as a status symbol. Generally these people are open to meet and enhance social interaction (G. van Heest, personal communication, 22 February 2022)."

Safety and security

Katendrecht became a notorious district, known for a lot of alcohol, violence and prostitution. However, that changed at the beginning of this century. Due to extensive demolition and new construction, the character of the area changed. "Katendrecht was of course just an insanely bad neighborhood. When you put love and attention in a place and improve that place the social safety changes" (G. van Heest, personal communication, 22 February 2022). The district has been on the rise in recent years because a lot has been invested in renovation and the construction of new homes and facilities. Katendrecht has received a major boost, especially due to the arrival of creative entrepreneurs. The redevelopment of Fenix 1 is a stimulus for the sense of safety and security of the area. Research participant 08 does not see any direct increase in safety and security. He experiences unwanted visitors in the cultural cluster. "the sense of security may even have deteriorated slightly." (R. Rietveld, personal communication, 08 February 2022).

Increasing accessibility and encounters

Old industrial sites are often very disconnected to the city fabric (Chen, 2020). The size of the warehouse is not contributing to this, the human scale is often lost in the size of the old derelict industrial sites. The Fenixloodsen were not the first development, a lot had already happened on Katendrecht. At some point, that important connection is made with the bridge. "If the bridge was not realized, you would never have developed the Fenix 1 in this way" (W. de Vries, personal communication, 09 February 2022). The bridge connecting the two islands has been an important factor for the start of the redevelopment (K. Thielen, personal communication, 17 February 2022). The value of the development is that the barrier was lifted. The quay and the water became accessible to the neighborhood. The Fenix Food Factory was able to establish itself in Fenix 2 and the development of Deli Plein has given the neighborhood a boost. Katendrecht benefited from a number of developments and the associated encounters there (G. van Heest, personal communication, 22 February 2022). The different functions naturally attract people, so the area becomes more accessible and more encounters take place. The accessibility and the encounters related to

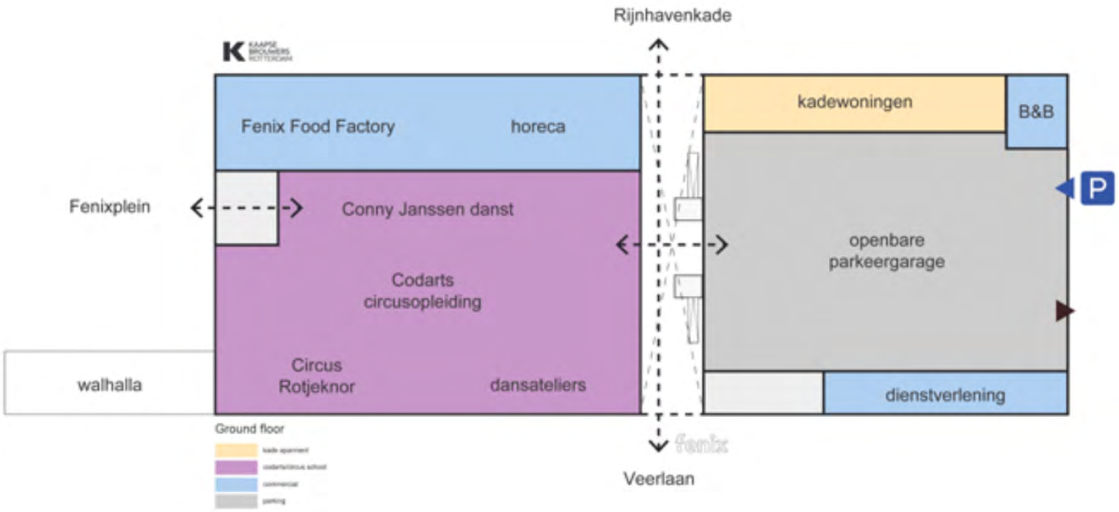


Figure 30: The mixed use program on the ground level of the redevelopment of Fenix 1 (Mei architects and planners, 2021a).

it contribute to enhancing the community stability. The actual accessibility in terms of road traffic has decreased (R. Rietveld, personal communication, 08 February 2022). Because of all the buildings you can hardly get in or out in the morning (H. van Langerak, personal communication, 07 February 2022). The adaptive reuse of Fenix 1 incorporated the creation of the Fenix passage that connected the Veerlaan with the quay. The Fenix passage is a gradual transition from the street to the quay due to the windows (G. van Heest, personal communication, 22 February 2022). The original structure was an obstacle that after adaptive reuse is becoming increasingly part of the city fabric. Research participant 04 calls it a textbook example of added value of adaptive reuse.

Pride and sense; attachment to place

The redevelopment of Fenix 1 makes old meet new, the creation of a steel building block on top of the old warehouse cultivates the industrial character of the area. The redevelopment of Fenix 1 won several prizes that demonstrate the success of the project. Satisfaction with the living situation indicates how pleasantly people live in the neighborhood and determines to a large extent whether people have plans to move. Neighborhoods where people live satisfactorily and do not want to leave have a stronger market position than neighborhoods where this is less (Lami & Mecca, 2020; Nash and Christie, 2003). There was a concern that the character created by the industrial heritage would disappear, which has not happened (R. Rietveld, personal communication, 8 February 2022). “Elements with a story and value have been preserved which contributes to the quality of the place. The story, context and time layers are made visible (G. van Heest, personal communication, 22 February 2022).”

Participation of groups and networks in redevelopment

Fenix 1 is characterized by the social participation within the redevelopment. Besides a transformation project, it was also decided to sell freely divisible lofts where, as a buyer, you could buy 1 to one and a half bays and then furnish them yourself. This strategy was necessary at the time to start the project (G. van Heest, personal communication, 22 February 2022). Deciding together had a great influence on the social participation of the new owners within the project. All stakeholders were really closely involved with the redevelopment. Before the start of the construction there was already an owners association which displays the collaboration and participation of different groups (H. van Langerak, personal communication, 07 February 2022; Heijmans, 2019). Although it is sometimes difficult, it is important that the involved parties are involved early in the project so that they can become ambassadors of the idea (G. van Heest, personal communication, 22 February 2022).

Environmental sustainability

Reduction of health risks by hazardous contamination

The contamination of the surroundings of the redevelopment is defined by the soil and air pollution. The soil and air pollution can have a relation with the former function of the area or the asset of the redevelopment. The urban background gives a high concentration of air pollution, by the location specific measures this concentration can get over the threshold of hazardous contamination (Milieu -en Natuurplanbureau, 2007). Commissioned by the Municipality of Rotterdam/ Stadsontwikkeling, a study was carried out in 2006 into the soil quality of the location of Fenix 1. Based on the indicative soil map of the municipality of Rotterdam, the location was suspicious for light contamination with heavy metals and PAH (Polycyclic aromatic hydrocarbons) in the upper meter of soil. The soil layer from 1.00 m-mv is not suspicious for contamination

with heavy metals and PAH. In view of the results of the present soil analyzes, it can be stated that the moderate to strong contaminants found in the soil are of a local nature. In view of the nature of the contaminants and the hardening layer present on the site, there are no current risks. Besides these contamination there is a group of owners that removes dirt from the bushes outside the building once every two weeks. It is a social activity and it has a positive effect on the living environment (H. van Langerak, personal communication, 07 February 2022).

Preserving the embodied energy

The redevelopment of Fenix 1 worked with the current structure and did not consume more land than the plot where the old warehouse was standing on. Using the old structure of the warehouse is reducing the waste involved with adaptive reuse. Although, preserving the embodied energy is quite debatable, you leave an existing shed partially standing, but at the same time tons of steel has been used to be able to realize the superstructure (G. van Heest, personal communication, 22 February 2022).

Public infrastructure

Fenix 1 is located at a former harbor area where there was little to no access to green space. The direct surrounding of the redevelopment of Fenix 1 is still very raw, and has a harbor look. The design incorporates solutions that are nature inclusive and ensure the environment to be incorporated within the building. Figure 31 shows a schematic drawing of the redevelopment with the nature inclusive design solutions. The redevelopment includes vertical green facades with an irrigation system, and a green roof garden for a healthy comfortable living environment. A conscious decision was made not to have the inner garden covered with sedum, but to have it landscaped. There is a garden committee, in which environmental sustainability is considered (H. Langerak, personal communication, 07 February 2022). The green roof garden contributes to a pleasant climate in the building and it prevents heat stress in the public areas. The atmosphere of the quay is also closely related to the location and former port area (G. van Heest, personal communication, 22 February 2022). Next to Fenix 1 a square is created that contributes to the overall quality of public space. The redevelopment of Fenix included greenery in the design and in addition to the greenery that was added in the development they incorporated charging points for electric vehicles such as cars and bicycles within the parking garage. All these solutions contribute to enhancing the environment in the redevelopment and the quality of the public space.

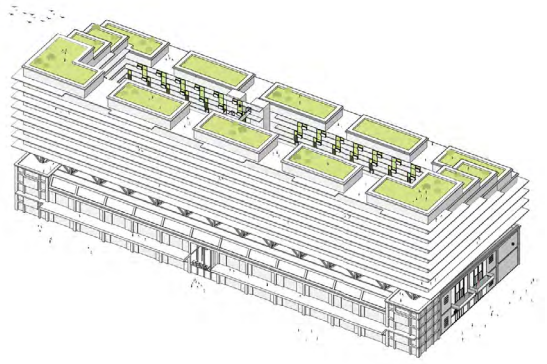


Figure 31: Nature inclusivity in the design of Fenix 1 that enhances the environment (Mei architects and planners, 2021).

Energy performance

For the cultural cluster the initial program requirements stated that the heating was to be controlled by radiators. The agreements made in the programme of requirements were simply very bad (K. Thielen, personal communication, 17 February 2022). Climate control is very important for the cultural cluster. The essential climate/ energy performance installations have been incorporated in the redevelopment. LED lighting that is switched on motion sensors is incorporated in the design. Besides the lighting an underfloor heating which was originally not incorporated in the design is eventually incorporated for the comfort of the users (R. Rietveld, personal communication, 08 February 2022). Despite some conflicting points in terms of environmental sustainability, environmental sustainability is an integral part of the adaptive reuse of Fenix 1. All apartments are optimally oriented for the entry of daylight. The glass facade is made

of high efficiency controlled glazing. The balconies and the external sun blinds the cooling need is being reduced. In addition to the use of LED lighting and the high-efficient mechanical ventilation system, and the use of heat and cold storage for cooling and heating makes the energy use of the building low (R. Rietveld, personal communication, 08 February 2022). By means of these energy sustainable installations and interventions Fenix 1 has an above average energy performance.

Consolidation sustainability Fenix 1

The sustainability of Fenix 1 is seen in figure 32 and is based on the consolidation of coding the three sustainability pillars that comprise sustainable development (Parkin et al., 2003; Guo et al., 2021; Kahn, 1995). Based on the coding of the interviews related to Fenix 1 one can see the ratio between the different sustainability factors. The figure displays which factors were mentioned most frequently during the interviews and whether they relate to each other or whether one of the factors stands out. When sustainability benefits are enhanced more than the sustainability challenges occur, the development tends to include that pillar of sustainability. If one sustainability pillar is coded more absolutely than another sustainability pillar the interviewees mentioned these sustainability pillars more. This can mean that the particular sustainability pillar tends to be more included in the adaptive reuse of this case. The coding yields an overview of the sustainability benefits and challenges mentioned but partly neglects the quality of the data and forgets to highlight the different interpretations of connotations in the data, meanwhile it gives a clear synopsis of the case (Glaser & Laudel, 2004).

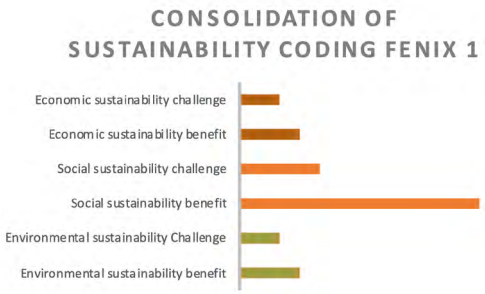


Figure 32: Sustainability of Fenix 1 as a consolidation of coding the three sustainability pillars that comprise sustainable development.

HAKA

Location	Vierhavenstraat 38, 3029 BE, Rotterdam
Monumental status	National monument
Old function	Warehouse, factory, and office
Year of construction	1932
Year of transformation	2022/2023 (future)
Surface	10.500m2
Programme new function	Multi-company office building, catering industry
Development costs	€22.000.000
Initiator development	Dudok Projectontwikkeling (Developer & Investor)

History HAKA

The history of HAKA is set out in the timeline seen in figure 33. The commercial building with grain silo was commissioned by the cooperative wholesale association "de Handelskamer" (HAKA). The HAKA building was delivered in 1932. At the time it was the place where goods were processed and packaged in the factory, and traded in the building's offices. Goods were delivered by water and were processed and packaged in the factory. During the use of the building there were various adjustments made in the building, in 1948 they installed a concrete elevator in the building. In 1962 the canteen building was replaced by a two-storey extension over the full width of the office volume. In the seventies the function of the building eventually became derelicted. .

In 2002 HAKA was designated as a national monument, and was included in the monument register. In 2006 the building was sold for the first time to a real estate investor that 2 years later sold the asset to "Vestia" which is the biggest housing association of the Netherlands. The goal of them was to transform the old warehouse into a clean tech campus. Their goal was to gain a good position in the area which will be revitalized in the future. Eventually the ministry of the interior and kingdom relations orders the housing association to sell the property (Vestia, 2016). In 2017 HAKA was sold to Dudok Real estate, who became the new owner of the building and started to initiate the redevelopment of the property (S. van Gurp, personal communication, 21 October 2021).

From 2010 till now different place making/ bottom up approaches took place. One of these place making ideas was in 2010 developed by DoepelStrijkers concept for the ground floor using secondary materials (HAKA RECYCLE OFFICE, n.d.). After this small creative initiatives have been housed in the building (S. van Gurp, personal communication, 21 October 2021). There is a plan ready for the transformation of a 10.500 m2 multi-company office building (J. Semijn, personal communication, 12 November 2021). The building is located at M4H which is an area that hosts multiple developments. The project is not yet started but is aimed to be realized by 2023. The construction and the design of the project will be executed by local companies.

Design adaptive reuse HAKA

(WDJArchitecten, 2020)

The point of departure for the design of HAKA is the integration of the new functions while maximizing the preservation of the building's own historic industrial character and appearance. This is achieved through a combination of careful restoration and renovation of historical components and precise interventions and additions of new components. The original use and structure of the building is taken as a point of departure to create a new working environment. It is the goal to transform HAKA into a 10.500 m^2 multi-company office building.

The central underpass will serve as the main entrance for all functions in the building (offices, restaurant, and sky bar) and at the same time connect the street with the rear area, where the parking facilities are located. On this ground floor a central reception lobby with a reception desk is realized, the stairs and elevators are also located here from where all other functions are accessible.

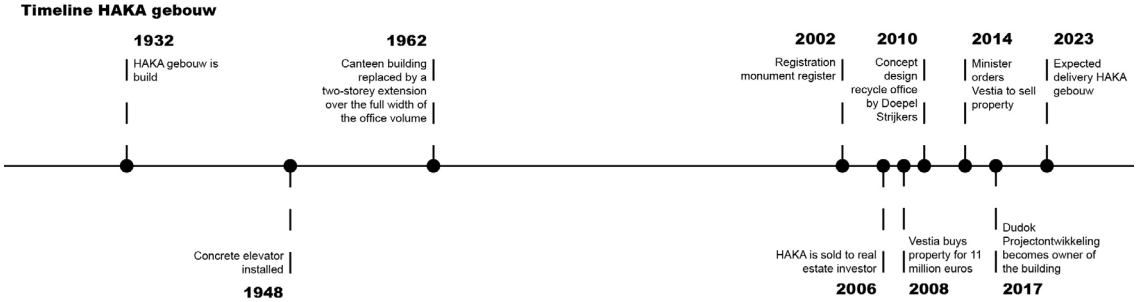


Figure 33: Timeline of major events during the lifespan of HAKA (own image).

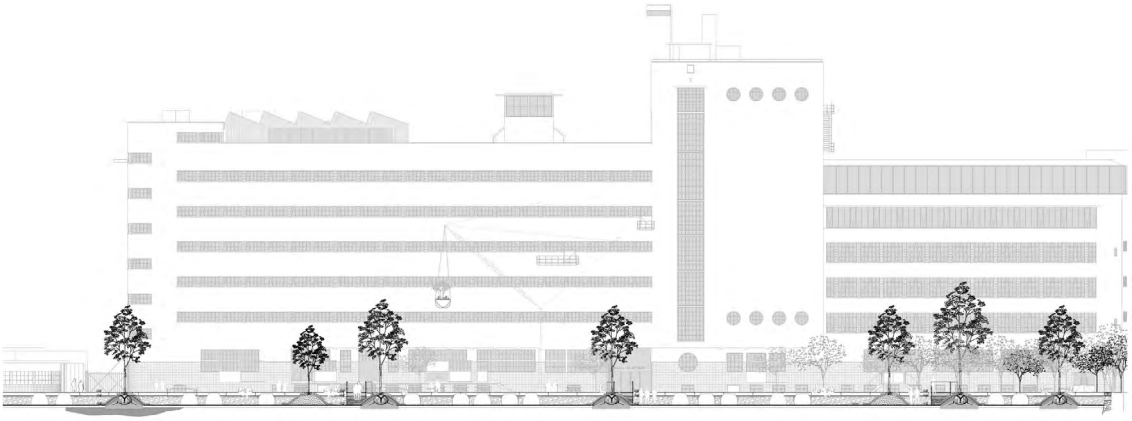


Figure 34: Redevelopment of HAKA with the profile of the parking garden with water buffer and vegetation (Delva landscape architecture urbanism, 2019).

The paternoster elevator that has monumental value will be preserved, although making it operational is unfeasible. In order to create a spatial connection with the basement, there will be a restaurant realized, which has access via the former loading dock connection to at the rear side of the building.

To be able to deal flexibly with (future) small and large tenants, the tenant option for office and factory is, among other things, the installation of internal walls. There will be a skybar created on the 6th and 7th floors above the central Silo, which is in line with the factory in terms of materialization and atmosphere.

Stakeholders involved adaptive reuse HAKA

In the process of adaptive reuse numerous stakeholders are involved with all different demands and perspectives on the project. Herazo & Lizarralde, (2016) mentioned the different approach of the abundance of stakeholders on sustainability, which affects the decision making process. In order to create sustainable projects there should be clarity on the sustainability ambitions of each stakeholder (Hörisch et al., 2014). If stakeholders aspire to reach the same sustainability standard it is likely that this goal will be met.

Figure 35 displays the stakeholder relation diagram for HAKA. This diagram shows the main stakeholders involved in the project and their primary sustainable goals. Haka is the only case in this research that is not yet developed. Still HAKA is a representative case and shows the potentiality of the adaptive reuse of the industrial heritage. Dudok Real Estate is owner, developer & investor of the project, which makes the project team fairly small in comparison with other cases. Dudoks sustainability goals are primarily focussed on economic and environmental sustainability (S. van Gurp, personal communication, 21 October 2021). HAKA is a national monument, which resulted in a debate between developer and advisory parties, within the municipality of Rotterdam, about the preservation of the building. In these consultations, the interests of the municipality are discussed with regard to the preservation of parts of the monument and the development of the surrounding area (E. van der Kleij, personal communication, 11 February 2022). If good arguments are listed and the municipality is included in the story and the decision making process, more is possible than expected (J. Semijn, personal communication 12 November 2021). In order to understand the context of HAKA Suzanne Fischer has been hired to establish a document with the historical context of the industrial heritage. In 2017 Dudok called WDJArchitecten and four other architectural firms to participate in the architect selection for the redevelopment of HAKA. WDJArchitecten won the tender and are involved from the initiation phase to where the project is currently standing. The field of tension in which WDJArchitecten mainly works is the redevelopment, transformations, and renovations of existing buildings (J. Semijn, personal communication, 12 November 2021). Delva the landscape architect has

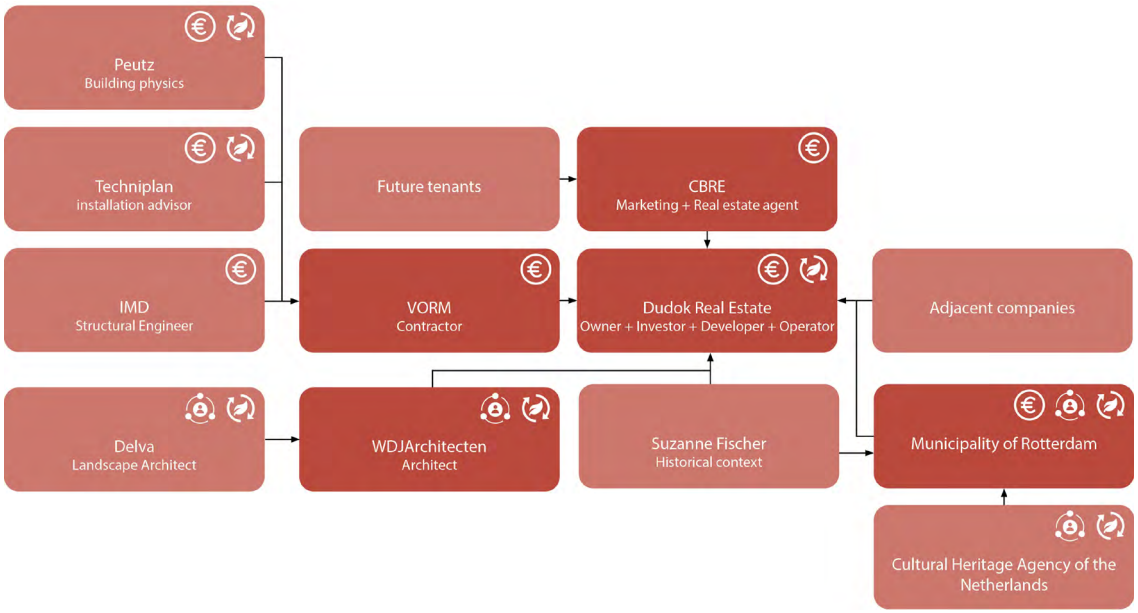


Figure 35: Stakeholders within the adaptive reuse of HAKA and their sustainability goals. The dark red boxes are the stakeholders that are identified as key stakeholders that are part of the project team.

been hired to boost and enhance the environmental sustainability in the direct surrounding of the HAKA case (E. van der Kleij, personal communication, 11 February 2022). Besides the architect, Dudok hired Vorm as a contractor to focus on the manufacturability, technology, and to spread their risks. Vorm entered into a cooperation agreement in bouwteam with Dudok to jointly tackle the redevelopment. Vorm's main focus is the process planning, realization and technical costs. Vorm is the main contractor who employs various subcontractors and constructors. The focus for these parties was on developing a plan with as little risk as possible (E. van der Kleij, personal communication, 11 February 2022). CBRE is hired as the marketing party that brings the operator Dudok together with the new tenants. The project team actively focuses on enhancing all pillars of sustainable development within their core business strategy. Where some stakeholders are more focused on one or two sustainability goals, all pillars of sustainable development are represented in the development of the case.

Financing adaptive reuse HAKA

HAKA has had numerous different owners throughout the years. "Het Havenbedrijf" owned the property for a long time, but sold the asset in 2006 to a real estate investor that two year later sold the property for 528% of the purchase value without making major alterations to "vestia". "Vestia" at that time was the biggest housing corporation of the Netherlands. The municipality of Rotterdam wants to redesign the entire M4H area in the coming years and move all port-related activities further away from the city (W. de Vries, personal communication, 09 February 2022). Vestia saw the development task of M4H and wanted to house a campus for the clean tech industry in the Haka building. The ministry of the interior and kingdom relations ordered the housing corporation to repel the asset because they were not performing their core business, which is the development of social housing (de Groot & Verbraeken, 2012). This is where Dudok Real Estate, a developer and investor, bought the asset for €2.700.000,- from Vestia in 2017 (S. van Gurp, personal communication, 21 October 2021). Over time Dudok Real Estate increased their portfolio with the (re)development of several buildings. This made them able to buy, invest and exploit HAKA. The total investment is €24.700.000,- of which €22.000.000,- (91,3%) are the estimated redevelopment costs (S. van Gurp, personal communication, 21 October 2022). The goal of Dudok Real estate is to house high-end offices in HAKA, which will be rented for €210,- m^2/per year (Haka Gebouw, Vierhavensstraat 40, n.d.). The total income per year has been calculated in appendix II and is and is estimated at €2.405.550,- for

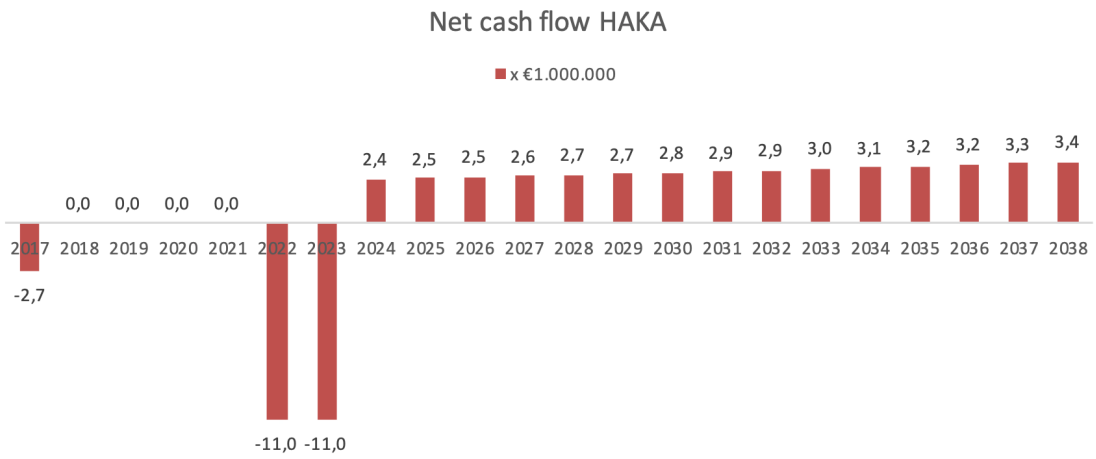


Figure 36: Net cash flow HAKA from purchase asset to expected break even point (own image).

the first year the tenants will occupy the offices. After the first year the annual rent increase is approximately set at 2,5% and is based on an average annual rent increase. Assuming that HAKA will be fully occupied once the project is delivered and the IRR of the redevelopment is set at 7% which is normal for development companies the HAKA case will roughly reach its break even point in 15 years from the first year tenants will move into the multi-company office building. This is a rough calculation on the financing of the project and does not take into account any more setbacks in the design and decision-making process. It is likely that either the occupancy rate is lower or the expected development costs will be higher which affects the financing and the financial feasibility of the adaptive reuse of HAKA.

Sustainability HAKA

Establishing an objective and substantiated assessment of the sustainability of de Fabriek van Delfshaven it is important to assess the sustainability factors of adaptive reuse in industrial heritage that define sustainability. The sustainability coding scheme has been drawn up from the literature and forms the basis that determines the sustainability outcome of the redevelopment project. The assessment of the factors is substantiated by data that is gathered in extensive literature research, case documents and conducted semi-structured interviews with involved parties or individuals. The assessment of the sustainability and the outcome of the sustainability are justified further on.

Economic sustainability

Value increase adjacent properties

The relative property value change around the redevelopment of HAKA gebouw together with the property value change of the Netherlands and Rotterdam is shown in appendix II. HAKA has no residential properties in the direct surrounding. Hence, there is no data available on the value of adjacent properties. Besides that this is an effect that can only be studied after a development has taken place.

Cost benefit (materials & time)

The cost effectiveness of the development is defined by the materials and time used in the redevelopment. Due to the monumental status of the building few interventions can be made, this reduces the number of materials used in the redevelopment. But at the same time the monumental status of the asset ensures that more time is needed with restoring industrial details that are being kept. The total time of the whole redevelopment will take approximately 1,5 years (S. van Gurp, personal communication, 21 October 2021). Due to high costs by the architect, savings had to be effectuated to ensure a financially feasible plan. concessions have been made on the use of fewer and cheaper materials (E. van Kleij, personal communication, 11 February 2022).

Economic viability

The economic viability is determined by the economic impact the adaptive reuse of the industrial heritage has on its

surrounding. The functions that HAKA is going to house will give an impulse to the surrounding of the asset. These functions contribute to the multiplier process where people spend money and at the same time jobs will be created (S. van Gurp, personal communication, 21 October 2021). The functions include; a gym, a canteen and, among other things, a nightclub with a 24-hour permit. Next to this the redevelopment consists of offices and a high-end restaurant. These are all ingredients that are going to take place throughout the day (E. van der Kleij, personal communication, 11 February 2022). The redevelopment of HAKA is going to house functions that will generate local employment in the area. Figure 37 gives an overview on the different functions and the dispersion of them within the adaptive reuse of HAKA. "If 300 people come to work there every day, partly by car, partly by train, going to the supermarket or the café next door, HAKA can be seen as a catalyst for the area" (E. van der Kleij, personal communication, 11 February 2022). Because these initiatives are economically prosperous, more can be effectuated economically and ultimately more socially (E. van der Kleij, personal communication, 11 February 2022). The redevelopment of HAKA is most likely to be a stimulus and catalyst for further development of the area (E. van Holland, personal communication, 07 October 2021).

Financial feasibility

Creating a feasible business case is hard. Due to the Covid-19 pandemic there are still no offices rented which means that they have not started redeveloping HAKA. In order to start the redevelopment they want to rent out at least 50% of the initiated office space (S. van Gurp, personal communication, 21 October 2021). Dudok is a vital party for the municipality of Rotterdam to stimulate development of the area. The roof is being converted into a high-end skybar. The addition of extra square meters is an important part of the financial feasibility of the business case for Dudok. The municipality made a concession because preserving the property is more important than preventing the topping (J. Semijn, personal communication, 12 November 2021). Everyone is waiting for each other until someone actually starts a development. Dudok has to develop on account and risks (E. van der Kleij, personal communication, 11 February 2022). The only thing that is still missing to guarantee Dudok's financial business case is a tenant. In the meantime, inflation and construction costs rose. The moment the redevelopment starts the plan has to be revised (E. van der Kleij, personal communication, 11 February 2022).

Social sustainability

Social interaction/ social networks

The adaptive reuse of HAKA will house functions that enhance the social interaction/ social networks. The realization of a nightclub that opens in the evening and a skybar with roof terrace creates places for people to gather and interact. These functions are located on the border of the city and the port. If you stand on the roof and look to one side, you see

Figure 37: Schematic overview on the different functions and the dispersion of them. The red arrows indicate the entrances and underpass that connect both sides of the building; the underpass is open to the public during the day (WDJArchitecten, 2021).

all the icons of the city; from the Euromast to de Rotterdam and the Erasmus Bridge. If you look the other way, you see the harbor. The catering industry is not only intended for the office building, but also for the neighborhood. The whole building is buzzing twenty-four hours a day and there is movement which attracts a lot of people (J. Semijn, personal communication, 12 November 2021).

Safety and security

It is unclear if the safety and security will become better than it is right now. The safety and security of the area is fine during the day due to the social security of the various companies. At night there is not much activity, which makes the area unfavorable and the sense of security far to be seen. In the redevelopment plans it is the idea that the building gets a 24/7 function which results in a more vibrant and active area. The initiatives and functions within the redevelopment will prosper economically, which ultimately also improve socially. there is a connection between the functions and the safety and security (E. van der Kleij, personal communication, 11 February 2022).

Increasing accessibility and encounters

HAKA is located at the periphery of the city and the front of M4H. M4H is a breeding pond for small businesses but is still very isolated from the city. The redevelopment of HAKA is contributing to the accessibility of the area by housing functions to attract people to the area (W. de Vries, personal communication, 09 February 2022). The design incorporates a semi-public underpass through the building that becomes a connection between the Vierhavensstraat and the rear side (port side). This design solution enhances the accessibility of the building and the area and creates encounters which helps as a catalyst for further development. On the other hand, the two-lane road between Haka and the rest of Rotterdam is a major barrier (E. van der Kleij, personal communication, 11 February 2022).

Pride and sense; attachment to place

Due to the monumental status of HAKA not many things could be changed on the building's appearance. This is why the building will keep its original appearance with some minor interventions. Many details are kept and some details are even emphasized on. HAKA is preserved in structure but changed in function (G. van Heest, personal communication, 22 February 2022). By placing the insulation on the outside, the inside has remained original, which contributes to the user experience of the tenants. Preserving the building and the details within ensures that the building cultivates cultural awareness by the users (J. Semijn, personal communication, 12 November 2021). At an architectural level, there is a lot of tension in the caution with how the asset is approached so the monument is not damaged but nevertheless a fitting function is created (E. van Holland, personal communication, 07 October 2021). HAKA is located at the juncture of the city and the harbor and contains an age-old piece of authenticity. It's not so much the hardware, but the whole ambiance, the atmosphere, the feeling it evokes (E. van der Kleij, personal communication, 11 February 2022).

Participation of groups and networks in redevelopment

During the initiation of HAKA there was no social participation with new tenants. The developer has a lot of experience in this type of redevelopment and they think that no extra social participation with the new tenants is needed (S. van Gurp, personal communication, 21 October 2021). The district is partly involved in the development due to the social return of investment. The developer has the obligation to employ 1 or 2 people from the neighboring district. This creates a certain social participation and connection (E. van der Kleij, personal communication, 11 February 2022).

Environmental sustainability

Reduction of health risks by hazardous contamination

The contamination of the surroundings of the redevelopment is defined by the soil and air pollution. The soil and air pollution can have a relation with the former function of the area or the asset of the redevelopment. The urban background gives a high concentration of air pollution, by the location specific measures this concentration can get over the threshold of hazardous contamination (Milieu -en Natuurplanbureau, 2007). The former warehouse is located in an active harbor area. The emissions of the adjacent juice factory creates restrictions for the redevelopment of HAKA. The presence of the factory ensures that there are restrictions for the development of housing within a certain radius of HAKA (J. Semijn, personal communication, 12 November 2021). In addition to the pollution of the environment based on the air quality, the harbor next to the building was damped with clean sand (WDJArchitecten, 2021). Before Dudok bought the building they did a preliminary soil investigation where no contamination was found (S. van Gurp, personal communication, 21 October 2021).

Preserving the embodied energy

From the perspective of sustainability, it is a waste to demolish and throw away structures and buildings that are still usable (J. Semijn, personal communication, 12 November 2021). In the redevelopment of HAKA there is little waste involved. For the demolition of parts a circular mining company will mine all the reusable materials from the building (S. van Gurp, personal communication, 21 October 2021). In addition, the monumental status of the asset ensures that they could not make major interventions within the building (J. Semijn, personal communication, 12 November 2021). The circular demolition together with the monumental status ensures that little waste is involved with the redevelopment of HAKA. The insulation will be on the outside of the building because the finish on the inside must be maintained due to the identity of the industrial heritage. As a result, much is preserved and little is demolished (J. Semijn, personal communication, 12 November 2021).

Public infrastructure

The area around HAKA provides an impulse to combat the “urban” heat effect. The context of HAKA is primarily defined by asphalt, business activities and little to no greenery. This affects the ecological system and reduces biodiversity. The landscape around HAKA is designed by Delva landscape architecture urbanism. The area behind HAKA is shaped as a parking garden that will be filled with approximately 30 scattered feather-shaped trees, planted on (seating) hills of grass. The semi-sunken and green parking garden functions as a water buffer during extreme rainfall (WDJArchitecten, 2020; E. van der Kleij, personal communication, 11 February 2022). The extensive plan for flora and fauna that is included in the design of the redevelopment of HAKA catalytic greening of the industrial M4H area (J. Semijn, personal communication, 12 November 2021). In addition to the green accessibility within the redevelopment and adjacent to the redevelopment, HAKA also offers space for about 50 electrical (shared) cars. Figure 38 is a section of the parking garden where the design solutions that enhance the environment are displayed.

Figure 38: Enhancement of green spaces in the direct surrounding of the redevelopment of HAKA (WDJArchitecten, 2020).

Energy performance

Despite the fact that the structure is old and other elements of the monument such as the old window frames have to be preserved the inside energy/comfort label will reach level A. Dudok’s principles

were to significantly increase the comfort of the building which has been a significant investment for HAKA. Placing the insulation on the outside of the facade, the tenants have the comfort of a new building, but the look of industrial heritage. (J. Semijn, personal communication, 12 November 2021). The steel frames remain in place, but double glazing will be installed. The insulation value is high and there is good insulation on the outside of the building. For a national monument it is quite exceptional to insulate on the outside, but in HAKA's case it was the best option. All in all, the energy performance is good (J. Semijn, personal communication, 12 November 2021). Besides the good insulation, the building will be connected to the district heating (E. van der Kleij, personal communication, 11 February 2022). The significant increase in comfort is due to the fact that the target group is high-end tenants, this means that the energy performance needs to be high (S. van Gurp, personal communication, 21 October 2021). The design included horizontal windows to bring more light into the offices. Without these horizontal windows you basically have an unlivable office or an unworkable office (E. van der Kleij, personal communication, 11 February 2022). And since Dudok wants to keep HAKA in their own portfolio, they also focus on higher quality (J. Semijn, personal communication, 12 November 2021).

Consolidation sustainability HAKA

The sustainability of HAKA is seen in figure 39 and is based on the consolidation of coding the three sustainability pillars that comprise sustainable development (Parkin et al., 2003; Guo et al., 2021; Kahn, 1995). Based on the coding of the interviews related to HAKA one can see the ratio between the different sustainability factors. The figure displays which factors were mentioned most frequently during the interviews and whether they relate to each other or whether one of the factors stands out. When sustainability benefits are enhanced more than the sustainability challenges occur, the development tends to incorporate that sustainability pillar. If one sustainability pillar is coded more absolutely than another sustainability pillar the interviewees mentioned these sustainability pillars more. This can mean that the particular sustainability pillar tends to be more included in the adaptive reuse of this case. The coding yields an overview of the sustainability benefits and challenges mentioned but partly neglects the quality of the data and forgets to highlight the different interpretations of connotations in the data, meanwhile it gives a clear synopsis of the case (Glaser & Laudel, 2004).

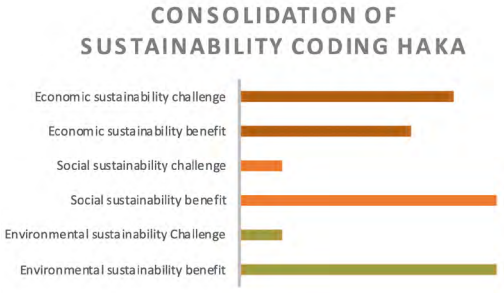


Figure 39: Sustainability of HAKA as a consolidation of coding the three sustainability pillars that comprise sustainable development.

SYNTHESIS

The synthesis reduces and summarizes the data to the main findings. In addition to the main findings from the cases, the foundation for the conclusion is established. The synthesis combines and cross examines the empirical research to find correlation between the adaptive reuse projects and the added value on the triple bottom line of sustainability. The cases are cross examined on various aspects of the redevelopment. The analysis is based on a methodological implementation of the concepts and themes to the transcripts (Mayring, 2000). Besides the methodological implementation, the synthesis highlights the different interpretations of connotations of the data that give a clear synopsis of the cases (Glaser & Laudel, 2004). The versatile analysis provides a clear picture of the relation between the cases and their sustainability. This all-encompassing analysis is the foundation to display how adaptive reuse of industrial heritage, in post- industrial Dutch urban area development, relates to the added value, in regards to the economic, social and environmental sustainability?

Sarvimäki (2018) mentions that in the qualitative research of multiple case studies, triangulation is vital to confirm the credibility of the outcome. Triangulation, or cross examination weighs the different characteristics of the case studies. Examining and interpreting the outcome and success of the adaptive reuse on sustainability with the various variables of adaptive reuse of industrial heritage, gives the foundation for a substantiated answer to the research question. The interviews conducted from different perspectives give insight to the sustainability of the projects and alludes to the general expected sustainability of adaptive reuse in industrial heritage. The main idea of the synthesis and cross examination is that the qualitative background of the research is interpreted with the advantages of quantitative content analysis (Mayring, 2000). Counting and measuring “patterns” or “themes” demonstrate the occurrence of them in the qualitative data (Fereday & Muir-Cochrane, 2006). Although it partly neglects the quality of the data and forgets to highlight the different interpretations of connotations in the data it gives a clear synopsis of the case (Glaser & Laudel, 2004). If differences in the quantitative content analysis are noted, the data is examined in detail to highlight different interpretations of connotations.

The data from the empirical case studies and the information derived from the analysis of the transcripts in AtlasTi are synthesized in a code-document table. The transcripts of the interviews are grouped per case. The occurrence of codes on sustainability in the interviews displays the ratio between the sustainability benefits and challenges in the adaptive reuse of industrial heritage from each interviewees perspective. Five interviews with experts are conducted to examine the expected

outcome and the incorporation of sustainability in an adaptive reuse project. An additional ten interviews are conducted with other case related interviewees. The occurrence of the codes per sustainability theme allows for an understanding of each case's sustainability benefits and challenges. In order to compare the cases and the expected outcome, it is key to normalize the number of codes. If the data of the cases is normalizes to the document group with the most codes, the cases are made comparable (ATLAS.ti Scientific Software Development GmbH, 2020). The two cases that have been delivered are synthesized with the expert view, whereas the case that has not yet been developed is only synthesized with the expert view. The relationship between the sustainability of the cases that have been delivered and the case that still has to be redeveloped cannot be established due to bias and skewness in the scope of the project.

Sustainability in adaptive reuse of industrial heritage

This analysis shows the sustainability of adaptive reuse in industrial heritage that has been delivered and the relation of factors that complement this result. The coding of the sustainability outcome of the cases with the expected outcome of sustainability from the expert view is displayed in table 6. This synthesis does not directly reflect the sustainability of de Fabriek van Delfshaven and Fenix 1, but rather reflects sustainability benefits and challenges per case as they are perceived by the research participants. This table shows the relativity of the sustainability factors in adaptive reuse in industrial heritage. If the occurrence of codes in the case studies deviate from the occurrence of codes in the conducted interviews with the expert panel, the relation between the sustainability pillars deviates from the expected outcome of adaptive reuse in industrial heritage (ATLAS.ti Scientific Software Development GmbH, 2020). This can show the differences in the cases and the factors that cause the differences in the separate sustainability pillars.

The sankey diagram that is displayed in figure 40 is a visualization of the normalized case- code occurrence table (sustainability factors). The diagram shows the relation between the cases and the expected outcome on the sustainability pillars in adaptive reuse by the expert panel. Derived from the sankey diagram and the case-code occurrence table the relativity of social sustainability to the other two sustainability pillars is about 50% of all codings. This tends to show the importance and presence of social sustainability in the adaptive reuse of industrial heritage but does not disclose that social sustainability is the sole sustainability pillar. If social sustainability is dissected into the benefits and challenges it is clear that there are more social benefits than challenges related to the adaptive reuse of industrial heritage. Economic sustainability is the pillar with the second most number of codes. Environmental sustainability and its benefits and challenges is the least coded sustainability pillar. This gives an overview on how the different pillars of sustainability are incorporated in the adaptive reuse of industrial heritage.

Table 6: Case- code occurrence table of de Fabriek van Delfshaven and Fenix and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	de Fabriek van Delfshaven Gr=49; GS=3			Fenix 1 Gr=85; GS=4			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Economic sustainability benefit	5	9,737	13,16%	7	7	9,46%	8	10,963	14,81%
• Economic sustainability challenge	6	11,684	15,79%	8	8	10,81%	12	16,444	22,22%
• Environmental sustainability benefit	4	7,789	10,53%	10	10	13,51%	11	15,074	20,37%
• Environmental sustainability challenge	3	5,842	7,89%	6	6	8,11%	5	6,852	9,26%
• Social sustainability benefit	15	29,211	39,47%	34	34	45,95%	15	20,556	27,78%
• Social sustainability challenge	5	9,737	13,16%	9	9	12,16%	3	4,111	5,56%
Totals	38	74	100,00%	74	74	100,00%	37	74	100,00%

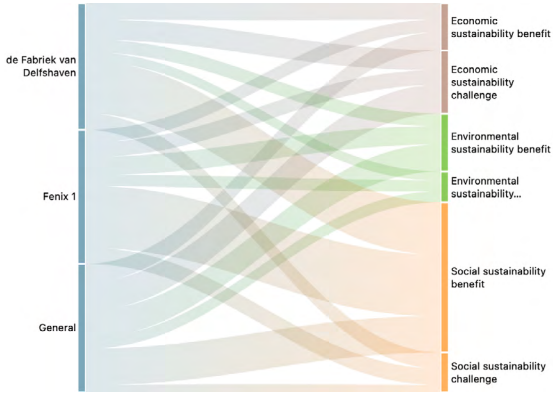


Figure 40: Sankey diagram of de Fabriek van Delfshaven and Fenix 1 with the general prospect of adaptive reuse of industrial heritage on the three sustainability pillars, the diagram is derived from coded conducted interviews in Atlas Ti.

Economic sustainability

Zooming in on economic sustainability in the cases that have been delivered and the perception of the expert panel, it is evident that it is hard to establish economic sustainability in adaptive reuse of industrial heritage. The coding of economic sustainability derived from the interviews is shown in table 7. There is no distinct difference between de Fabriek van Delfshaven and Fenix 1 on economic sustainability. However, compared to the expected economic sustainability from the expert panel, the benefits of economic sustainability are slightly more enhanced.

The coding yields an overview of the economic benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. Both cases have a serious impact on the value increase of the adjacent properties, and the economic viability of the area, which means the indirect appraisal of the direct surrounding of the redevelopment. A difference between the cases is the alteration of the structure which has an impact on the cost-benefit. De Fabriek van Delfshaven has worked with the existing structure and did not make too many alterations, resulting in a high-cost benefit. Fenix 1 made many alterations to the structure, resulting in long procedures and a negative effect on economic sustainability. Another difference between the cases is the financing that impacts the project's economic sustainability. In the case of de Fabriek van Delfshaven, the owner made the investment which resulted in financial risks to exploit the asset. Fenix 1 shared risks by attracting investors to the project. Involving third parties is based on a contractual model which due to the delay of the project has been a setback for the economic sustainability. As the coding shows there have been more economic challenges than benefits. Although the coding for both cases is almost identical the reasoning behind the enhancement of economic sustainability can differ.

Social sustainability

Zooming in on social sustainability in the cases that have been delivered and the perception of the expert panel, it is evident that social sustainability is strongly incorporated in the adaptive reuse of industrial heritage. The coding of social sustainability derived from the interviews is shown in table 8. Both cases practically follow the expected outcome on social sustainability. The expected outcome from the expert panel on social sustainability assumes there are more benefits than challenges related to the adaptive reuse of industrial heritage. Both redevelopments strongly enhance social sustainability.

The coding yields an overview of the social benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. As the coding shows there are serious more social sustainability benefits than challenges. This

Table 7: Economic sustainability case- code occurrence table of de Fabriek van Delfshaven, Fenix 1 and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	de Fabriek van Delfshaven Gr=49; GS=3			Fenix 1 Gr=85; GS=4			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Economic sustainability benefit	5	9,091	45,45%	7	9,333	46,67%	8	8	40,00%
• Economic sustainability challenge	6	10,909	54,55%	8	10,667	53,33%	12	12	60,00%
Totals	11	20	100,00%	15	20	100,00%	20	20	100,00%

Table 8: Social sustainability case- code occurrence table of de Fabriek van Delfshaven, Fenix 1 and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	de Fabriek van Delfshaven Gr=49; GS=3			Fenix 1 Gr=85; GS=4			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Social sustainability benefit	15	29,211	75,00%	34	34	79,07%	15	35,833	83,33%
• Social sustainability challenge	5	9,737	25,00%%	9	9	20,93%	3	7,167	16,67%
Totals	20	43	100,00%	43	43	100,00%	18	43	100,00%

tends to show the enhancement of social sustainability in both cases. The adaptive reuse of both cases contributes to the increasing accessibility and the encounters that take place in and around the industrial heritage, due to the function that has been incorporated in the design of Fenix 1 this benefit has been more noticeable. Both cases present an increase in the safety and security and the attachment to the place after the industrial heritage had been adopted. Due to the function of the redevelopment and the number of stakeholders involved and the spreading of risks, Fenix 1 has a high participation of users which contributes to the social sustainability of the project. Too many stakeholder involvement makes procedures and processes take longer. Although the coding for both cases is almost identical the reasoning behind the enhancement of social sustainability can differ.

Environmental sustainability

Zooming in on environmental sustainability in the cases that have been delivered and the perception of the expert panel, it is evident that environmental sustainability is strongly incorporated in the adaptive reuse of industrial heritage. The coding of environmental sustainability derived from the interviews is shown in table 9. The expected outcome from the expert panel on environmental sustainability assumes there are more benefits than challenges related to the adaptive reuse of industrial heritage. Both redevelopments strongly enhance environmental sustainability.

The coding yields an overview of environmental benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. As the coding shows there are more environmental sustainability benefits than challenges. This tends to show the enhancement of environmental sustainability in both cases. The adaptive reuse of both cases contributes to the reduction of contamination and the improvement of the energy performance. Housing new functions takes away the old hazardous functions of the building and the area and improves the energy performance to meet the comfort standards. De Fabriek van Delfshaven sustains the old structure and therefore uses the embodied energy of the building. Fenix 1 enhances the public infrastructure more due to the location of the industrial property. Although the coding for both cases is almost identical the reasoning behind the enhancement of environmental sustainability can differ.

Table 9: Environmental sustainability case- code occurrence table of de Fabriek van Delfshaven, Fenix 1 and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	de Fabriek van Delfshaven Gr=49; GS=3			Fenix 1 Gr=85; GS=4			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Environmental sustainability benefit	4	9,143	57,14%	10	10,00	62,50%	11	11,00	68,75%
• Environmental sustainability challenge	3	6,857	42,86%	6	6,00	37,50%	5	5,00	31,25%
Totals	7	16,00	100,00%	16	16,00	100,00%	16	16,00	100,00%

Sustainability in design and decision-making process

The previous synthesis of the two cases, de Fabriek van Delfshaven and Fenix 1, reflected the sustainability pillars in comparison to the expected outcomes in cases that have been developed. The next analysis reflects the sustainability of adaptive reuse in industrial heritage that is still in development and the relation of factors that complement this result. The coding of the incorporation of sustainability in the design and decision-making process of the case with the expected outcome of sustainability from the expert view is displayed in table 10. This synthesis does not intend to predicate the outcomes on sustainability in the HAKA case, but rather investigates how the sustainability benefits and challenges are perceived by the research participants included in the design and decision-making process. The table shows the relativity of the sustainability factors in adaptive reuse in industrial heritage. If the occurrence of codes in the case study deviates from the occurrence of codes in the conducted interviews with the expert panel, the relation between the sustainability pillars deviates from the expected outcome (ATLAS.ti Scientific Software Development GmbH, 2020). This can show the differences in the case and the factors that cause the differences in the separate sustainability pillars.

The sankey diagram that is displayed in figure 41 is a visualization of the normalized case- code occurrence table(sustainability factors). The diagram shows the relation between the case and the expected outcome on the sustainability pillars in adaptive reuse by the expert panel. Derived from the sankey diagram and the case-code occurrence table the relativity of the three pillars of sustainability are not far deviated from one another. It shows that economic sustainability is most enhanced in the design and decision making process; whereas the relativity of the social and environmental sustainability pillars are almost identical. This tends to show the importance and presence of economic sustainability in the design and decision-making process but does not disclose that economic sustainability is the main factor. It gives a synopsis of the incorporation of the different sustainability pillars in the design and decision-making process of adaptive reuse of industrial heritage. The coding of sustainability of HAKA is not far from the coding of the expert panel on the expected sustainability of adaptive reuse of industrial heritage. This shows that HAKA tends to follow the same path as the adaptive reuse in industrial heritage according to the expert panel.

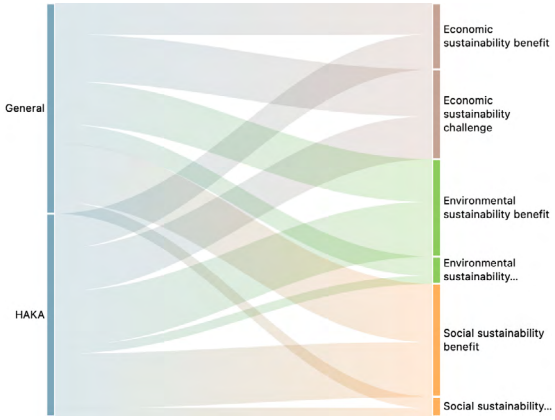


Figure 41: Sankey diagram of HAKA with the general prospect of adaptive reuse of industrial heritage the three sustainability pillars, the diagram is derived from coded conducted interviews in Atlas Ti.

Table 10: Case- code occurrence table of HAKA and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	HAKA Gr=71; GS=3			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Economic sustainability benefit	8	9,391	17,39%	8	8	14,81%
• Economic sustainability challenge	10	11,739	21,74%	12	12	22,22%
• Environmental sustainability benefit	12	14,087	26,09%	11	11	20,37%
• Environmental sustainability challenge	2	2,348	4,35%	5	5	9,26%
• Social sustainability benefit	12	14,087	26,09%	15	15	27,78%
• Social sustainability challenge	2	2,348	4,35%	3	3	5,56%
Totals	46	54	100,00%	37	54	100,00%

Table 11: Economic sustainability case- code occurrence table of HAKA and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	HAKA Gr=71; GS=3			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Economic sustainability benefit	8	8,889	44,44%	8	8,00	40,00%
• Economic sustainability challenge	10	11,111	55,56%	12	12,00	60,00%
Totals	18	20	100,00%	20	20	100,00%

Economic sustainability

Zooming in on economic sustainability in the design and decision-making process of HAKA and the perception of the expert panel, it is evident that it is hard to establish economic sustainability in adaptive reuse of industrial heritage. The coding of economic sustainability derived from the interviews is shown in table 11. It is difficult to guarantee economic sustainability because more challenges are coded than there are benefits. This tends to show the complexity of the economic sustainability in the design and the decision making process of adaptive reuse in industrial heritage.

The coding yields an overview of the economic benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. From the interviews it becomes clear that it is hard to establish a feasible plan because it is hard to attract people and companies. The complexity lies in the nature of the context of the project, where adaptive reuse is seen as a kickstarter for urban development. At the same time this gives great impact on the economic viability and the catalyst of the area. If tenants will be found the concept is financially feasible. Although, the longer it takes to find tenants the design and finances should be revised. As the coding shows there have been more economic challenges than benefits which shows the complexity of economic sustainability.

Social sustainability

Zooming in on social sustainability in the design and decision-making process of HAKA and the perception of the expert panel, it is evident that adaptive reuse in industrial heritage is a meaningful driver of social sustainability. The coding of social sustainability derived from the interviews is shown in table 12. Adaptive reuse in industrial heritage is a way to further social sustainability due to the many benefits in ratio with the challenges. This tends to show the stimulation of social sustainability associated with this type of redevelopment in the design and decision making process.

The coding yields an overview of the social benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. As the coding shows there are serious more social sustainability benefits than challenges. This tends to show the enhancement of social sustainability in the design and decision making process of the cases. The new function of the case enhances social interaction and social networks and increases the accessibility and encounters in the area. There are currently limited equivalent functions taking place in the area and HAKA should work as a catalyst or kickstarter. The monumental status of the building contributes to the pride and sense of the place which has a positive impact on social sustainability. As the coding shows there have been more social benefits than challenges which shows the incorporation of social sustainability.

Table 12: Social sustainability case- code occurrence table of HAKA and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	HAKA Gr=71; GS=3			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Social sustainability benefit	12	15,429	85,71%	15	15,00	83,33%
• Social sustainability challenge	2	2,571	14,29%	3	3,00	16,67%
Totals	14	18	100,00%	18	20	100,00%

Environmental sustainability

Zooming in on environmental sustainability in the design and decision-making process of HAKA and the perception of the expert panel, it is evident that adaptive reuse in industrial heritage is a meaningful driver for environmental sustainability. The coding of environmental sustainability derived from the interviews is shown in table 13. Adaptive reuse in industrial heritage is a way to further environmental sustainability due to the many benefits in ratio with the challenges. This tends to show the stimulation of environmental sustainability associated with this type of redevelopment in the design and decision making process. On the other hand, there is a big difference between the HAKA case and the perception from the expert panel. This could most likely mean that environmental sustainability ambitions of the adaptive reuse of HAKA are higher and are more enhanced in the design and decision making process than in average adaptive reuse in industrial heritage cases.

The coding yields an overview of environmental benefits and challenges mentioned but does not give much insight into the reasoning behind the quantification. As the coding shows there are more environmental sustainability benefits than challenges. This tends to show the enhancement of environmental sustainability in this case. The adaptive reuse of HAKA is still allocated in an active industrial area which comes with pollution and nuisance. These are challenges to attract tenants and to further the project. The monumental status of the asset ensures high preservation of the embodied energy due to the restrictions of demolition. In addition to the embodied energy preservation the energy performance of the design is high due to the target group and the energy comfort related to them. The design of HAKA incorporated many alterations for the development of the public infrastructure. As the coding shows there have been more environmental benefits than challenges which shows the incorporation of environmental sustainability.

The cross examination of the cases give a brief description and a first impression on the ratio of the sustainability pillars and their benefits and challenges in the adaptive reuse of industrial heritage. It is the first step to be able to establish relations between the actual sustainability and the redevelopment methods of the cases. It also gives an idea of how sustainability is integrated into the design and the decision-making process. This synopsis is the blueprint for the development of the conclusion on how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social, and environmental sustainability.

Table 13: Environmental sustainability case- code occurrence table of HAKA and the comparison with the general interviews on adaptive reuse of industrial heritage. (Gr=codes & Gs=documents)

Codes	HAKA Gr=71; GS=3			General Gr=117; GS=5		
	Absolute	Normalized	Column relative	Absolute	Normalized	Column relative
• Environmental sustainability benefit	12	13,714	85,71%	11	11,00	68,75%
• Environmental sustainability challenge	2	2,286	14,29%	5	5,00	31,25%
Totals	14	16	100,00%	16	16	100,00%

CONCLUSION

This chapter provides the conclusion of the research. The conclusions are drawn from the literature and the qualitative data that is collected within the empirical case studies. The sub-questions are mainly based on the literature review which is the blueprint for the substantiation of the main research question. The composition of the subquestions either supports or neglects the findings from the cases. The case studies together with the subquestions are the basis for the answer to the main research question.

The main goal of this research is to gain a better understanding of how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social and environmental sustainability, and how the implementation methods and financial instruments affect the outcome. The case adaptive reuse of industrial heritage is assessed on the basis of coding different sustainability benefits and challenges to determine the actual sustainability of the redevelopment. A consolidation of these codes yields an overview of the sustainability of the project but partly neglects the quality of the data and forgets to highlight the different interpretations of connotations in the data, meanwhile it gives a clear synopsis of the case (Glaser & Laudel, 2004). The differences in the coding content analysis are examined in detail to highlight different interpretations of connotation to give a substantiated answer to the research question.

The sub questions that were presented in the introduction are answered on the basis of the literature study and the empirical cases. These answers give a better understanding of the scope and background of the research and are the blueprint for answering the main research question of this research "Adaptive reuse of industrial heritage in Dutch post-industrial urban area development". The sub questions are also the basis for the theoretical framework of the research.

Subquestion #1

What challenges or barriers are faced by the industrial heritage transformation if the aim of adaptive reuse is to achieve sustainable results?

Adaptive reuse of industrial heritage in the urban redevelopment of post-industrial areas is an increasingly more important concept that copes with the current demand for housing, new economic sectors and preserves the historical context that is created over the years. Due to the vacant segregated post-industrial areas, the urbanization, modernization, and population growth and the expanding power of the city reaching its limits, the opportunity for adaptive reuse in industrial heritage arises. Adaptive reuse of industrial heritage is facilitated by the factors mentioned above and is a catalyst for sustainable development. The adaptive reuse of industrial heritage should emphasize on the benefits and

cope with the challenges to strengthen the sustainability of the redevelopment project. Adaptive reuse in industrial heritage is an interplay between coping with challenges and barriers and the emphasis on the benefits. If both are dealt with accordingly the result of adaptive reuse in industrial heritage is likely to be sustainable.

The facilitating factors display the importance, in the same way the numerous inheriting factors stress the challenges and barriers related to adaptive reuse in industrial heritage.

According to an extensive literature study, the main challenges and barriers that inhibit the facility of sustainability are directly related to the sustainability pillars. The following challenges that inhibit sustainable results in adaptive reuse of industrial heritage are found in the empirical case studies and at the same time in the literature.

The adaptive reuse of the industrial heritage should be relatively simple and work with the existing structure. A drastic change in the structure can lead to delays or unexpected defects in the property, which has an impact on the economic sustainability of the project. Bringing together stakeholders to finance the project who see the need and opportunity for adaptive reuse is hard and can be time-consuming. The abundance of stakeholders can make the project take longer due to procedures and processes. The challenges related to the context of the project are difficult to change and should be dealt with accordingly. The adaptive reuse of industrial heritage quickly gives an upgrade to environmental sustainability, but may still have to deal with hazardous pollution or nuisance of adjacent properties. It is difficult to attract new tenants in remote areas. This is partly due to the limited functions within industrial areas that are not yet developed. The adaptive reuse of industrial heritage can work as a Kickstarter to ensure that the functions that attract people are realized in the area. Challenges that inhibit adaptive reuse in industrial heritage take place on multilateral levels within the adaptive reuse of industrial heritage and if they are not dealt with accordingly can affect the outcome of sustainability.

Subquestion #2

Which implementation methods have been adopted and what financial instruments have been explored if the aim of adaptive reuse is to achieve sustainable results?

There are different implementation methods and financial instruments that can be adopted within the adaptive reuse of industrial heritage and the revitalization of post-industrial urban areas. The implementation methods and financial instruments that effectuate adaptive reuse in industrial heritage are implied to be sustainable. The implementation methods of adaptive reuse of industrial heritage are mainly defined by the context of the project. These contextual implementation methods are complementary to the involvement and collaboration between stakeholders, the adaptive reuse of industrial heritage plan/ design, and the moment of initiation.

The moment of initiation of the adaptive reuse of the industrial heritage is of high importance for the success of the project. The redevelopment can take place as a pioneer or as a climax of the urban area development. The adaptive reuse as a pioneer can result in a catalyst effect for the revitalization of the urban area, whereas the adaptive reuse as a climax can be seen as a crown on the urban area development. As a pioneer, it can be difficult to attract new tenants but the redevelopment can work as a catalyst for furthering the area development.

The collaboration of stakeholders was highly dependent on the stakeholders involved and the size of the project. With the high involvement of stakeholders, adaptive reuse of industrial heritage can be taken to a higher sustainability level. More stakeholders represented results in the consideration of multiple sustainability aspects within the design of adaptive reuse. Simultaneously, the involvement of more stakeholders increases the chance of conflicts between stakeholders which can

result in delays and legal actions.

The financial instruments used in the adaptive reuse of industrial heritage relate to managing and spreading risks and achieving the demands of the stakeholders. The main distinction between the financial instruments used in adaptive reuse is the party that makes the investment and bears the risk. The owner of the asset can invest in the property or the owner engages other parties that (partly) make the investment. The main difference in the financing of adaptive reuse is the spread of risk with the financial instruments used. Spreading risks results in more stakeholders being involved in the project which can result in conflicts and delays but also the consideration of multiple sustainability aspects. Due to the sustainable character of adaptive reuse in industrial heritage investors or developers can lend money more easily by tax or interest reduction. The case studies show that these incentives make the normally unprofitable redevelopment of industrial heritage more likely to be furthered. Redevelopments cannot take place without the use of financial instruments which makes all financial instruments (in)directly contribute to the sustainability of the redevelopment of adaptive reuse. The financial instruments adopted in the adaptive reuse of industrial heritage determine to a certain extent which stakeholders are involved and which interests are represented/safeguarded.

Subquestion #3

To what extent have adaptive reuse methods and financial instruments led to sustainable outcomes?

The assessment of sustainability in adaptive reuse in industrial heritage is characterized by the equilibrium of three pillars of sustainability: economic, social, and environmental sustainability. The consolidation of the three sustainability pillars comprise sustainable development. Adaptive reuse in industrial heritage is adding value to the direct and indirect surroundings of the asset. On the basis of extensive literature study and the empirical case studies the adaptive reuse benefits per sustainability pillar are established. If these adaptive reuse benefits, which can be seen as methods to incorporate sustainability, are enhanced the adaptive reuse will lead to sustainable outcomes.

The implementation of adaptive reuse has a great impact on the social and environmental sustainability outcome. Adapting underused industrial heritage and finding new fitting functions will impact social sustainability by increasing the accessibility and encounters. The industrial heritage is, depending on the level of development of the former industrial sites, allocated in areas where the number of functions to attract people are inadequate. The adaptive reuse attracts new people and positively contributes to social sustainability.

Making use of existing structures to house new functions does emit substantially less. Working with the existing structures not only preserves the industrial legacy but also preserves the embodied energy. The formerly deserted area is becoming increasingly vibrant after the adaptive reuse which results in reclamation of public infrastructure.

The economic sustainable outcome of adaptive reuse cannot be defined because there are no substantial effects taking place. This also applies for the financial instruments adopted, there is no clear link between the financial instruments adopted and the sustainable outcome of the project. When risks are financially spread among stakeholders it is more likely that adaptive reuse of industrial heritage is being furthered. Synergies between the different interests of the project team's sustainability goals should be created. To effectuate sustainability in adaptive reuse it should be the core value around which the project team cooperates.

Central question of this research

How does the adaptive reuse of industrial heritage, in post- industrial Dutch urban area development, relate to the added value, in regards to the economic, social, and environmental sustainability?

The sub questions established a foundation to answer the central question of the research that displays how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to the economic, social and environmental sustainability. This framework supported the empirical research with a structure to assess the sustainability of the case studies. Subsequently the synthesis and cross examination of the cases support and exemplify these findings. Examining three cases does not allow results to be generalized to other cases. Instead this research reveals interesting indications that are present in at least three instances of adaptive reuse of industrial heritage, in post-industrial Dutch urban area development. Adaptive reuse in industrial heritage has to work with the context of different time layers. This context it is a great way to incorporate sustainability in the project and surroundings. To incorporate sustainability, the redevelopment has to emphasize on the benefits and deal with certain challenges associated with the complexity of the adaptive reuse of industrial heritage. Sustainability in adaptive reuse in industrial heritage is an interplay between the sustainability benefits and challenges. The key takeaways that can be deduced from the research and that show a relation between adaptive reuse in industrial heritage and the sustainability pillars are described below.

Economic sustainability

The cases show the complexity of the incorporation of economic sustainability in the adaptive reuse of industrial heritage. In the empirical case study the challenges associated with economic sustainability are more mentioned than the benefits. This tends to show the complexity of achieving economic sustainability in these redevelopment projects. The findings confirm the literature and the qualitative data gathered from the expert panel noting the revitalization of post-industrial urban areas. It is challenging to enhance economic sustainability in the design and decision making process of adaptive reuse in industrial heritage.

There can be a distinction made between the economic sustainability of the adaptive reuse of the case and the economic sustainability of the surrounding area and the people using that area. In the case studies it is evident that there are many economic challenges related to the redevelopment of the asset itself but the effects that take place after the redevelopment is delivered are substantial. If the economic sustainability of the area is perceived, the adaptive reuse of the industrial heritage should make concessions to enhance this effect. The unprofitable top that is related to the development of the dilapidated asset can be supplemented with incentives or measures that make the redevelopment more likely to be furthered.

Social sustainability

All case studies show substantial incorporation of social sustainability in the adaptive reuse of industrial heritage. After the redevelopment took place in the area there are indicators that the previously unfavorable place is becoming more livable again. In the empirical case study, the benefits associated with social sustainability are substantially more mentioned than the challenges. This tends to show that social sustainability in adaptive reuse is an important factor that is enhanced by the type of development. These findings confirm the literature and the qualitative data gathered from the expert panel noting the revitalization of post-industrial urban areas.

Social sustainability is related to the functions and design of the redevelopment. In general, these developments have a positive impact on social sustainability as they reconnect remote and underused areas with the city and bring them back to life. If the social sustainability of the area

is perceived, the project team should make the right decisions and make the design to enhance social sustainability. Development or designs that have more interaction with people related to the project are likely to enhance even higher social sustainability. The case studies also show the inhibiting factor of the abundance of stakeholders which can increase the chance of conflicts between stakeholders which can result in delays and legal actions. Derived from the empirical case study, the adaptive reuse of industrial heritage effectuates social sustainability in the formerly deprived industrial area.

Environmental sustainability

All cases show substantial incorporation of environmental sustainability in the adaptive reuse of industrial heritage. In the empirical case study, the benefits associated with environmental sustainability are substantially more mentioned than the challenges. This tends to show that environmental sustainability in adaptive reuse is an important factor that is enhanced by the type of development. These findings confirm the literature and the qualitative data gathered from the expert panel noting the revitalization of post-industrial urban areas.

The projects that have been developed in the past may have had less access to improved technologies or processes to enhance environmental sustainability. The building sector is reacting to a growing societal focus on environmental sustainability and sees the urge for adaptive reuse in industrial heritage. The conservation and preservation of old structures, and the upgrade of old derelicted, segregated post-industrial urban areas diminishes the carbon footprint and makes use of the embodied energy that is stored in the old structures. Besides, the formally polluting harbor areas are being revitalized and distant from the former polluting industries with new cleaner functions. Coupled with the adaptive reuse of industrial heritage and urban area development is the refurbishment of public infrastructure which contributes to the general life satisfaction of users. All cases positively related to environmental sustainability, due to the preservation of structures and creation of new functions in vacant assets.

Final thoughts

In conclusion, it is difficult to give a univocal answer to the question of how adaptive reuse of industrial heritage, in post-industrial Dutch urban area development, relates to the added value, in regards to economic, social and environmental sustainability. The empirical case studies show that adaptive reuse of industrial heritage greatly improves the social and environmental sustainability of the area. The degree to which this sustainability is improved is dependent on various benefits associated with adaptive reuse in industrial heritage. If the benefits are emphasized and the challenges are coped with accordingly sustainability in the project can be safeguarded.

Although some of these signals are substantiated in literature and the case studies, other findings cannot be generalized to other cases. This thesis begins to understand the factors that impact the degree of added value. By understanding these factors, the process of adaptive reuse of industrial heritage can be optimized to ensure more sustainable and successful end-products. Adaptive reuse of industrial heritage has clear benefits, furthering the research presented in this thesis ensures benefits are optimized; thereby further highlighting the opportunity of adapting and reusing industrial heritage in post-industrial Dutch urban areas. The cases reflected that a push for sustainability in society is mirrored in a growing focus on social and environmental factors that ultimately also positively influence economic sustainability.

EPILOG

The Epilog discusses the process, steps, and decisions made during the research. The discussion is a reflection of the methodology and the execution of it, that helps to substantiate further research in this field. The discussion dives into the meaning and relevance of the results. In addition to the discussion, the limitations give an overview on why data is missing or why data cannot be used for scientific purposes. If the limitations could have been prevented the research would have been more unambiguous and the results more clear and substantiated. In addition to the limitations, recommendations are presented that give future research possibilities that were either not touched upon or unclear within the scope of the research.

Discussion

Due to the complexity of adaptive reuse in industrial heritage, the various implementation methods and financial instruments, and the slightly biased and skewed results, it is difficult to legitimately draw a valid conclusion. In the discussion, the process, steps, and decisions that result in the limitations which are related to the bias and skew of the research are concluded. The context of the case studies made the outcome of the research less unambiguous and substantiated. All cases were located in the context of Rotterdam which made them easier to compare with one another. If adaptive reuse of industrial heritage would take place in a different context the assessment and the outcome might differ from this research.

How research is conducted is the primary source on the actual outcome of the project. In this research three case studies are performed, this is limited to a certain extent. Conclusions that have been drawn from these cases might not be applicable to other cases or is at all the conclusion in other cases. Some data was only available from a certain year why it was not possible to find proper and unambiguously linkage between the data and the adaptive reuse of the industrial heritage. In this research the data is also dependent on the interviewee and what they mention about the case studies. The sustainability benefits are established on economical, social, and environmental standards of the present day. Resulting the older redevelopment cases to be less sustainable now then when they were actually redeveloped. In addition to the technological standards the outcome may skew results of the other sustainability pillars in adaptive reuse of industrial heritage.

For some cases it was hard to get in contact with involved parties or individuals. They either did not reply to the emails that were sent or did reply that they did not have any time to participate in the research. When an interview had been arranged the information that was given was often fairly biased which made the assessment of the input of the interviewee multi-interpretable, which makes the outcome of

the sustainability assessment of the cases subjective. After the interviews had been conducted the transcripts of them were coded on the basis of the challenges and benefits of the sustainability pillars. Coding transcripts is to some extent subjective because connotations of interviewees can be interpreted differently which skew the results of the coding and the sustainability benefits and challenges in the adaptive reuse of industrial heritage.

Limitations

The limitations that made the research less substantiated are derived from the discussion points that have been described above. The limitations are presented as an enumeration which makes the flaws of this research evident. The limitations are important factors that should be enhanced in further research to make it more substantiated and significant.

- Context of the cases limits the credibility of framework and conclusion.
- The number of case studies limits the validity and significance of the conclusion.
- The different characteristics of the cases limits the validity and significance of the conclusion.
- Old cases limit the possibility to find proper unambiguously data.
- Limited qualitative data makes the assessment biased and multi-interpretable.
- Interview protocol is heading in a certain direction.

Recommendations

In addition to the limitations that counter the success of the research, recommendations that give future research possibilities that were either not touched upon or unclear within the scope of the research are established. There are some tools to capture the potential adaptive reuse in industrial heritage, although there are no tools that actually assess the incorporation of the adaptive reuse plan. If there would be an assessment potential framework prior to the redevelopment there is an extra juncture to revise the design and improve the plan. The creation of a holistic assessment framework potential tool can be incorporated within practice of the decision-making process of adaptive reuse in industrial heritage. Incorporating the tool within practice can make the actual sustainability of redevelopment projects more sophisticated. In addition to making the redevelopment projects becoming actually more sustainable, the holistic assessment framework potential tool for adaptive reuse in industrial heritage can exclude or diminish uncertainties and risks that would normally appear at the end of the redevelopment.

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APPENDICES

This table displays the relative property value change per year from 2008 to 2020 of the Netherlands, Rotterdam and the direct surroundings of all three case studies. It provides a comparison between the direct surroundings of the adaptive reuse and the context (city and country). The change in percentage of the property value of the adjacent properties before and after the adaptive reuse of the particular case is compared with the percentage of the indicated city and country. If the percentage rose after the redevelopment took place and this is substantially higher than the change in property value in the context, the adaptive reuse of the case study potentially had a positive effect on the economic sustainability.

Relative Property Value Change all cases														
Property value change index the Netherlands		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
x €1000	Value of immovable property of residential and non-residential properties	232	241	242	236	232	223	211	206	208	217	230	248	270
%	Property Value Change		3,9	0,4	-2,5	-1,7	-3,9	-5,4	-2,4	1,0	4,3	6,0	7,8	8,9
Property value increase index Rotterdam														
x €1000	Value of immovable property of residential and non-residential properties	159	163	164	162	159	153	148	146	148	153	166	192	222
%	Property Value Change		2,5	0,6	-1,2	-1,9	-3,8	-3,3	-1,4	1,4	3,4	8,5	15,7	15,6
DE FABRIEK VAN DELFSHAVEN (2013)														
Property value increase index de Fabriek van Delfshaven 500m		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
x €1000	Value of immovable property of residential and non-residential properties	X	X	X	X	X	X	X	X	103	106	114	142	166
%	Property Value Change										2,9	7,5	24,6	16,9
Property value increase index de Fabriek van Delfshaven 100m														
x €1000	Value of immovable property of residential and non-residential properties	X	X	X	X	X	X	X	X	106	112	123	148	177
%	Property Value Change										5,7	9,8	20,3	19,6
FENIX 1 (2019)														
Property value increase index FENIX 1 500m		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
x €1000	Value of immovable property of residential and non-residential properties	X	X	X	X	X	X	X	X	187	201	229	275	369
%	Property Value Change										7,5	13,9	20,1	34,2
Property value increase index FENIX 1 100m														
x €1000	Value of immovable property of residential and non-residential properties	X	X	X	X	X	X	X	X	110	121	139	166	239
%	Property Value Change										10,0	14,9	19,4	44,0
HAKA (Future)														
Property value increase index HAKA gebouw 500m		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
x €1000	Value of immovable property of residential and non-residential properties	X	X	X	X	X	X	X	X	119	119	126	143	164
%	Property Value Change										0,0	5,9	13,5	14,7
Property value increase index HAKA gebouw 100m (No data available)														

This table displays the actual income of Fenix 1 and the potential income for HAKA. The income for Fenix 1 and the average price of an apartment is calculated on the basis of the sales brochure of Fenix 1. The sales brochure is provided by research participant HvL (07). The sales brochure contains presale drawings that give an overview of the price level with a heat map. The potential annual income of the HAKA case is derived from the marketer CBRE (Beschikbare kantoorruimtes in Nederland, n.d.).

Fenix owner occupied apartments			
	Square meter	Price per square meter	Total income per floor
Ground level	345,87	€ 3.300	€ 1.141.371
1st Floor	345,87	€ 3.300	€ 1.141.371
1st Floor entresol	213,5	€ 3.300	€ 704.550
2nd Floor	630	€ 3.400	€ 2.142.000
3th Floor	Syntrus Achmea Real Estate and Finance		
4th Floor	Syntrus Achmea Real Estate and Finance		
5th Floor	Syntrus Achmea Real Estate and Finance		
	168,56	€ 2.900	€ 488.824
	1105,02	€ 3.050	€ 3.370.311
	126,42	€ 3.150	€ 398.223
6th Floor	562,12	€ 2.850	€ 1.602.042
	538,02	€ 2.900	€ 1.560.258
	126,42	€ 3.050	€ 385.581
	1277,5	€ 3.100	€ 3.960.250
	126,42	€ 3.200	€ 404.544
7th Floor	225	€ 2.900	€ 652.500
	120,4	€ 3.100	€ 373.240
	120,4	€ 3.180	€ 382.872
	1397,9	€ 3.200	€ 4.473.280
	126,42	€ 3.300	€ 417.186
8th Floor	121	€ 3.200	€ 387.200
	1269,5	€ 3.300	€ 4.189.350
	126,42	€ 3.400	€ 429.828
9th Floor	62	€ 3.150	€ 195.300
	88,5	€ 3.350	€ 296.475
	1204	€ 3.400	€ 4.093.600
	126,42	€ 3.500	€ 442.470
10th Floor	62	€ 3.550	€ 220.100
	337,12	€ 3.650	€ 1.230.488
	337,12	€ 3.700	€ 1.247.344
	218,56	€ 3.900	€ 852.384
Total	11508	€ 3.231	€ 37.182.942
Average price per apartment (134 apartments)			€ 277.485

Fenix Syntrus Achmea Leased dwellings			
	Square meter	Price per square meter	Total income per floor
3th Floor	2630	€ 3.000	€ 7.890.000
4th Floor	2630	€ 3.000	€ 7.890.000
5th Floor	2630	€ 3.000	€ 3.690.000
Total/ Average	6490	€ 3.000	€ 19.470.000
Bulk discount investor	25%		€ 15.000.000

HAKA			
	Square meter	Price per square meter	
Basement	1027	€ 210	€ 215.670
Ground level	1103	€ 210	€ 231.630
1st Floor	1751	€ 210	€ 367.710
2nd Floor	1671	€ 210	€ 350.910
3th Floor	1678	€ 210	€ 352.380
4th Floor	1629	€ 210	€ 342.090
5th Floor	1625	€ 210	€ 341.250
6th Floor	707	€ 210	€ 148.470
7th Floor	244	€ 210	€ 51.240
8th Floor	20	€ 210	€ 4.200
Total/Average	11455	€ 210	€ 2.405.550

de Fabriek van Delfshaven

Legend

Nominal rent per square meter	€ 14	
Nominal rent per office loft per month	€ 3.458	250 m2 received end of the year, price level t=2
Nominal rent per standard unit per month	€ 415	30 m2 received end of the year, price level t=2
Nominal rent per square meter	€ 14	m2
Nominal annual rent increase	8,40%	
Nominal rent per standard office unit per year	€ 4.980	
Nominal rent office loft year	€ 41.500	
Number of standard office unit	36	
Initial investment	€ 4.000.000	At t=0 (2011)
Terminal value building	€ 4.100.000	At t=8; price level t=8

IRR 6,2%

The Internal rate of return is determinend by using goal seek:
The NPV is set at zero by changing the discount rate.

Period	0	1	2	3	4	5	6	7	8
	2011	2012	2013	2014	2015	2016	2017	2018	2019
Occupancy rate	0%	0%	100%	100%	100%	100%	100%	100%	100%
Income									
Rent income office units	0	0	179.280	194.340	210.664	228.360	247.542	268.336	290.876
Rent income social functions			41.500	44.986	48.765	52.861	57.301	62.115	67.332
Investment									
Purchase/re-sale price	-4.000.000								4.100.000
Return analysis									
Net cash flow	-4.000.000	0	220.780	239.326	259.429	281.221	304.843	330.450	4.458.208
Present value net cash flow	-4.000.000	0	195.862	199.975	204.174	208.462	212.839	217.308	2.761.379
							Net present value		0

HAKA

Legend

Rent	€ 210	m2/p.j.
Size building	11455	m2
Nominal annual rent increase	2,5%	
Purchase costs	€ 2.700.000	
Development costs	€ 22.000.000	

IRR 7,0%

The Internal rate of return is determinend by using goal seek:
The NPV is set at zero by changing the discount rate.

Period							0	1
Year	2017	2018	2019	2020	2021	2022	2023	2024
Occupancy rate								100%
Income								
Rent income								2.405.550
Investment								
Purchase/re-sale price	€ -2.700.000					-11.000.000	-11.000.000	
Return analysis								
Net cash flow HAKA	-2.700.000	0	0	0	0	-11.000.000	-11.000.000	2.405.550
Present value net cash flow	-2.700.000	0	0	0	0	-11.000.000	-11.000.000	2.248.178

Fenix 1

Listed amounts of euro's are stated in price level t=0

Owner occupied apartments	€	37.182.942
Rental properties	€	15.000.000
Concrete structure	€	11.700.000
Parking garage	€	4.119.552
Development costs	€	48.000.000
Refund for delay	€	1.340.000

Expected rate of return

Expected IRR	7,0%

Period	0	1	2	3	4	5	6
Year	2013	2014	2015	2016	2017	2018	2019
Occupancy rate	0%	0%	0%	0%	0%	0%	100%
Investment							
Purchase/re-sale price			€ -9.600.000	€ -9.600.000	€ -9.600.000	€ -9.600.000	€ -9.600.000
Owner occupied apartments			€ 37.182.942				
Rental properties			€ 15.000.000				
Parking garage				€ 4.119.552			
Concrete structure					€ 11.700.000		
Refund for delay							€ -1.340.000
Return analysis							
Net cash flow	€ -	€ -	€ 42.582.942	€ -5.480.448	€ 2.100.000	€ -9.600.000	€ -10.940.000
Present value net cash flow	0	0	37.193.591	-4.473.678	1.602.080	-6.844.667	-7.289.784
					Net present value		20.187.541

2	3	4	5	6	7	8	9	10	11	12	13	14	15
2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
2.465.689	2.527.331	2.590.514	2.655.277	2.721.659	2.789.701	2.859.443	2.930.929	3.004.202	3.079.307	3.156.290	3.235.197	3.316.077	3.398.979
2.465.689	2.527.331	2.590.514	2.655.277	2.721.659	2.789.701	2.859.443	2.930.929	3.004.202	3.079.307	3.156.290	3.235.197	3.316.077	3.398.979
2.153.628	2.063.055	1.976.291	1.893.176	1.813.556	1.737.285	1.664.222	1.594.231	1.527.184	1.462.957	1.401.431	1.342.492	1.286.032	1.231.946
											Net present value		695.664

For this qualitative research, stakeholders that were directly or indirectly involved in the cases are interviewed. The table displays all interviewees, they are defined by (code)name, involvement in case, profession and date of interview. The interviewees whose (code)names are bold are part of the expert panel that gave an explanation of the challenges and benefits associated with adaptive reuse in industrial heritage.

Interviewees Master Thesis, Development and Preservation Industrial Heritage							
Code name		Involvement in case	Relation to the case	Profession	Company	Date of interview	Location of interview
01	RW	de Fabriek van Delfshaven, FENIX 1	Architect	Architect	Mei Architecten and Planners	11/06/2021	Office Mei Architecten and Planners
02	IJ	de Fabriek van Delfshaven	User	Architect	jvantspijker & partners	30/09/2021	de Fabriek van Delfshaven
03	**JDK**	HAKA	Monument inspector	Monuments inspector	Municipality of Rotterdam	01/10/2021	Online
04	**EvH**	All	-	Director of advice on urban renewal	NRP Gulden Fenix	07/10/2021	Online
05	SvG	HAKA	Developer	Senior Project Developer	Dudok	21/10/2021	Office Dudok
06	**JS**	HAKA	Architect	Architect	WDJArchitecten	12/11/2021	Office WDJArchitecten
07	HvL	Fenix 1	Founder owner association	-	-	07/02/2022	Online
08	RR	Fenix 1	Building manager	Concierge	Codarts	08/02/2022	Fenix 1
09	**WdV**	HAKA, All	Urban development planner	Urban development planner	Municipality of Rotterdam	09/02/2022	Online
10	**AB**	All	-	Developer	BOEI	11/02/2022	Telephone
11	EvdK	HAKA	Head of Plan Preparation	Head of Plan Preparation	Vorm Transformation & Renovation	11/02/2022	Online
12	PB	de Fabriek van Delfshaven	Activist, local resident	Civil planner	Delfshaven cooperatie	15/02/2022	Online
13	KT	Fenix 1	Project leader cultural cluster	-	-	17/02/2022	Online
14	RG	de Fabriek van Delfshaven	Director real estate development PWS	Housing advisor	Housing associations	18/02/2022	Online
15	GvH	Fenix 1	Project leader implementation phase	Project developer	Leyten	22/02/2022	Online

Email for research participants

Beste Deelnemer,

Mijn naam is Corné de Broekert, Ik ben een masterstudent aan de Technische universiteit Delft. Voor mijn master thesis kijk ik naar hoe industrieel erfgoed in Rotterdam adaptief wordt hergebruikt. Het gaat voornamelijk over de uitdagingen die bij dit soort (her) ontwikkelingen komen kijken, en hoe hier een financieel haalbare business case van kan worden gemaakt. Het gaat over welke financiële instrumenten worden gebruikt om dit project financieel haalbaar te maken. Ook wordt er gekeken naar de effecten van de herbestemming op economisch-, sociaal-, en ecologische duurzaamheid die deze (her)ontwikkelingsprojecten met zich meebrengen.

In dit onderzoek is het doel om van verschillende casussen te onderzoeken hoe deze projecten financieel tot stand zijn gekomen en hoe deze projecten waarde toevoegen aan het gebied. Voor mijn master thesis wil ik kwalitatieve data verkrijgen door het afnemen van semi-gestructureerde interviews met betrokken personen en partijen in de verschillende casussen die ik onderzoek. De casussen die ik wil onderzoeken zijn: De Fabriek van Delfshaven, Fenix 1 en HAKA. De resultaten van dit onderzoek zullen worden gebruikt om de literatuur te bevestigen.

Als u besluit om mee te doen in dit interview zullen de antwoorden enkel voor onderzoeksdoeleinden worden gebruikt en niet met derden worden gedeeld. Wel wordt het interview opgenomen zodat de informatie kan worden geanalyseerd en gebruikt in het onderzoek.

In de bijgevoegde informed consent staat meer informatie over het interview en wat achtergrondinformatie over mijn onderzoek. Ik hoop u bij deze genoeg te hebben geïnformeerd en ik hoop een afspraak te kunnen maken voor het afnemen van een interview. Mocht u nog vragen hebben over het onderzoek dan kunt u altijd contact opnemen via: C.M.deBroekert@student.tudelft.nl of telefonisch via +31652216038

Alvast bedankt

Met vriendelijke groet,

Corné de Broekert

Background information on the research

Verstedelijking, modernisering en bevolkingsgroei zetten de huidige Nederlandse bouwvoorraad zwaar onder druk. Binnenstedelijke ontwikkelingen in Nederlandse steden zijn beperkt door de hoge dichtheid van het stadsweefsel. Daarom verschuift de focus van stedelijke transformatie in de binnenstad geleidelijk naar ontwikkelingen aan de rand van de stad. Deze grenszones bevatten vaak voormalige industriële gebieden die momenteel vaak braak liggen en/of onderbenut zijn als gevolg van de snelle de-industrialisatie in Europa. Deze gebieden bieden een unieke kans om in te spelen op de vraag naar woningen en de ruimte voor nieuwe economische sectoren. De Nederlandse stedelijke industriegebieden zijn meer dan verlaten industrieterreinen die moeten worden geregenereerd. De aanwezigheid van industrieel erfgoed is een bron van meerwaarde voor deze herbestemmingen. De herwaardering van industrieel erfgoed is een katalysator effect dat zorgt voor verdere stedelijke revitalisering vanwege zijn maatschappelijke, historische, architecturale en technologisch belang. Dit type ontwikkeling is een kickstarter voor verdere herbestemming en het opwaarderen van achterstandswijken. Bovendien zal de herwaardering van industrieel erfgoed door adaptief hergebruik een positief effect hebben op de triple bottom line van sustainability. Ondanks de bekende voordelen, staat de revitalisering van de Nederlandse stedelijke industriegebieden ook voor tal van uitdagingen. De financiering van complexe stedelijke industriegebieden, met industrieel erfgoed, is een grote uitdaging. Gevolg van de uitdagingen waarmee deze ontwikkeling wordt geconfronteerd, stijgen de kosten mee. Het is daarom dat ontwikkelaars lastiger een winstgevende of financieel haalbare business case kunnen maken zonder prikkels van derden. De belangrijkste uitdaging is het vinden van een haalbaar en geschikt financieel instrument dat de voordelen maximaliseert op economische, sociale en ecologische duurzaamheid van het herstel van deze gebieden.

Interview protocol gebruiker/ ontwikkelaar/ expert

Overkoepelend thema interview
Hoe verhouden implementatie technieken en financiële instrumenten in adaptief hergebruik in industrieel erfgoed, in na-industriele Nederlandse herbestemmingen, tot economische, sociale en ecologische duurzaamheid.

Opname
Zorg ervoor dat het interview op twee manieren wordt opgenomen, als één van de manieren mislukt dan is er een reservekopie.

Introductie - wat is het hoofddoel van het onderzoek?
- Korte introductie over mijzelf en het onderzoek
- Uitleg over het doel van het onderzoek
- Structuur van het interview (interview protocol)

Profilering - achtergrondinformatie over de geïnterviewde en bedrijf waar men werkt
- Wie bent u en wat is uw functieomschrijving binnen het bedrijf waarin u werkt?
- Hoelang bent u al betrokken bij het bedrijf?
- Wat is uw relatie op professioneel en individueel gebied met de herbestemming van (industrieel)erfgoed?
- Wat is de reden waarom u gebruiker bent van het industrieel erfgoed?
- Kunt u zeggen dat het bedrijf waarin u werkt ervaring heeft of een relatie op het gebied van herbestemming van (industrieel) erfgoed?
- Welke herbestemmingsprojecten van industrieel erfgoed in Rotterdam bent u bij betrokken geweest of heeft u kennis van?

Algemeen - perspectief van de geïnterviewde op hergebruik van industrieel erfgoed
- Ziet u het aantal herbestemmingsprojecten in industrieel erfgoed in de stad de afgelopen jaren toenemen/afnemen?
- Wat zijn de hoofdredenen waarom industrieel erfgoed moet worden hergebruikt?
    - Professioneel perspectief
    - Persoonlijk perspectief
- Welke problemen ziet u aan de start van een herbestemmingsproject?
- Ziet u effecten nadat industrieel erfgoed is herontwikkeld in de directe omgeving?
    - Economisch
    - Sociaal
    - Ecologisch
- Ziet u dat de directe omgeving rondom de herbestemming wordt opgewaardeerd en er steeds meer mensen en bedrijven naar dit gebied trekken?
- Wat doet men om zoveel mogelijk erfgoed te behouden in de stad?
- Hoe is het contact met de verschillende die industrieel erfgoed willen ontwikkelen (community)?
- Welke stimulansen kan men ontwikkelaars bieden om meer erfgoed te herontwikkelen en het voor hen meer financieel haalbaar te maken?
- Bent u tevreden met het aantal herbestemmingsprojecten en de uitkomst ervan?

Geef een introductie over het desbetreffende project waarin de geïnterviewde aan heeft meegewerkt

Profilering casus - achtergrondinformatie over de betrokkenheid en het gebruik van de casus
- Op welke manier was u of het bedrijf betrokken bij het desbetreffende project?
- Welke partijen zijn betrokken geweest bij de realisatie van het herbestemmingsproject?
- Op welke manier is het pand aangekocht?
    - Eigen vermogen?
    - Financiering van derden?
- Wat was de staat waarin het desbetreffende pand werd aangetroffen op het moment van initiatie?
- Was het gemakkelijk om een financieel haalbare business case te creëren?
- Op welke manier is de ontwikkeling gefinancierd, is de gemeente hierbij betrokken geweest?

Ontwikkeling casus - informatie over de ontwikkeling van het pand
- Zijn er tijdens de ontwikkeling onverwachte dingen naar boven gekomen die te maken hadden met de vorige functie of de leeftijd van het pand?
- Hoe was de buurt tegenover de herbestemming van het pand?
- Bent u zelf tevreden met de uitkomst van de herbestemming?

Uitkomst casus - informatie over het resultaat en gebruik van het pand
• Zijn er effecten zichtbaar die plaatsvonden na de herbestemming van het pand?
Economisch
• Verandering van woningwaarde in directe omgeving
• Kosteneffectieve ontwikkeling (materiaal & tijd)
• Economische levensvatbaarheid
• Financiële haalbaarheid van het herbestemmingsproject

Sociaal
• Sociale interactie & sociale netwerken
• Gevoel van veiligheid
• Arrangeren van bereikbaarheid en ontmoetingen
• Trots en gevoel; gehechtheid aan plaats (woonbeleving)
• Maatschappelijke participatie van groepen en netwerken in de herbestemming

Ecologisch
• Milieuvervuiling
• Behoud van belichaamde energie in materiaal
• Public infrastructure
• Energieprestatie

Afsluiting - beëindiging van het interview
Korte conclusie

Dit is het einde van het interview. Hartelijk dank voor uw deelname. Ik waardeer het dat u besloten heeft bij te dragen aan mijn onderzoek. Als u twijfelt over uw deelname of de gegeven informatie dan kunt u contact opnemen via het volgende e-mailadres: C.M.deBroekert@student.tudelft.nl

* beeindig de opnamen*

Opmerking: Sommige vragen zijn gericht op de kennis van geïnterviewde binnen de expertise adaptief hergebruik van industrieel erfgoed en hebben geen betrekking op de gebruikers van de herbestemmingen.

“PEOPLE FEEL THAT THE BUILDING IS AGED, ALL FOOTSTEPS SET BY OTHERS BEFORE RESONATE. IT IS A SUBCONSCIOUS ENTHUSIASM THAT CANNOT ALWAYS BE DEFINED.”

- Research participant AB (10) -

Adaptive Re-use of industrial heritage in Dutch Post-industrial Urban Area Development

Corné de Broekert
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