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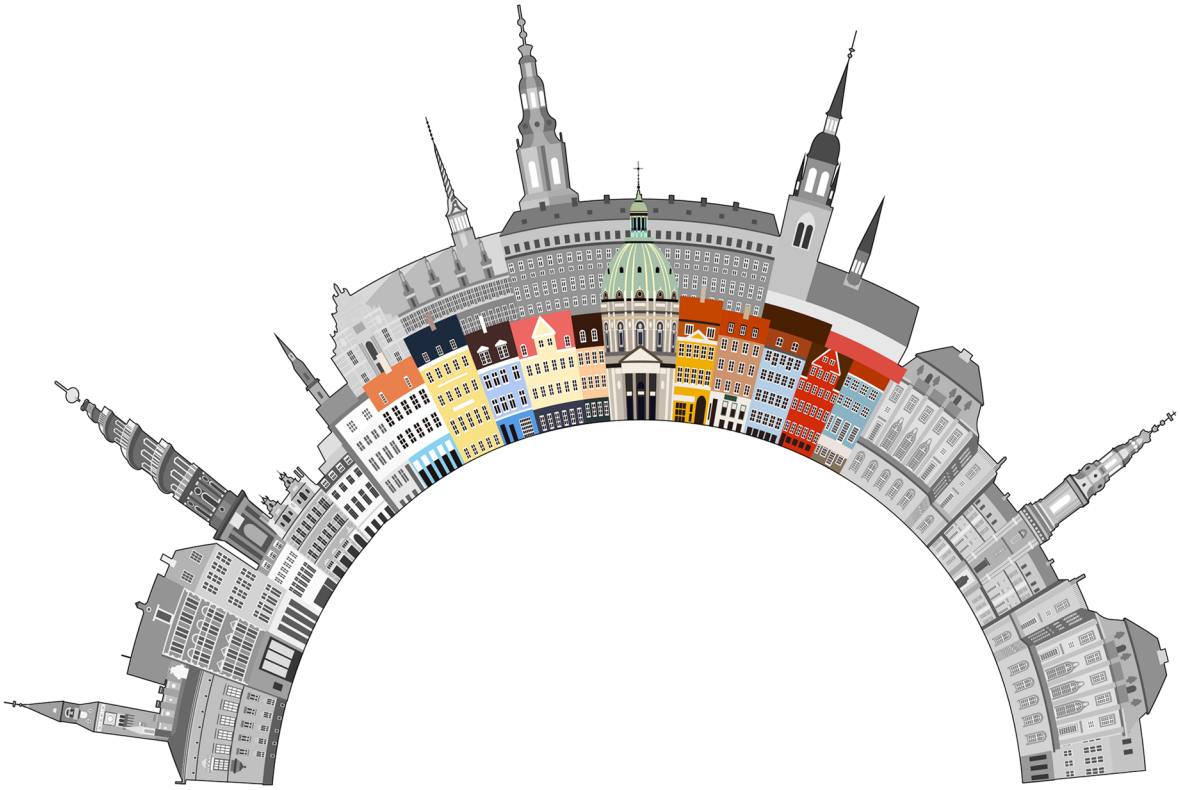
Regenerating Urban Brownfields Based on Economic Assessment:

Case Studies From Danish Experiences

Supervisor:
Prof. Mario Artuso
Co-Supervisor:
Prof. Isabella Maria Lami

Candidate:
Mohammadsaleh Sorkhei



"*First we shape the cities – then they shape us*." Jan Gehl

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ABSTRACT

The development and evolution of cities require the updating of urban infrastructures and abandoned sites to prevent the urban phenomenon known as “brownfield”. Leaving brownfield sites unattended can cause a wide range of urban problems, such as a lack of land use, soil degradation, as well as the loss of potential income-generating avenues. The challenge for the recovery of brownfield areas - due to the specific conditions and problems it brings about - needs to be addressed through different approaches in every city affected by this phenomenon. This thesis examines the case of Copenhagen, where one of the most significant urban development plans calls for the regeneration of brownfields so as to reap the benefits of these potential opportunities for improving social, economic, and environmental values. The city of Copenhagen has been dealing with brownfield regeneration practices since the 1990s, which has resulted in vibrant regenerated waterfronts, and industrial and residential districts. This thesis attempts to review urban policies implemented in Copenhagen for brownfield regeneration and assess the economic valuation of cases using a Discounted Cash Flow (DCF) valuation model, construction and selling type, adopted in the Danish context. The thesis is concluded by discussing two aspects: (1) a critical appraisal of Danish brownfield regeneration policies, structures, and strategies and (2) assessing the economic feasibility of regenerating brownfield sites. Despite the systematic collaboration within urban planning and land-use systems involving the private sector for regulation of regenerative policies are appreciable, modern urban policy frameworks and indexes could also be introduced to gain greater attention for a better understanding of brownfields and their potential economic benefits. Furthermore, the DCF analysis suggests that brownfield regeneration investment scenarios in Copenhagen can be profitable by controlling variables such as construction duration, sale plan, and leverage.

Keywords: Brownfield Regeneration, Brownfield Potentials, Discounted Cash Flow Analysis, Economic Assessment, Urban Regenerative Policies, Urban Development, Copenhagen.

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GLOSSARY

BR: Brownfield Regeneration
CPD: CPH City and Port Development
DCF: Discounted Cash Flow
IPC: Index of Production in Construction
IRR: Internal Rate of Return
KP19: *Kommuneplanen 2019* / The Municipal Plan 2019
NPV: Net Present Value
ODC: Ørestad Development Corporation
TPI: Tender Price Index
UR: Urban Development

CHAPTER 1 INTRODUCTION

1.1 Background of The Study

Abandoned sites are spread out in many nations in Europe. They have been recognised as obstacles to urban development (UR). As cities progress, urban facilities must be updated to respond appropriately to the new complex social, economic, and environmental matters. That is why major developed cities such as Copenhagen have been paying considerable attention to redeveloping derelict sites for the last two decades. Nevertheless, disused urban sites, so-called "brownfields", as the persistent challenge that growing cities have been dealing with, needs to be adequately addressed.

Among the different types of brownfields, abandoned industrial sites are the widely common ones everywhere. After de-industrialisation, industrial zones were gradually shifted to suburban areas for the growth of the cities. Industrial sites became even more peripheral once they failed to adapt to the new demands of cities, technological advancements, and environmental degradation concerns (Lakatos, 2015). They lost their importance in new urban fabrics with their dominant architectural style (Postekkis, 2011). De-industrialisation caused a range of industrial buildings to fall into decay or closure, and as a result, the function of buildings stopped, and brownfields emerged. Brownfields are abandoned or vacant sites, formerly used for different purposes, but they have been left derelict and may get contaminated. They could be located on waterfronts, commercials, or industrial sites, which provide land waste (Njunge, 2021).

Abandoned sites often bring about different environmental, economic and social problems not only to the area itself but also to its surrounding. The most common thread could be the urban degradation and social and economic vitality that brownfields can bring about (Rey *et al*., 2022). The issue becomes more critical when it comes to UR, and brownfields are considered a significant obstacle to the development of cities and contribute to urban sprawl. Thus, it is widely agreed on the necessity to revitalise or reuse brownfields and redevelop them in light of the sustainability approach to achieve economic, cultural, and social benefits (Lapel, 2006; Cantell, 2005; Othman & Heba, 2018).

In Denmark, many industries closed down in the 1970s. Several shipyards, harbours, and factories in the capital region stopped their industrial activities due to the economic recession and de-industrialisation. Therefore, the abandonment of industrial brownfields became pervasive in the 1980s, and major cities such as Copenhagen mostly harbour industrial districts that became disused. Initiatives of UR in Copenhagen mainly happened in the central harbour areas intending to redevelop Copenhagen's waterfront in the 1990s (Alkhani,1995). It is worth mentioning that the growth of the economic structure, the role of political and social powers, and the allocation of specific unity for organising the UR paved the way for the redevelopment of brownfields. Over the last decades, a range of redeveloped brownfield areas has been manifested in Copenhagen, while many are awaiting redevelopment across Denmark and urban areas.

The definition of brownfields and programmes to tackle them are diverse across European countries, while in Denmark, it needs to be directly mentioned in policies and definitions. However, the aim has been to improve the quality of existing urban areas by integrating environmental protection besides economic and social interests. Spatial planning in Denmark is based on three levels, including local and municipal planning, regional planning in counties, and national planning coordinated by the Ministry of Environmental and Energy. Therefore, in addition to different political, economic, and social parameters combined to address the brownfield redevelopment issue, the first and foremost objective is reusing the land and bringing the properties back into the economic cycle. (CLARINET, 2002).

On the other hand, the regeneration of brownfields comes with several challenges. It may be faced with planning-related issues, conflicting ownership interests, and potential long-term implementation periods, which might bring long-term aftercare costs. These all constitute policy risks for the redevelopment of brownfields. Another challenge is overcoming other factors, such as the project's environmental, socio-culture, and economic dimensions, as well as the careful monitoring of sustainability objectives during the transformation process (Rey *et al*., 2022).

1.2 Statement of The Problem

Since the 1950s, de-industrialisation has made the role of industrial activities fade out; very few of these activities within metropolitan regions were able to adapt and alter due to their functionality or localisation (Rey *et al*., 2022). At the same time, cities faced a great square meter of abandoned factories, warehouses, and harbours. Things worsened in Denmark; the unemployment rate increased, and large industrial cities were depopulated then. However, various parameters integrated and boosted UR, economic and social benefits, and redeveloped abandoned waterfront harbours. That is a city like Copenhagen's tortuous path from industrial decline to a regeneration city by redeveloping waterfront areas like Islands Brygge (Urban, 2021) and significant UR projects such as Ørestad. Despite this transformation of brownfields in light of economic growth and policies, this issue remains in some parts where regeneration has not been implemented and is in the long-term perspective of the UR plan. Having been in contact with the municipality of Copenhagen, The Economic Administration Centre for UR, two critical former industrial sites, namely Tunnelfabrikken (The Tunnel Factory) and Jernbanebyen (The Railway Town), which also have been aimed at redeveloping in the Municipal Plan 2019 (KP19). Therefore, the redevelopment of brownfields remains a challenge and task in Copenhagen. By studying successful Copenhagen's redeveloped brownfield projects and the knowledge about policies and impacts of transforming post-industrial sites, it is possible to understand better how methods of developing brownfields incorporate economic values while favouring citizens' will and UR.

1.3 Questions and Aims of The Thesis

This study, whose context is in Copenhagen, Denmark, primarily attempts to understand what

brownfields are like and how they can be redeveloped into the urban area with a positive impact on social and economic values. The thesis also brings an understanding of how Copenhagen took advantage of the redevelopment of brownfields and how it has contributed to social and economic benefits in the UR of Copenhagen. These are carried out within two phases; first, by studying the overview of brownfields in Denmark and case studies, identifying budgets and stakeholders, and then critically analysing them in terms of cost per square meter and activity to understand to what extent they provided economic benefits. The latter studied Copenhagen's urban area, the city's background, policies, urban analysis, and programmes for brownfield regeneration (BR). In the end, two case studies in Copenhagen are already introduced aimed at redeveloping. At this point, two approaches exist to studying BR. In-depth research about urban regenerative urban policies for one of them and a Discounted Cash Flow (DCF) valuation analysis will be carried out to know and compare different regeneration scenarios to assess economic profitability solutions. Then the result of the analysis and the kinds of policies are compared and critically analysed. To further understand the relationship between economic parameters and brownfields regeneration, it is crucial to respond to the following questions:

1. What are brownfields and their role in urban development?
2. What are regenerative strategies and programmes to tackle brownfields?
3. What are the potentials and challenges to the redevelopment of brownfields?
4. What are the economic benefits in brownfield regeneration?
5. How to assess the economic feasibility of redeveloping brownfields?

This thesis is an extensive study of previous research on the redevelopment of brownfields, definitions, tools and methods, and strategies accompanied by case studies and practices which have already successfully been implemented in the transformation of abandoned districts in Copenhagen.

1.4 Methodology

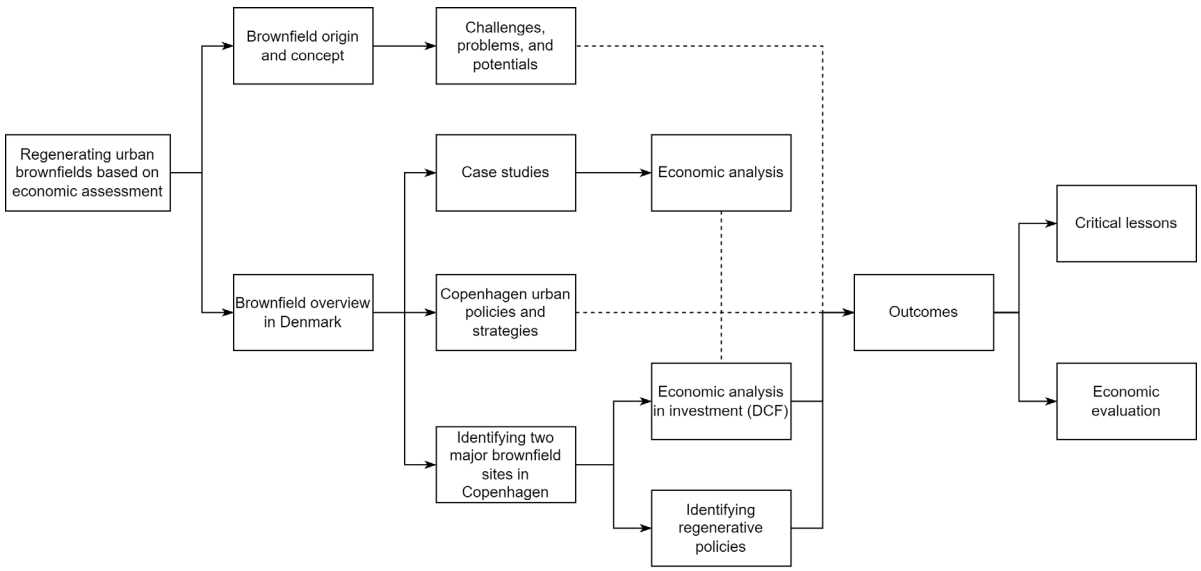
Considering the purposes of the research and responding correctly to the questions, it is necessary to carry out an in-depth study on existing research and use a variety of case studies in Copenhagen to understand success factors in regenerated brownfields. In general, quantitative and qualitative methods are used to study the background of the topic, policies, and contribution of BR to economic profits and analyse the socioeconomic aspects of similar projects. Such analysis includes the total budget, which kind of activities and size, and how much each square meter of activities is. The methodology is based on the following steps:

i) Introduction: studying all the research, papers, books, and journals in the brownfields and Denmark context; intending to know the background of industrialisation, why and how abandoned industrial sites and brownfields emerged, and how they can be problematically associated in cities. It is also followed by citing how Copenhagen has been successfully trying to redevelop these areas.

ii) Case studies analysis: a selection of case studies to examine how they are successfully redeveloped are studied. The process is based on different types and locations in Copenhagen and Denmark, and the economic features of projects are highlighted. Such aspects include the project's total investment, developers, stakeholders, history, the period of the transformation, what activities include, and the most significant sustainability features. In the end, a comparative analysis based on the cost per square meter and activities is made to assess the socioeconomic benefits of the projects.

iii) Identifying Copenhagen's urban area, brownfield case studies, and leading strategies and challenges for the transformation of brownfields: the development of brownfield areas is a complex matter and involves political interventions, regulations, collaborations, and stakeholders. So studying the context, strategies, and policies to address brownfields are crucial to finding specific regulations and practices. To further understand the context, two major case studies of former industrial sites were chosen in Copenhagen, which is planned to transform. The sites were identified according to KP19, the perspective development areas of Copenhagen, and also in contact with the UR department of the Copenhagen municipality. The case studies are introduced with a descriptive study, followed by the mobility and facilities analysis. Then a critical urban brownfield policies study is carried out for one of them.

iv) Assessing urban policies and economic values in regenerating brownfields: considering central policies and the urban and mobility analysis of the area, as well as finding out methodologies for construction costs and references for properties value, helping assess the economic benefits of BR through a DCF model, based on the construction and selling model, customised in Danish context. The different scenarios of redeveloped proposals with respect to required activities in square meters are achieved. The DCF analysis, applied to a case study, paves the way to compare profitable scenarios of regenerating brownfields. Finally, effective parameters in the DCF to manage in scenarios while meeting profitable requirement in BR are evaluated.



Source: Produced by the thesis author

Figure 2.1 Thesis methodology scheme.

PART I
CHAPTER 2 BROWNFIELDS AND AN OVERVIEW IN DENMARK

2.0 Introduction

In the literature review of the urban regeneration realm, multiple scholars have addressed this topic in the field of sustainability in the recent decade. The topic became popular among researchers in the early 2000s when the working group CLARINET (2002), for the first time in the 21st century, dealt with the brownfield challenges, problems, and policies. The paper clearly mentioned economic breakdown, attracting new investors, challenges, unemployment rate, social conflicts, etc. caused by brownfields if not managed. The primary objective of the brownfield redevelopment was to reuse the land and reintegration properties into the economic cycle (CLARINET, 2002).

After that, different books and articles were published with the aim of highlighting the sustainability benefits of brownfield regeneration (BR). Appreciable attempts by Dixon *et al*. (2007) to introduce new sustainability frameworks in brownfield redevelopment and contextualise them in the UK according to policies. Dealing with sustainability in BR at the European level has been a critical element in which many researchers have been involved since then, such as The European RTD project RESCUE (2004) to prepare criteria for BR. In the meanwhile, the issues with remediation techniques were addressed by the working project CABERNET (2014) and later on the report about the soil remediation on the brownfield redevelopment (2017) by the European Union. In one of the latest publications by Morar *et al*. (2022), policies and EU funding frameworks that support brownfield redevelopment have been discussed. The paper suggests implementing brownfield remediation in sustainability goals and supporting the regeneration of multiuse spaces to meet individuals' needs and integrate into socioeconomic values.

One of the leading research studies on the assessment methods of sustainable abandoned urban regeneration was carried out by the research group at EPFL, namely Laprise, Lufkin, and Rey, specialising in architecture and environmental engineering, in 2015. In addition to the statement that regenerating disused urban areas can offer the crucial potential to revitalise existing built fabrics, which also many researchers had already agreed on, they proposed an indicator system, namely 'SIPRUS', to examine the sustainability of the regeneration of abandoned urban areas. The system involves different environmental, sociocultural, and economic parameters to measure regenerated projects' sustainability. Socioeconomic factors are considered an indicator in the system by which the average distance to commercial zones is counted to ensure there is reasonable proximity to the closest commercial area.

The popularity of this topic led the research group to publish the most recent, maybe the most

important, book in the field of urban BR in 2022. The book addresses BR in two parts; first, introduces a framework for the definitions of brownfields, and second, carrying out an in-depth analysis of case studies and sustainability assessment of urban BR. The book is about a struggle to achieve sustainable means, focusing on the environment, society, economy, and governance for the transition of urban brownfields. The importance of the book is supported by a few reasons. First of all, it is the most recent document in the field of urban regeneration addressing the topic at the European level since 2005, when the research group of CABERNET carried out a comprehensive study on European urban brownfields. Secondly, the book is cited by many scholars and is one of the most reliable and popular documents among researchers. In addition, the authors have a strong background and experience in sustainable architecture from EPFL university. This book was one of the primary references for this thesis to explain general concepts and definitions of urban brownfields in chapter two.

2.0.1 Danish Context

The regeneration of brownfields has been considered a critical issue in the realm of sustainability over the past two decades. Although the information about the number and size of urban brownfields in Denmark was poorly addressed in primitive research studies when the brownfield topic gained attention in the early 2000s, it is more addressed in vacant houses, thanks to Jensen (2017) and Larsen *et al*. (2014). Albeit, there has been much more discussion at the EU level.

To demonstrate how BR can affect the social and economic growth in the Danish context, mainly in the urban area of Copenhagen, it is essential to study chronologically what policies could transform disused harbour and industrial sites into important lively areas, resulting in social and economic growth. The primary purpose of this review is to ascertain crucial parameters in regenerating brownfields that can improve social and economic benefits in the city.

Historically, in the 1970s, Denmark experienced various social and economic crises when the country had already seen the prosperity of industrialisation in the 19th century. At the same time, major cities such as Copenhagen experienced industrial areas, harbours, and waterfront activities closed down, and these areas fell into decay, leading to emerging so-called 'brownfields'. However, in the 1990s, by introducing new urban planning programmes, urban regeneration, and improving infrastructure to attract more investors, policymakers have been able to turn the capital region into a radical economic growth hub among the northern European countries. The literature review indicates that some of such initiatives were basically connected to harbours and infrastructural areas regeneration in Copenhagen, which constitute the most popular zones for acquiring a high rate of social and economic benefits. That could be why the municipality is targeting such areas with great potential for future urban regeneration programmes which were mainly related to transforming former industrial sites or brownfields into revitalised areas

The very first BR case studies could be mentioned by citing the centralised space close to the central station and the Town Hall. The area became abandoned after the redevelopment of the railway system

in the beginning of the 20th century. Alternatively, primitive struggles for the regenerative process in Copenhagen were initiated by the transition of the inner harbour basin into a public swimming bath. This urban practice was considered as the motivation for the contribution to the urban regeneration of Copenhagen, which was proven and analysed by Jensen *et al*. (2017).

Vibrant Copenhagen's waterfront and many abandoned industrial sites have witnessed splendid views of constructions that historically resemble Danish wealth and identity, arising from regenerated postindustrial harbours that started in the mid-1990s. It is also argued that the main motivations that dramatically improved Copenhagen were the introduction of regeneration and financial policies in the 1990s. The materialisation and entrepreneurial strategies were applied mainly in former industrial areas (Andersen, 2008). That is why the Copenhagen model, in which the regeneration in postindustrial areas has come up with social and economic growth, is widely appreciated by many researchers such as Urban (2019) and Fayed *et al*. (2019). Today, as a result of those changes, Copenhagen has become wealthy with a high level of welfare vibrant with the revitalised waterfront, harbours, and regenerated areas made Copenhagen one of the most liveable cities in the world. That is, Danish urban policies resulted in reaching a high rate of social and economic measurements.

In contrast, not always all of the brownfields were welcome for regeneration. The former Danish cake factory Dansk Sojakagefabrik which produced chloride had contaminated the area with toxic emissions, shut down in 1991 and then demolished (Urban, 2019). Although the decontamination process of the brownfield could have been applied, it seems that there are also other brownfields which were rejected for redevelopment and led to demolition or being leftover. The data for these brownfields is limited as they vanish. But the former amusement park, Fun Park Fyn, which is characterised by its traditional outdoor recreational equipment, was disused in 2006 and today, there is no trace of this amusement park.

There is some controversy about this system. While neo-liberal approaches made Copenhagen enjoy a high level of social welfare and large infrastructural plans as well as strategic regional and local plans, thanks to the great dialogue between the public authorities and stakeholders, a high portion of the poor population's needs are yet to be addressed (Cucca and Ranci, 2015). It is also argued that another kind of shortcomings, such as poor architecture and over-densified districts, is derived from the desire to maximise profit, and citizens argue there is no considerable gain to the public, as Urban (2019) criticises. The author also believes that architectural design as a separate element influenced Copenhagen's growth by citing and analysing different architectural projects. The research states that the urban infrastructure development in an improved vision made by 'prestigious construction projects'. This 'prestigious construction' as the result of regeneration shows that it does not always constitute a positive process, and many projects in Islands Brygge brought about an increase in the cost of living and pressure on low-income groups, which causes gentrification (Urban, 2019).

Learning from such experiences, BR is still a growing topic in the Danish municipality's view. For instance, in Copenhagen, there is a long-term perspective for the redevelopment of substantial decayed areas, especially in infrastructural districts and formerly closed-off areas like Nordhavn

(North Harbour). The former railway station neighbourhood called *Jernbanebyen* (The railway town) is another post-industrial district with high potential for regeneration. The importance of regenerating both districts was realised through communication with the municipality and the urban analysis of Copenhagen according to the latest plan called The Municipal Plan 2019 (KP19), which are discussed in chapter five as the case studies. Besides, Eternitten in the city of Aalborg is also another interesting reference of the post-industrial area since 1927 with the size of 36 ha located 1.5 km away from the city centre, offering great potential for regeneration which is mentioned by the famous researchers of EPFL (Rey *et al*., 2022).

2.1 Urban Brownfields, Origin, Definition, and Typology

The rest of this chapter is followed by concepts, reasons, and causes of brownfields. Research is done on the primary impacts on Danish urban planning and architecture, first by explaining the industrialisation and then de-industrialisation which left many abandoned industrial sites. The chapter is finalised by surveying Danish urban policies to address brownfield sites.

When it comes to brownfields, the definition is diverse. There is no common and official definition of brownfield at the European level and it is defined nationally. Struggles to reach a common definition of brownfields began by the group research CLARINET (2002), where "brownfields are not necessarily contaminated. The "brownfield" term was initially introduced in a general sense to describe sites which had been previously in use, to contrast them with "greenfield" land which had not previously been used for development." However, regarding the legal framework for brownfields development, brownfields are considered to act on contaminated soil.

According to the working group of CLARINET (2002), the term "brownfields" mainly refers to sites that:

- have been affected by the former uses of the site and the lands surrounding it;
- have been abandoned or are insufficiently used;
- have real or remark pollution problems;
- mostly found in developed urban areas;
- intervention is required for beneficial use.

Later on, the study by Oliver *et al*. (2005), identified 19 different definitions for the brownfield term in Europe alone. By comparing different definitions, it reveals that the term in some countries such as Canada refers to "abandoned, idle or underutilized commercial or industrial properties where past actions have caused environmental contamination", whereas in the USA, the term is defined as a "property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant". However, emphasising on the single issue of contamination to reduce the scope of brownfields would be rather technical and limit our resources to discuss urban sustainability and policies dimensions. Hence, in this thesis,

brownfields refer to abandoned sites or properties that were formerly used for industrial or other purposes. It is worth noting that the term brownfield in Denmark has no official definition and it focuses on dealing with contamination based on the Danish Environmental Protection Agency's glossary.

Perhaps the notion of brownfield stated by Clément (2020) can thoroughly embrace the nature of brownfields. According to the French philosopher, brownfield refers mainly to something "abandoned" or "reserved". The first category embraces abandoned lands, where different activities were used in the past like agricultural, industrial, urban or tourist areas. While the other category mentions non-utilised areas due to the inaccessibility which makes it impossible or costly to take advantage of.

However, in the most recent research of urban BR by EPFL research group (2022), the concept of brownfield is more broadly addressed than the past. The definition is introduced by a framework, including three factors of dimension, type, and activity. Once sites meet these condition we can name them brownfield.

Dimension: It is larger than half a hectare (5,000 m^2), while smaller areas that enjoy great significance may also be considered for urban continuity.

Type: The nature and quality might be various according to the activities performed and the level of infrastructure degradation.

Vacancy: The vacancy period is at least one year, while the longer time site remains disused, the more negative impacts on the surroundings will be (Rey *et al*., 2022).

The classification of brownfields and methods have been different among scholars. Ferber and Grimski (2001) identified brownfields based on the location as the following categories:

• Brownfields in traditional industrial areas, as the result of de-industrialisation and the growth of unemployment in the early 1980s.
• Brownfields in urban areas, due to the relocation to suburban areas over the urbanisation process.
• Brownfields in rural areas, due to the closure of industrial sites caused by economic crisis.

Economy-wise, brownfields are intelligently categorised in Switzerland, where brownfields are sorted out according to: (i) brownfields location in urban areas where the value of land after regeneration will increase which are attractive enough for private investors without intervention of state. (ii) derelict land located in suburban areas having lower land value, require public attention to attract potential investors. (iii) the location in rural and urban areas where the value of the land is negative, demanding direct financial support and tax exemption from the state (SCTM, 2011).

After having a review on the notion and concept of brownfields, it is important to understand the typology of brownfields. There is a common agreement between some scholars such as (Ferber *et al*., 2006) or (Dolezelová *et al*., 2014) to prioritise brownfields economic viability by naming A, B, C categories. While others categorise them based on localisation (rural, peri-urban, urban) type (under-utilized, vacant, derelict, dangerous), development phase (urgent need of action, in planning, etc.) (Ferber *et al*., 2006), ownership situation (multiple or single landowner, private or public), and size of the site (Clarinet 2002).

In this research I relied on the classification in most recent publication on urban brownfield publication by Rey *et al*. (2022), which it is referred to the primary activities conducted prior to abandonment. This approach helps understand the extent of potential soil contamination and estimate the remediation costs, if necessary. It also paves the way to reach different reuse or regeneration strategy options. Based on the experiences mentioned by Rey *et al*. (2022), there is an updated list of eight categories, including industrial, railway, military, waterfront, infrastructural, commercial, energy, and diverse.

For this thesis, I tried to mainly focus on the context of Denmark's typical brownfields and different brownfield categories proposed. Therefore, by merging the most recent categories by Rey *et al*. (2022) and an ongoing brownfield phenomenon 'vacant houses' and prioritise them according to the issues of Danish context, I have defined four main categories, including industrial, waterfront, vacant houses, and other types of brownfields which is subdivided into four individual categories. The categories are prioritised based on their availability in Denmark, mainly in Copenhagen metropolitan area, and their importance. In the following, these classifications with the reason for emergence and causes are addressed.

2.2 Industrial Brownfields

As mentioned earlier, there is a lack of common definition of brownfields in Europe and it is defined nationally. In order to refer the wide-spectrum definition of brownfield and its availability in Denmark, industrial brownfields could be the first choice to explain which is the most common and important type of brownfields known. Based on the definition of Rey *et al*. (2022), 'sites that hosted artisanal, handicraft or small manufacturing activities, lightly mechanized, medium in size and production scale, are also included within the "industrial brownfields" category. ' In Denmark, industrial sites often were seen in factories, silos, warehouses, etc. mostly since the 1960s which later on brought about a variety of social and economic problems. More on this topic about Copenhagen from misery to prosperity is dedicated to chapter five.

The creation of industrial brownfields is mainly due to de-industrialisation wave happened in Europe, resulting in an industrial decline, including all types of industrial activities. But before it industrialisation was the core parameter to blossom industrial activities and the construction of manufactories (Rey *et al*., 2022). To more know about the industrial brownfields it is necessary to

study the origin of industrialisation and then de-industrialisation.

Table 2.1 Table 1. Industrial brownfields phases.

Phases	Main Effects	Period
Industrialisation	Innovative machinery factories, like iron and textile manufactories in Copenhagen and the cement factory in Aarhus, economic and social growth	1870s - 1890s
Deindustrialisation	Socio-economic decline, unemployment, change in the way of manufacturing, abandoned traditional factories and warehouses	1970s - today
Industrial Heritage	Registration of 42 industrial sites as well as several industrial buildings	1990s

Source: Produced by the thesis author

2.2.1 Industrialisation

The Industrial Revolution, which began in Britain in the mid-1760s and extended to the rest of Europe, historically brought about a number of changes to both the economy and culture). In fact, the milestone, for the first time, transformed the handicraft economy into a machine manufacturing economy. Industrialisation introduced a new way of the factory system, which led to the invention of machines and other kinds of power for the process. This resulted in an increase in large-scale factories and the growth of cities.

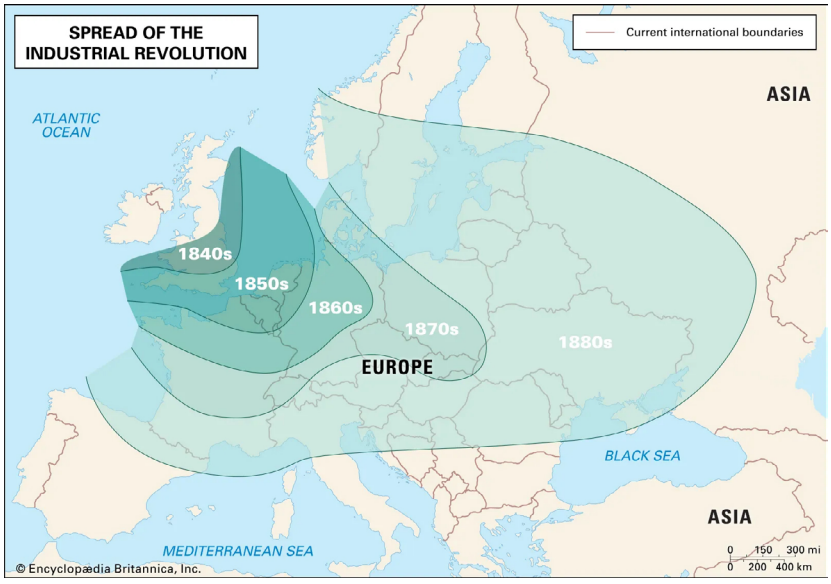


Figure 2.1 The Industrial Revolution map in Europe

Source: Encyclopædia Britannica

Denmark's industrialisation is considered the result of fundamental changes in the economic and political structure (Kristensen, 1989). Industrial development in Denmark mainly happened in the second phase in the early 1870s, late compared to the first happened in England (Johansen, 2012). The Industrial Revolution flourished in machine-tool factories and innovations in agriculture to promote

this sector, even though agriculture has always played a significant role in Denmark (European Route of Industrial Heritage, n.d.). Despite the developments in industry sectors, Denmark still remained an agricultural nation (Vleuten, 1992). However, as the result of profitable trade between China and India in the late 18th century, the country experienced a golden period which was later damaged by the Napolenic wars (Kidokoro *et al*., 2008).

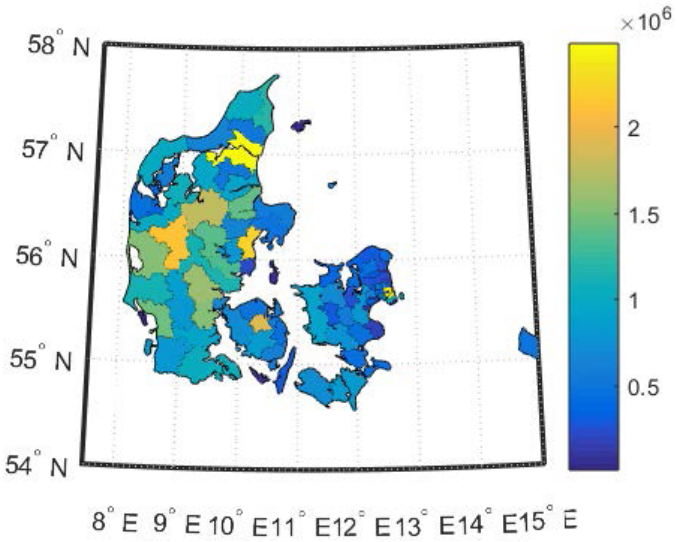


Figure 2.2 Total industrial built area in Denmark among 98 municipalities

Source: Using open-access data in the development of exposure data sets of industrial buildings for earthquake risk modeling, by Sousa *et al*. (2017)

Fayed *et al*. (2017), in the book 'Unequal Cities' explains "The industrialisation from the mid-nineteenth century onwards further fuelled the city's economy and was backed up by major investment in rail lines, harbour facilities, new fortifications (1880s) and various state functions. The result was a fast growing city, based economically on the manufacturing industry, trade, transport and public services as well as many private organizations." Many factories during the Industrial Revolution were primarily merged with existing buildings such as warehouses or houses; only iron manufactures appeared in new buildings. But during the main phase of industrialisation, large-scale factories emerged, particularly in the city of Odense. The city saw the emergence of large-scale factories during the industrialisation phase, which were located between the city and its surroundings. This led to an increase in suburban worker houses, which is the basis of the city's expansion (Vleuten, 1992).

On the other hand, the city of Copenhagen, with its iron works and textile factories, began to expand workers' houses districts in the 1890s. At the same time, the other major industries were booming by constructing cement factories in Aalborg, railroad construction in Randers, paper factories, and small shipyards (ERIH, n.d.). The figure shows the built industrial areas in Denmark as a result of industrialisation. This also affected the population and urbanization of Copenhagen. Compared to 1864, when Denmark's capital embraced 190,000 people and around five thousand houses, numbers significantly increased by 1914, counted five times as many houses, mostly five floors, and a population of 614,000 inhabitants. The rate of change in other major cities also increased. For example, Odense, the second largest city in 1864, was from 15,000 to 50,000 and Arhus from 13,000 to 70,000 (Vleuten, 1992).

Industrialisation made more people employed in the industry. While most people were employed in the textile industry, the steel industry was considered Denmark's second most important industry (Johansen, 2012). Denmark's dependence on the industry was such that in 1864, roughly one-fourth of the population mainly lived from handicrafts and industry. The rate of individuals employed in industrial firms reached its highest in 1872, with around 23,000 regular workers. For instance, half of the industrial labour force in Copenhagen was employed at the same time by 37 factories (Vleuten, 1992). As the centre of Danish politics, industry, and labour across time, Copenhagen has been the focus of several industries, administrative, and financial institutions, besides its location, offered a well-situated harbour (Hyldtoft, 1984). According to Andersen and Jøgensen (1995), the development of Copenhagen was primarily influenced by the rise of the nation-state first and then industry. In 1914, Copenhagen factories alone employed over half of all Danish industry workers (Hyldtoft, 1984).

On the other hand, the transformative process in Danish infrastructures like social and political reforms which lead to formation of national political parties, basic human rights, and democratic basis sped up the industrialisation and urbanisation in the 19th century. These were driving force to shift Denmark from a typical farming-based country to an industrialised nation with massive growing urban and social changes (Kidokoro *et al*., 2008).

2.2.2 De-industrialisation

De-industrialisation in Europe and the United States basically refers to the removal of industries and manufacturers due to social and economic changes. It started in the late 1970s, and great numbers of industrial workers were kept away from their occupations. The de-industrialisation crisis mainly refers to the significant decline in the labour industry. Restructuring economic foundations affected the experience of work. In the United States, the social cost of de-industrialisation affected not only industrial labourers but also their children and communities (Linkon, 2018). De-industrialisation is considered a threat to the existing standard of living and future income levels. The economic troubles as a consequence of deindustrialisation in Denmark introduced a long period of problematic various issues in the late 1970s. The employment has dramatically dropped from 200,000 to 5,000 occupations in Copenhagen itself which resulted in a decline in the population as well from 721,000 to 466,000 residents (Kidokoro *et al*., 2008).

Generally, there were two types of transformation for manufacturers: Some of them completely ceased manufacturing and transformed into wholesalers. These firms mostly switched to employing low-skilled workers. The other switching types employed a more skilled workforce and switched from manufacturing to services. It is argued that these switching companies were likely to be in Copenhagen (Bernard *et al*., 2017). Therefore, a series of large former industrial areas in harbours, rail stations fell into decay in the late 19th century (Kidokoro *et al*., 2008). The transition from industrialisation to de-industrialisation in the capital of Denmark and increasing industrial activity, mainly in the west part of Denmark, is visible as it is shown in the figure.

However, the role of technology was not negligible. New technology inventions preferred a skilled workforce to the manual labour force, which caused the elimination of a high number of manufacturing jobs. At the same time, the share of workers (who) contributed to high-tech activities

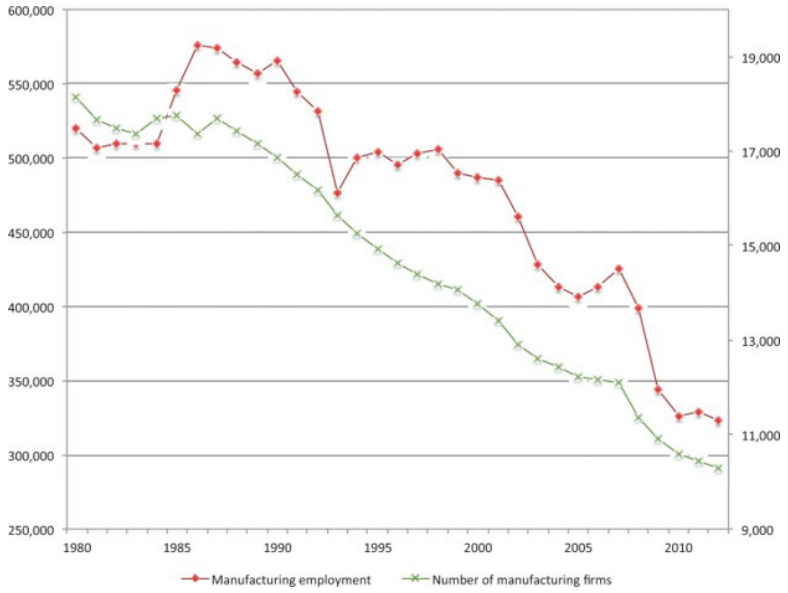


Figure 2.3 Employment in Danish industries rate

Source: Statistics Denmark, adapted from Rethinking deindustrialization, p. 08, by Bernard *et al*., 2017

Note: the number of manufacturing industries and labourers has dramatically fallen by about 98% over a period of 30 years until 2012.

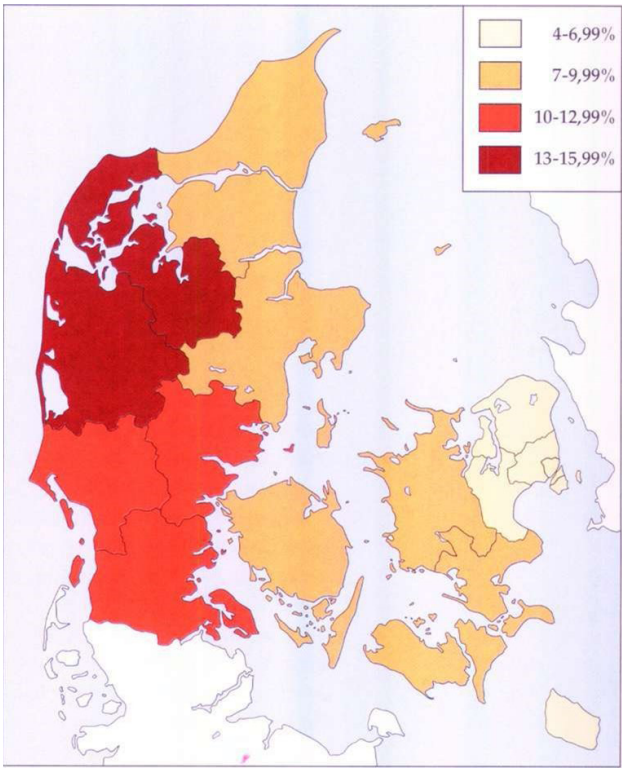


Figure 2.4 Employed persons in industry 2002 as a percentage of the population in the Danish regions

Source: Industrien (Danmark i tal), by Johansen (2012)

Note: The growth of employment in industries in western part of Denmark compared to the eastern cities like Copenhagen is another sign of de-industrialisation and closure of industries in Copenhagen region and relocating them to suburban areas..

grew from 9.2% in 1994 to 13% in 2007 in Denmark. De-industrialisation also came from Danish governmental policies to increase the productivity of industries. Changing the work environment and improving the flexibility of the Danish labour market make Denmark an attractive location for production (Bernard *et al*., 2017).

In summary, de-industrialisation has considerably changed industrial ways. Although the rate of workers' losses in their jobs in the industry has grown, much manufacturing has been able to adapt to the new economic strategies of the government in Denmark. In this vein, Copenhagen has been highly affected by de-industrialisation. Industries in Copenhagen, more than in other cities, were switched to a new manufacturing method, which increased employment in the sector in western cities compared to other regions. This also probably was a reason for the emergence of vacant factories and brownfield sites, which will be explained later.

2.2.3 Industrial Heritage

Industrial heritage basically refers to the remains of industrial culture, which are considered historical, technological, social, architectural, or scientific assets. These remains consist of buildings, factories, workshops, mine sites, warehouses, places where energy is generated, used, or transported, and all its infrastructure, as well as places for social activities concerning the industry, like housing, religious worship, or education (TICCIH, 2003). In fact, industrial heritage interprets characteristics of history, architecture, and technology over time (McAdam and Bateman, 2005). It is widely agreed that it is essential to preserve such assets everywhere for future generations (TICCIH, 2003; McAdam and Bateman, 2005). Industrial heritage plays an important role in our built environment and landscape. It links the past industrial era to the contemporary world. It is crucial to assent to them as evidence of history and prioritizes them with protection to make them a substantial factor in urban transformation (Rossi, 1984). According to World Heritage, industrial heritage constitutes cultural heritage, comprising merely 4% of the world heritage. In fact, industrial heritage, considered a social value that forms the place's identity, needs to be protected (TICCIH, 2003).

In Denmark, the first signs to preserve industrial heritage can be found from 1600s. As an example, in 1670s, Modelkammeret in order to develop ships building process was built which today this building is transformed into Danish national museum to showcase extensive archive of drawings. By developing machines and technology in 1840s, many factories like iron foundry constructed by Royal Danish Academy of Fine Arts students. During that time, factory design became an aesthetic value among architects and its point alongside holding exhibitions, museums, and educating craftsmen and industrialists towards a higher aesthetically values casting light of how Danish industrial heritage promoted. Meanwhile the restoration project of Strandmollen north of Copenhagen can be considered the first example of the preservation of a factory instead of demolition in 1918. This year, the first Listed Buildings Act was defined to preserve the history of building culture. Although at first there were only a few windmills and riggers shears at Holmen in the list, older production factories such as Carlsberg and warehouses were mentioned in articles. The Industrial Society and the Society of Artists and

Craftsmen established an industrial museum in 1911 the result of the historical interest. Another critical case was Carlsberg's museum in 1916, which highlighted their importance in the brewery and background. This also resulted in the restoration of the old Carlsberg brewery building. Building the B&W museum in 1946 was another example of companies attempting to exhibit their industry. This highlights museums' role in conserving industrial heritage during the primary attempts to enhance industrial heritage.

In the 1990s, the system for registering industrial heritage was completed, and several industrial plants were listed using thematic registers (can be seen in the table 2.2). In addition, the Industrial and Trades Pool published a survey of an introduction to the history of dairies buildings in 1997. Thus, the industrial heritage listing was carried out more systematically than before (Christensen *et al*., 2013). Attempts to promote industrial heritage have had different results. Increased museums and collections, promoted TV programs, school study trips to industrial heritage, and a range of publications and research projects funded by the Heritage Agency of Denmark.

Figure 2.5 The rigging sheers from 1750 at Holmen was declared protected in 1918.

Source: Caspar Jørgensen (2007), adapted from Industrial Heritage in Denmark, p. 258, by Christensen *et al*. (2013)

Table 2.2 The Danish national industrial plants list within 1990s based on theme.

Industry Theme	Buildings	Year
Mill Structures in Denmark	-	1993
The work report of Industrial Buildings in the Municipality of Copenhagen	-	1992
On the basis of reuse	Aarhus Central Workshops	1862
	Waterworks in Copenhagen	1999
	Hydroelectric Power plants	1890-1940
	Danish Lighthouses	1750-1950

Source: Industrial Heritage in Denmark, p. 271, by Christensen *et al*. (2013)

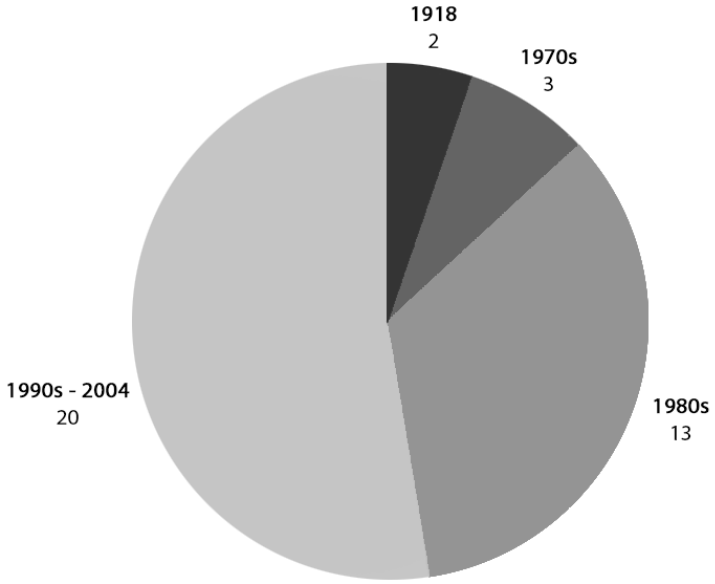


Figure 2.6 The number of industrial sites registered.

Source: Industrial Heritage in Denmark, p. 275, by Christensen *et al*. (2013)

Today, there are 42 industrial plants registered out of around 4,032 listings. Likewise, 117 traditional grain mills, most of which were built between the 1950s and 1960s, were protected. Concerning transport and communication, 121 buildings and objects were listed, like 22 lighthouses and 11 navigation marks, 17 bridges, and 43 railway stations (Christensen *et al*., 2013).

2.2.4 The Emergence of Industrial Brownfields

Generally, industrialisation brought about the emergence of large-scale urbanisation and revolutionised the urban landscape and built environment. As mentioned earlier, industrial site construction became abundant during this period. Cities became a platform for industry and related activities as a result of how industrialisation affected them. An industrial building mainly refers to a building designed to house industrial operations and activities and provide necessary conditions for workers and the operation of industrial utilities.

There are different reasons behind industrial sites getting abandoned. The integration of industrial sites and growing cities was slow, which left industrial production outside the newly introduced city's limits or abandoned inside cities (Lakatos, 2015). In a general view, deindustrialisation and suburbanisation were main motivations to appear brownfields. It became even widely apparent in the late 1960s and early 1970s in European countries and America (Kurtovic *et al*., 2014). Another underlying reason was radical changes in economic conditions, pollution, environmental issues, technological factors, urban area growth, and decentralization or relocation of industrial buildings. However, the most substantial factor was the incompatibility of industrial products with today's requirements (Geraedts, 2009). Economic crises can also highly affect market demands and industrial production, which cause dramatic changes in production systems. In addition, the emergence of new technologies has influenced the production system. The need for an inexperienced workforce was transformed into educated and professional labour (Savini & Dembski, 2016). The facilities and machines for old production were inconsistent with this technological advancement. The acceleration of technological developments between the 1960s and 1980s resulted in various European abandoned industrial sites (Lapel, 2006). Environmental matters were also highlighted concerning the impact of special production activities, which transformed polluted production into an unpolluted and sustainable production system (Savini & Dembski, 2016). Thus, brownfields are mainly the result of such process and deindustrialisation which caused a great number of certain areas to be abandoned and the loss of importance of certain formerly well-known towns (Tolle, 2009).

Urbanisation plays a crucial role in the emergence of abandoned industrial sites. Urban growth and the population relocated industrial buildings to suburban areas. Once there are no industrial activities in industrial buildings, the structure may not be used in the short or long term (Lapel, 2006). According to CABERNET survey mentioned by Ovliver *et al*. (2003), the main resource for brownfields in Scandinavian countries was timber processing and paper and pulp production.

In general, the abandonment of industrial buildings results from critical changes in technology, the economy, etc. Old industrial sites cannot adapt to new conditions, and then led into brownfields as the result of Europe's twentieth century industrial legacy.

2.3 Waterfront Brownfields

Waterfront sectors mainly offer multiple commercial activities, which come with combined storage, warehouses, handling, and production. The role of the waterfront became more highlighted in the industrialisation era once it was used to transport machines to favour manufacturing purposes. They are often close to the centre of urban areas and function as economic bases. Waterfronts are usually characterized by a sector that is likely to separate the harbour and the urban regions from their industrial zones, which makes the transformation of such areas difficult (Rey *et al*., 2022).

However, by the 1970s, a wide range of waterfront areas across Europe faced reconsideration, which caused a significant number of abandoned waterfronts. There were some changes in technology, new constraints, handling, and management, and the storage function of these areas was reduced (Rey *et al*., 2022). As a result, many warehouses in these areas were left abandoned. At the same time, Copenhagen, a city known for its harbour waterfront, also encountered this issue. Once deindustrialisation and economic problems left Copenhagen's port, warehouses and buildings became derelict and abandoned.

By the late 1980s, national and local state and port authorities undertook planning and policy initiatives to redevelop the Copenhagen waterfront. So, by the late 1990s, a range of large cranes came back to the waterfront, illustrating a new beginning of waterfront transformation of former military, shipping, and industrial areas into commercial, office, residential, educational, cultural, and entertainment purposes (Desfor & Jørgensen, 2004).

Redevelopment waterfront projects were according to economic restructuring, new technologies, and their spatial needs in central urban areas. The new transformation of waterfront development, which was influential on the economy, included re-allocating land-use activities regarding the economic structure of maximum profit with a new pattern of land rents (Desfor & Jørgensen, 2004). Port of Copenhagen Ltd. was formed to manage such issues and corporate strategies in Copenhagen.

In the recent work, Bruns-Berentelg *et al*. (2022) take the case studies of Hamburg in northern Germany and Copenhagen in Denmark exploring each of their governance methodologies such as entrepreneurial strategies towards urban regeneration over waterfront brownfields. This approach is nearly similar in the two considered cities, pursuing entrepreneurial governance of new-built neighborhoods. Both cities raised their urban land value by implementing large-scaled speculative development projects. Their way of action is traditionally the same; they use land value capture to fund capital for their municipal activities. These actions, obviously, have been shaped as well by their geo-politics and economics.

It worthy to mention that, nevertheless, both cities implemented state-owned enterprises (SOEs); "Copenhagen's immediate aim in redeveloping its Ørestad and harbour districts was to fund a citywide mass transit system and thereby enhance competitiveness through infrastructure development, while

Hamburg sought to use its HafenCity waterfront redevelopment to boost competitiveness through port modernisation, increased in urban quality and commercial expansion in the city centre (Bruns-Berentelg *et al*., 2022). Though there is more to discuss Copenhagen waterfront regeneration when it comes to urban regeneration policies in the capital in chapter five.

However, as a result of their entrepreneurial and speculative conception and execution, the redevelopment projects in both cities did not go in a perfect or smooth way; albeit, economic-wise results were a success. It is crucial mentioning that the strategy used by Ørestad Development Corporation (ODC) and Copenhagen City & Port, for the management of waterfront brownfields in Copenhagen, would never been and never will be a good application in the context of the 1990s city of Hamburg, and vice versa (Bruns-Berentelg *et al*., 2022).

In another point of view, Clark (2018) affirms that private property in urban land is the main generating cause of rent gaps. This allows the exploitation of capitalised land rents, a speculative entrepreneurial bidding on future ones, and labeling potential rents as "higher and better" in the means of land usage. Municipal governments in the considered case contexts are raising revenues by applying a "close the rent gap" policy on public lands.

Copenhagen city governments are not public anymore, rather they act like a private investor. This model revolving funds may clearly lead to long-term economic benefits to both the city and its inhabitants, but it is important to clarify that the real reason behind any entrepreneurial UR is not mainly to raise these benefits. Rather, it is to attract foreign and local investments, skillful youth, industrial and high tech companies, etc. The existing stakeholders will come in the second plan often (Bruns-Berentelg *et al*., 2022).

In addition, a large number of benefits in Copenhagen has achieved thanks to its new metro system has come at the expense of terrestrial and water spaces developing into built neighbourhoods which only recently started to benefits the city inhabitants and meet the local needs. The actual name of this phenomenon is "entrepreneurial city", but that is not fixed as there is no book with fixed rules. What can work perfectly and positively in one city and a context, may never work in another city with another economic and political context. The comparison in this research showed that the experiences of different cities on this matter clearly show how large-scale speculative redevelopment processes operate differently, with distinct circumstances (Bruns-Berentelg *et al*., 2022).

In fact, geographical similarities of urban redevelopment initiatives, with taking into account the attractiveness of historical land and newly reclaimed land for regeneration, have been overlooked in the literature for the paper by Bruns-Berentelg *et al*. (2022). "Yet, the cases considered suggest that they may be significant for the degree to which state actors can succeed in making the most of the benefits of speculative urban redevelopment while containing its negative impact".

Waterfront brownfield development is considered a significant turning point in the economic

growth of Denmark, as mentioned in the literature on Copenhagen waterfront development; it suggests that the waterfront development in Copenhagen came with new practices in social regulations. A cluster of individuals and organizations appeared in relation to new patterns of economic accumulation and social practices (Desfor & Jørgensen, 2004). Today, many redeveloped waterfront projects can be seen in Copenhagen due to policy and economic structure changes. For example, MVRDV's Frsilo or Cobe architects' The Silo both emphasize the importance of regenerating waterfront brownfields in order to achieve social and economic development.

2.4 Vacant Houses

Regarding brownfields in Denmark, vacant single-family houses are another part of the challenges that have been manifested recently in Denmark. The vacancy is mainly related to increasing urbanization and changing suburban demography. "Shrinking cities," which cause lack of affordable houses in growing cities, as well as the centralization of public administration and services in major cities, have resulted in the depopulation of small towns and the appearance of vacant houses. On the other hand, as the population decreases, the number of vacant houses increases (Møller, 2017). Thus, it is an issue that demands political decisions.

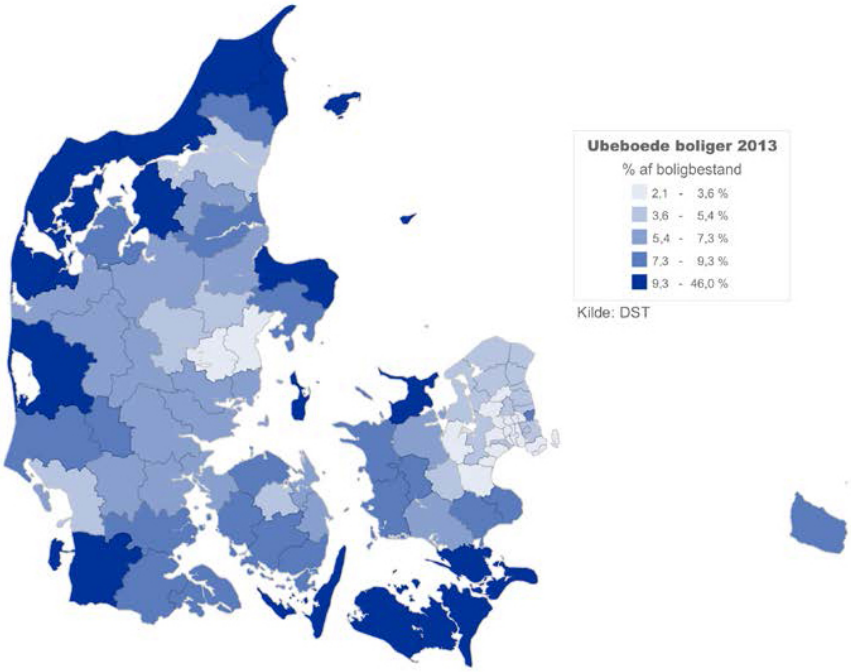
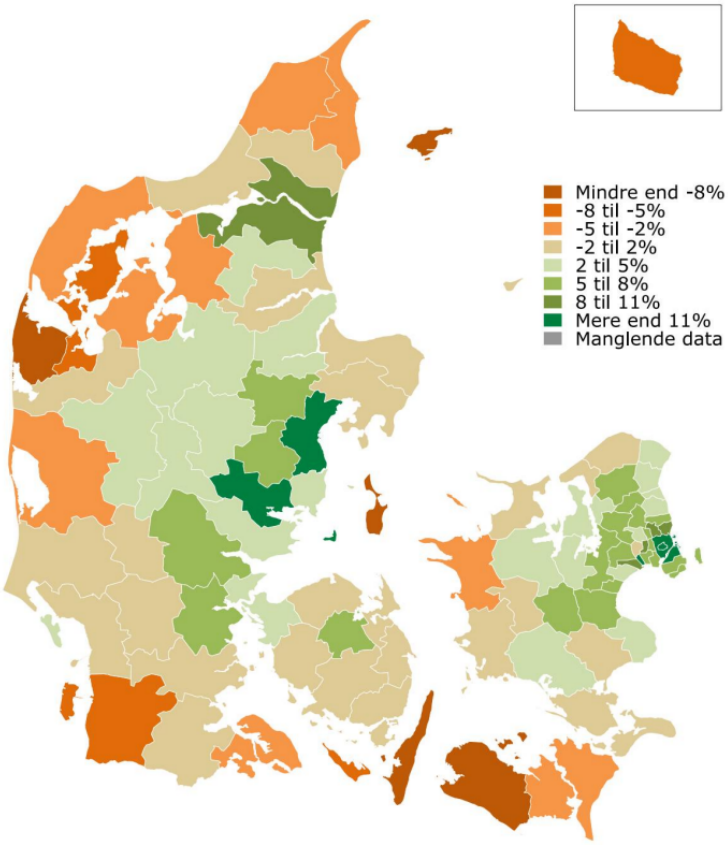


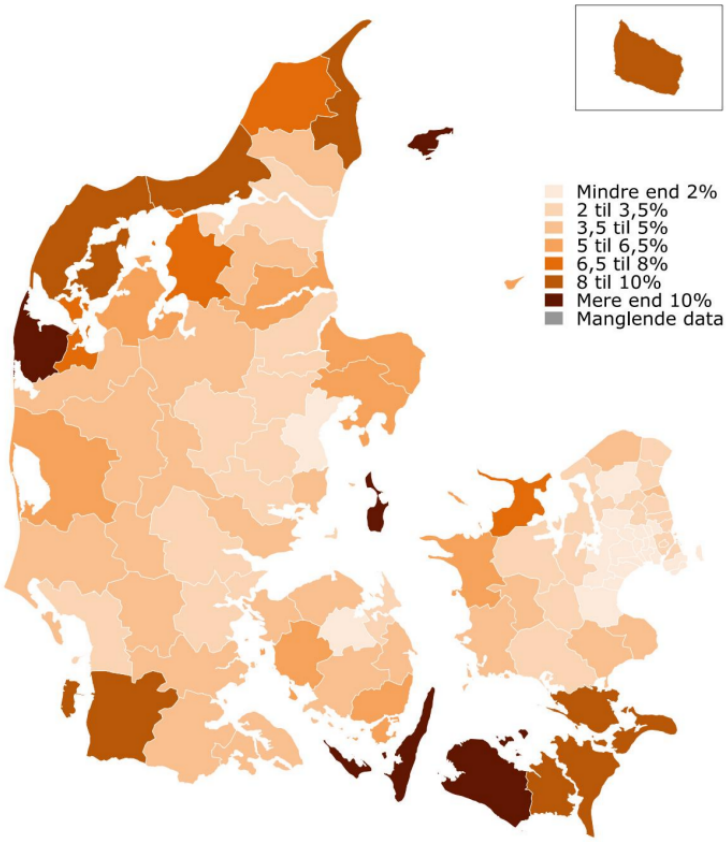
Figure 2.7 Percentages of vacant homes in Denmark 2013, for the 98 municipalities.
Source: Boligmarkedet uden for de store byer Analyse, p. 26, by Larsen *et al*. (2014)

Vacant houses like abandoned industrial sites usually bring about some problems in the neighborhood. They can adversely influence property values and cause vandalism, social and environmental problems in the surroundings (Andersen, 2017).



Source: Statistics Denmark table BOL101, adapted from Boliger som ikkebliver brugt, p. 07, by Møller (2017)

Figure 2.8 Population development between 2008 and 2017



Source: Statistics Denmark table BOL101, adapted from Boliger som ikkebliver brugt, p. 09, by Møller (2017)

Figure 2.9 Properties without CPR registration until 1 JANUARY 2016.

Note: The comparison between the data of population development and vacant houses represents that the depopulated areas come with more abandoned dwellings than highly populated areas.

While overall housing vacancy is 5 percent which is not alarming on the overall scale, in recent decades, urbanization has led to depopulation from villages and towns to large cities. Although large cities have experienced a stable vacancy rate between 2000 and 2015, it has increased in towns, especially near major cities, from 6% in 2000 to 9% in 2015 (Andersen, 2017).

The data of the CSR (Corporate Social Responsibility) community's report in Denmark shows that there are 60,000 vacant houses across Denmark as a result of depopulation in Denmark's outer areas (CSR, 2017).

Although no national register can count abandoned properties, relying on the source of Statistics Denmark, we can access the data of dwelling addresses that have not been registered for any person with a Danish CPR number. Figure ... shows the rate of non-registered houses proportional to the cities in Denmark. The data shows that around 4.6% of Danish houses and farmhouses had not been registered with anyone in January 2016 (Møller, 2017).

However, the fact that homes do not function as a population register address does not necessarily mean that they are permanently abandoned and not maintained. The following are the possible reasons for the rate of abandoned houses acquired:

• The house is being registered to a new resident during the new year. Since the data was obtained on January 1st, it is possible, for instance, that some inhabitants moved in on January 2nd while the previous residents left on December 31st or earlier.

• The house is under renovation. This is also more common, especially in large municipalities.

• Except for living in, the house is registered for all purposes. While this can be an illegal scenario, and others might live in a house without registering the address, it could cause an error in the calculation of abandoned houses.

• The house is abandoned (Møller, 2017).

The abandonment problem of houses is addressed in Denmark's national housing policies. For instance, chapter 7 of the Act on Temporary Regulation of Housing Conditions (The Housing Regulation Act), which is applicable in all other than 19 municipalities, deals with the fact that the house is constantly used throughout the year (Møller, 2017). In general, there are restricted regulations for properties to ensure that they are occupied. For example, if a property is empty for more than six months, the owner has to report to the municipality to offer tenants so that the owner accepts; otherwise, vacant properties are subject to the land value tax (Andersen, 2017).

The first national program in Denmark to address housing vacancy, called "The Effort-Pool," was launched in 2010, allocating 150 million DKK (approximately 20 million EUR) in 2010 and 100 million DKK (approximately 13 million EUR) in 2011. In 2013, the "Village Renewal Pool" was established to provide solutions related to abandoned houses. This pool was allocated 400 million DKK (approx. 54 million EUR) in total, which was assigned to 70 municipalities to use (Andersen,

2017).

2.5 Other Types of Brownfields

In addition to the major brownfields already explained that can mostly be seen in Denmark and Copenhagen, there are other types of brownfields in general that may be seen less frequently in Denmark. According to the most recent research conducted by Rey *et al*. (2022) about the origin and definition of urban brownfields, some other urban brownfield types can be classified as follows:

Railway Brownfields

In most European countries, railway companies often constitute the largest urban landowners. So, the redevelopment of railways is considerably significant for UR, Even though they might not be located within the metropolitan area. Today, most European countries acknowledge these railway brownfields as a strategic asset. As they are located in urban, suburban, or peri-urban territories and positioned in close connection to the public transport system, they offer important features and possibilities for sustainability. The significance of the regeneration of railway brownfields in Denmark is highlighted when the Copenhagen municipality has recently decided to redevelop the potential railway station into a vibrant district, explained as a case study in chapter five. Several railway companies have established their own real estate management divisions considering this valuation. In Denmark, the DSB Ejendomme corporates this responsibility. The interest of railway brownfields is the ability to engage in a joint reflection with a single stakeholder (Rey *et al*., 2022).

Infrastructural Brownfields

In the same way as industrial sectors, many facilities and infrastructures have been faced with technological advancements which lead to the disused areas or, in other words, the creation of urban brownfields. Several categories of infrastructures are significant in terms of functional evolution and rehabilitation potential. In Copenhagen, multiple buildings such as warehouses and silos were found abandoned after the transformation of the harbour waterfront. Therefore, there was an excellent opportunity for developers to transform the functionality of former buildings into another purpose. In this vein, several former silos and warehouses, such as The Silo project by Cobe, transformed into residential functions (Rey *et al*., 2022).

Energy Brownfields

The matter of energy brownfields has recently appeared as a new category, and their emergence is related to the energy transition. It is argued by Rey *et al*. (2022) that the evolution of energy consumption patterns over the past decade has caused the emergence of energy brownfields. The strategies prioritizing renewable energy resources have impacted several infrastructures related to energy production and distribution. Many European countries have proceeded with the closure of energy plants to terminate the dominance of oil. However, this energy transition has brought about several heavily exploited sites, which present challenges in terms of environmental and economic issues (Rey *et al*., 2022).

Diverse Derelict Sites

In addition to the brownfield types mentioned, which are identified by their activities, there are a great number of derelict sites that need to be taken into account. Since the 1950s, when various buildings and sites were recognized for their activities, they often resulted in the liberation of unbuilt spaces and sometimes accompanied by abandonment or demolition. In Denmark, the issue of abandoned houses in small towns and suburbs is common, whereas there are multiple houses and other public buildings like hospitals spread out mainly in suburban areas that are abandoned and derelict. Another example of this category of brownfields is an abandoned amusement park called Fun Park Fyn in Funen, characterized by traditional types of outdoor recreational equipment abandoned in 2006 (Rey *et al*., 2022).

Figure 2.10 Fun Park Fyn, an bandoned amusement park in Funen.

Source: WebUrbanist, A Fyn Mess: Denmark's Eerie Abandoned Fun Park Fyn (2019)

2.6 Brownfield Problems and Potentials – from Trash to Treasure

It is widely agreed that abandoned buildings can attract vandals, homeless, arsonists, and drug dealers that cause the devaluation of properties, taxes, services and discourage in investment (Bunnell, 1977). In addition, they "strain the resources of local police, fire, building, and health departments." The drainage of municipality services is crucial in terms of the economy due to the fact that vacant properties contribute little or no tax revenue in return (Smart Growth America, 2004). As tax revenues decline, fewer resources would be needed to attract investment and revitalize neighbourhoods and business districts (Accordino and Johnson, 2000). While in recent years, the focus has been chiefly on environmental policies for the reuse of local abandoned sites (Kim and Kang, 2019), a range of social costs on local jurisdictions can be generated through abandoned and vacant buildings (Schilling, 2002). The issue becomes even more critical regarding urban sprawl (Rey *et al*., 2022).

An abandoned building can affect nearby areas and result in neighbourhood decay and blight. The abandonment can be spread throughout a transitional neighbourhood. The local feel unsafe, and local investors and developers become unwilling to invest in such regions. Many residents leave the neighbourhood, and the social activities of the district will, as a result, decrease. The consequences could go further once the abandoned lots spread over the district (Schilling, 2002). Moreover, economy-wise, the market value of abandoned land and its surroundings are negatively affected and become devalued (Kurtovic *et al*., 2014; Rey *et al*., 2022), and as a result, the resale of the properties is difficult. Likewise, derelict sites increase suburbanisation and then urban sprawl which lead to remote communities adversing unemployment situation, increased crime, and a decrease in GDP (Gibson, 2007).

According to CLARINET (2002), the significant side effects of brownfields could be mentioned in the following:

1. Breakdown of economics
2. Problems in attracting new investors
3. High unemployment rate
4. Adverse effects on urban life
5. Decline of tax income for the communities
6. Social conflicts
7. Consumption of greenfields

Despite the fact, brownfields matter have gained more attention among developed countries. At the same time, the role of sustainability has been saturated in the realm of brownfields in different nations in recent decades. Since having accessibility to sufficient land and resources has always been key factors for human civilisation, the sustainability of land and resources is one of the cores of sustainable development. In fact, taking advantage of efficient, cost-effective, and sustainable land use has directly impacted on enhanced competitiveness of nations within the past decade (Kurtovic *et al*., 2014).

European countries have started to implement BR policies since 1980s when first brownfield sites appeared in Europe as mines, steel mills, and textile companies, more particularly in British area of Lorraine, France area Nod-Pas de Calais and the German area of Northrhine-Westphalia. The trend started in the early 1990s in the Danish capital when Ørestad region development and later major waterfront brownfield redevelopment like Frøsilo took place by the help of both private and public sectors, namely CPH City and Port Development. The story of Denmark is explained more extensively in chapter five. However, at the European level, the European Regional Development Fund (European Regional Development Found - ERDF) was used for the main financial resource for the redevelopment of former industrial sites. In addition, different social programmes were established in supporting the adaptation of traditional industrial areas, such as "RESIDER" related to steel mill areas, "RECHAR" for mining sites, and "RECHAR" linked to mining sites. The issue later on became popular in a manner of environmental contamination in EU since the early 2000s, by

defining specific principles of urban renewal, like setting up ESDP (European Spatial Development Perspectives), which shows the EU's interest on regeneration of brownfields (Kurtovic *et al*., 2014).

The importance of brownfields at the scale of Europe has also been studied by Oliver *et al*. (2005) in an attempt to define the origin of brownfields and categorising them. The study which was based on the previous research by CABERNET research group mentions that formerly developed sites in Scandinavian countries are mainly regenerated through private investment and development in highly competitive cities. It seems that there is no beneficial contribution from regeneration of previously developed sites outside of urban areas, which are suggested that such low-dense countries with high competitiveness already enjoy ample greenfields for redevelopment (Oliver *et al*., 2005).

European countries have been likely to benefit from the reuse of brownfields. While opportunities from regenerating brownfields, is increasing among European countries, less dense countries tend to redevelop brownfields in light of the concept of "contaminated sites" such as Denmark. Even though it was agreed that the little information about the nature of brownfields was still poor at the European scale. The paper also mentions the significance of the issue from European cities like Mallorca, where abandoned hotels were the main source of brownfields as the result of the growth of the tourism industry and the consequences of the poor management between 1960s and 1970s in a prospered-tourist era. Scholars suggesting urban regenerating by the reuse of such infrastructure could be of paramount importance in managing brownfields among Mediteranean Europe countries. This also embraces the popularity of regenerating more diverse types of brownfields not only so-called "large contaminated industrial sites" (Kurtovic *et al*., 2014).

It is believed that brownfields enjoy several benefits in different field, representing their cultural identity and it is gained through the activities take place in the area. In the cultural point of view, they evoke memory of the past in the present among people and psychological value of the brownfields could signal a sense of primitive properties of the area in the past. Ecological values are reserved through the restoration of the local landscape. Spatial values are represented by their topography, and finally economic values achieved through the possibility for investment (Kurtovic *et al*., 2014). "Increasing property values and employment opportunities are just some of the impact of relevant investment" (Baskaya, 2010). All of these become motivations for rising the value of brownfields. A survey about brownfields value between 2006 and 20011 shows that the value grew by 32.6% in the EU. Brownfields attraction has been to the extent that the European Union has invested about 336 billion euro under the programme of European Regional Development Fund (ERDF) for the development of brownfields in the EU for the period of 2014 to 2020.

In addition, the evaluation of brownfields have been considered crucial for making right decision about the management of brownfields and solve the problem of choosing potential brownfields. There is a well-known and reliable model from Thomas (2002), in which a criteria for ranking brownfield sites on a priority basis. The GIS model integrates three factors, including geographic, spatial, and socio-economic data through which it is possible to assess brownfields on a ranking criteria. Thomas model helps stakeholders and the public access the information of brownfields and

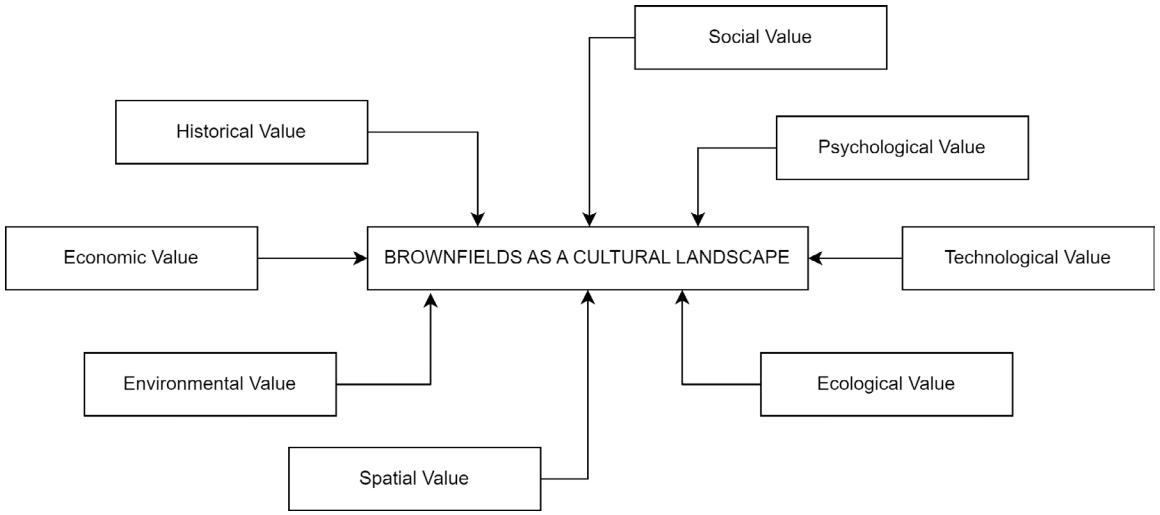


Figure 2.11 Value of brownfield sites.

Source: Ways to sustainable brownfield regeneration in Istanbul, p.76 , by Baskaya (2010)

Table 2.3 Value of Brownfield Foreign Direct Investment by Countries (in billions dollars).

Country	2006	2007	2008	2009	2010	2011	Average annual growth rate 06- 11 (previous year=)	Grow rate in 2011, 2007=100
EU Total	**333337**	**527718**	**251169**	**116226**	**115974**	**172257**	**500,5**	**32,6**
Austria	1145	9661	1327	1797	432	6928	2620,7	71,7
Belgium	1794	961	2491	12089	9444	3920	917,7	407,9
Bulgaria	807	971	227	151	24	-96	-173,9	-9.9
Cyprus	294	1343	-909	52	680	780	1805,8	58,1
Czech R.	1154	107	5169	2669	-457	725	4716,0	677,6
Denmark	**11235**	**5761**	**6095**	**1651**	**1448**	**7659**	**800,8**	**132,9**
Estonia	3	-57	110	28	3	239	5909,9	-419,3
Finland	1321	8313	1153	508	324	973	1051,3	11,7
France	19423	28207	4590	724	3837	24325	1341,2	86,2
Germany	41388	44091	31911	12790	8507	12709	432,9	28,8
Greece	7309	723	6903	477	-899	1205	652,7	166,7
Hungary	2337	721	1559	1853	213	1714	1182,1	237,7
Ireland	2731	811	2892	1712	2127	2181	672,3	268,9
Italy	25760	23630	-2377	1109	6329	13450	818,2	56,9
Latvia	11	47	195	109	72	2	966,9	4,3
Lithuania	97	35	98	20	462	386	2730,0	1102,9
Luxembourg	35005	7339	-3570	444	5446	9393	1358,9	128,0
Malta	517	-86	0	13	315	0	2391,3	0,0
Netherlands	25560	162770	-8156	17988	4113	14031	775,3	8,6
Poland	773	728	966	776	1063	10043	1389,0	1379,5
Portugal	537	1715	-1279	504	2208	911	684,7	52,1
Romania	5324	1926	993	314	148	88	225,9	4,6
Slovakia	194	50	136	13	0	0	307,3	0,0
Spain	7951	51686	33708	32173	8669	17298	1037,2	89,0
Sweden	15228	4563	18770	1098	221	7616	3913,4	33,5
UK	125421	171646	147748	25164	60833	35691	540,4	20,8

Source: Foreign direct investment flows in the period of world economic crisis, p.176, by Warzala, (2013)

Note: The value of brownfields comparison shows that in Denmark the value considerably increased in 2011 compared the previous year after a great reduction since 2007. Lithuania and Poland are the top countries for the growth of brownfields value in 2011.

let them participate in the redevelopment process. These criteria which are at the local level, which considers physical factors, and country level, which is to do with market factors (Kurtovic *et al*., 2014).

The methods of brownfields classification, generally, help to evaluate them and reach the best solution in the way of regeneration of brownfields. In this vein, Kurtovic *et al*. (2014) proposed methodological steps to identify brownfields, namely indexing methods, cost-benefit analysis, and multivariate analysis. The indexing methods takes into account large-scale sites for transformation which are subdivided into three indicators. Socio-economic index includes information regarding population, density, the value of real estate, and unemployment. This index helps to identify potential brownfields which could contribute to economic growth. Spatial index of growth assesses the welfare of sites, including the availability of amenities, transport, employment, and housing conditions. Environmental index which deals with the potential contamination sources in soil, water, and the environment. It is suggested to integrate these indices and have an acceptable average value of them. Also these indices could be combined and get more weighted to one specific index depending on the significance of the site (Kurtovic *et al*., 2014).

The method of cost-benefit analysis aims to identify all costs and benefits of brownfields. The main challenge of this approach is quantifying effects, particularly in large-scale brownfields. The costs of BR mainly include common costs for remediation of certain sites. Though regeneration costs are linked to the types of the final redevelopment purpose. For instance, recreational purposes demand a varied degree of cleanness compared to industrial land use. The cost issue becomes again critical when it comes to contaminated sites and difficulties to estimate the status of cleaning process. Moreover, BR is associated with financing costs of high potential risks (Kurtovic *et al*., 2014).

Table 2.4 Weighting and Ranking Criteria for Brownfield Site Selection at The Local Level.

Local government ranking criteria	Max. point value (weight)
Site Conditions	30
Compatibility with Local Land Use Controls (Zoning Ordinance)	25
Current Use Compatibility with Local Land Use Plans (Master Plan)	20
Compatibility with Surrounding Land Uses	15
Utility Infrastructure Capacity	10
Telecommunications Infrastructure	10
Transportation Infrastructure	10
Total available points (local)	120

Table 2.5 Brownfield Site Selection, Weighting and Ranking Criteria at The Country Level.

County authority ranking criteria	Max. point value (weight)
Financial Incentives	40
Environmental Risk and Compliance	30
Land Re-Use Preferences	20
Labour Resources	10
Market Conditions	10
Total available points (regional)	120

Source: a GIS-based decision support system for brownfield redevelopment, pp. 7-23, by Thomas (2002)

BR benefits according to Kurtovic *et al*. (2014) point of view are defined as the framework of economic, social, and financial benefits for private investors as well as tax revenue for the state. Economic and social benefits of brownfields are dealing with:

- the protection of public health and safety, and natural resources;
- management of construction over greenfields, avoid urban sprawl;
- reduction of external transport in suburban traffic and air pollution;
- maintaining and growth of employment;
- re-management of urban structure and mitigation of socio-economic problems in the area.

The challenge of abandoned industrial sites can be considered a practice to turn threats into opportunities. Once an industrial building's architecture is saved, the result is its potential to be transformed for its rich architectural fabric (Cantell, 2005). In addition, sustainable UR is of an essential part in promoting economy, employment, social and environmental measurements (Kurtovic *et al*., 2014). For investors, the main motivation for brownfields redevelopment is the actual profit gained through the regeneration. The commercial benefits achieved as the result of cash flow from economic structure in redeveloped site and an income from selling properties. The government also benefits from such regeneration by taxation of properties, income, construction, development fees, etc. (Groenendijk, 2006). Therefore, the importance of an abandoned building in a neighbourhood is to the extent that it could bring about such conditions to the community if no one cares, while they also offer an opportunity to bring revitalization of the neighbourhood and enhance social and economic values.

2.6.1 Challenges

Basically, regenerating brownfields has always been followed by various risks and challenges. Such barriers, regardless of their location, are expensive and challenging most of the time. Since the last decade, the investment over redeveloping brownfields have considerably declined mainly in developed countries. The main reason behind it is that regeneration of brownfields constitute a high risk investment and weak perspective for economic growth. Over the period from 2007 to 2009, when financial crisis started, brownfield investments in the EU have declined so that in 2013 the trend has decreased by 67% in EU compared to 2007 (Kurtovic *et al*., 2014). Another problem associating with the regeneration of brownfields is that the majority of abandoned sites are not registered. The reason behind the lack of registration is the potential fear of negative effects on the value of properties by gathering information, and there is always a potential concern between stakeholders about the limited institutional capacity to promote as well as lack of knowledge about the purpose of having a registration system between communities (Coffin and Meyer, 2002).

According to a survey and studies carried out by Meijer & Syssner (2017), the reasons behind the challenges to addressing whether large or small-scale abandoned properties are the following:

Limited funding

Funding sources for the management of vacancies are limited, and the pools gradually became smaller between 2016 and 2020. The criteria for using the funding and national subsidies have also changed recently, which creates uncertainty for the future of long-term financing of abandoned properties.

Time-pressure

The transformation process is time-consuming because of the difficulties in communication with citizens and owners. The other processes, such as demolition and monitoring, can also take time.

No national facilitation

The facilitation provided by the government is limited. Since this support is left to the municipalities to take care of, they have a limited budget for the management of the transformation process; therefore, strategic planning of vacant buildings may not be prioritized, and sometimes it is neglected.

A new discipline

The process of the management of abandoned properties is time-consuming to be fully implemented because it is a new topic in many towns. On a local level, this new discipline also produces a huge list of unoccupied buildings that need to be maintained.

Lack of resources and competences

Since the management of vacant buildings requires communication between different actors, there is a lack of knowledge in many municipalities' regeneration of the built environment. The methodology of the transformation process or reuse of abandoned buildings is not widely trained among architects, especially in small municipalities.

Despite these challenges, it could be mentioned that the collaboration between the municipality and citizens is an advantage. According to surveys, about half of the municipalities have collaborated with society to manage vacant properties. Such collaboration as the "Better Housing in Mors" as mentioned earlier and the initiative "Vestervig Regeneration" in Vestervig (a village in Thisted Municipality) illustrates a successful dialogue between citizens and the municipality and investment in the management of abandoned properties (Jensen, 2017).

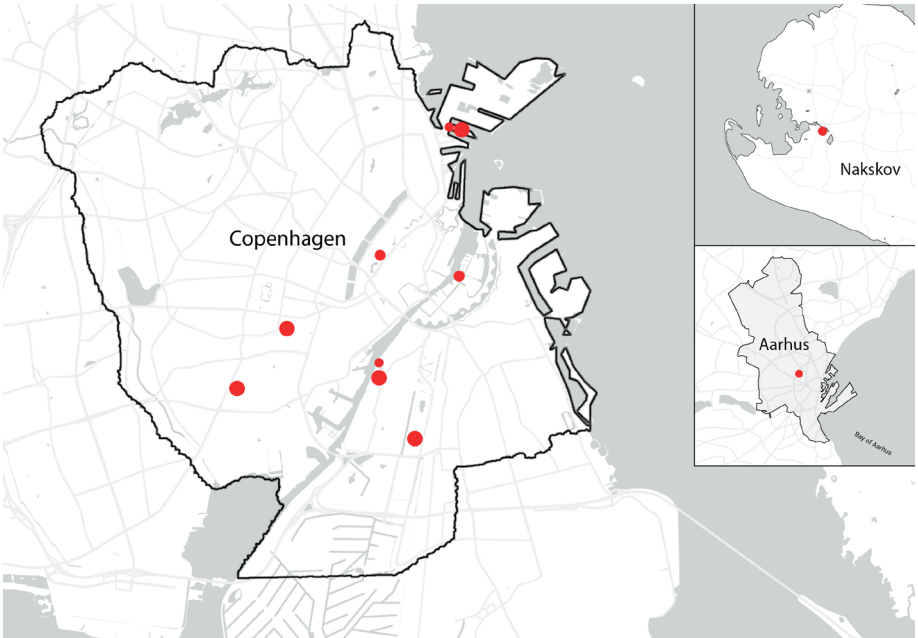
It should be noted that recently, many national funding pools have been established, and several municipalities in Denmark and local communities have started their own initiatives for the management of vacant properties. While strategies on a local and national scale have been newly introduced, there are still some challenges in managing abandoned buildings that need to be considered. According to research and surveys, the collaboration between civil society and municipalities is critical in the practices for managing abandoned properties.

CHAPTER 3 CASE STUDIES IN COPENHAGEN AND DENMARK

3.1 Structure and Locations

This chapter focuses on the analysis of nine brownfield development projects in Denmark, mainly in Copenhagen. The case studies are explained according to a descriptive and numeric structure, making it possible to compare the information of the projects. The first part includes a description, stakeholders, developers, and the project's cost. Then the history of the project and important events in chronological order are stated. In the end, the primary highlighted outcomes of the project are mentioned. Some information, such as the project size—including gross and net area—the budget derived from different sources or contact with developers, or using Google maps to calculate the area size of the projects.

As mentioned earlier, the research was carried out mainly in Copenhagen, where most brownfield regeneration (BR) projects have manifested in the last two decades. The reason for choosing Copenhagen is to understand the transformation of the brownfield process and its economic benefits in the Danish context as Andersen (2008) declares there is a clear Copenhagen mark on urban thinking, planning, and policies in Denmark. This casts light to know how Denmark's brownfield projects have been successfully transformed, generating social and financial profit to respond to the primary question of the research. This is to be accomplished by conducting an in-depth case study analysis in Copenhagen. The selected projects are on the basis of their importance in Denmark and Copenhagen's development and are in critical and influential locations in Copenhagen. They are picked from different brownfield types and functions to have a great scope of variant redevelopment projects. Another underlying reason for choosing mostly the capital region's case studies was the ability to observe projects. Many of the projects in Copenhagen are observed, and the effects of the projects are assessed and criticised.



Source: Produced by the thesis author

Figure 3.1 Locations of selected case studies in Copenhagen, Aarhus, and Nakskov

3.2 Ørestad

Figure 3.2 The location of Ørestad in Denmark
Source: Produced by the thesis author

Figure 3.3 The aerial photo of Ørestad.
Source: Ørestad Innovation City Copenhagen

Location: Amager Vest, Copenhagen

Brownfield type: Former military base

Architects: Danish KHR Studio, Finnish ARKKI Studio

Budget: 13.7b DKK

Net Floor Area: 2.778m m^2

Stakeholder: CPH City & Port Development (By & Havn), Denmark government

Activity: residential 555,600 m^2 (20%), offices 1,666,800 m^2 (60%), commercial and education 555,600 m^2 (20%)

Sustainability highlight: Providing jobs for 60,000 people resulting in high market land value and diverse social activities, reserving one-third of the total area for green areas in the most significant urban development (UR) in Copenhagen

3.2.1 Description

Figure 3.4 The location of Ørestad district in Copenhagen

Source: Produced by the thesis author

The district was previously located in a greenfield area on the island of Amager and is now one of Copenhagen's most significant URs. Ørestad basically devided into four districts; north Ørestad, common east Amager, Ørestud city, and south Ørestad. The development, which was initiated by the Copenhagen municipality and the Danish government, embraces a range of activities such as offices, housing, and facilities for a period of 30 years (Majoor, 2008). The district houses 20,000 inhabitants, provides 60,000 jobs and offers education to 20,000 students (Jensen and Myklestad, n.d.). The first office building was constructed in 2001, and residential buildings were completed three years later. By December 2016, the population reached 10,000 and 17,000 for residential and worker populations, respectively (Katz & Noring, 2017). The metro's construction significantly affected the district's value, which was inspired by English New Towns principles (By & Havn, n.d.).

"Ørestad and the metro are success stories of Copenhagen. This part of the city has developed faster than anyone could have envisaged in the end 1990s."

Jens Kramer Mikkelsen - CEO of CPH City & Port Development and former lord mayor of Copenhagen (1989–2004)

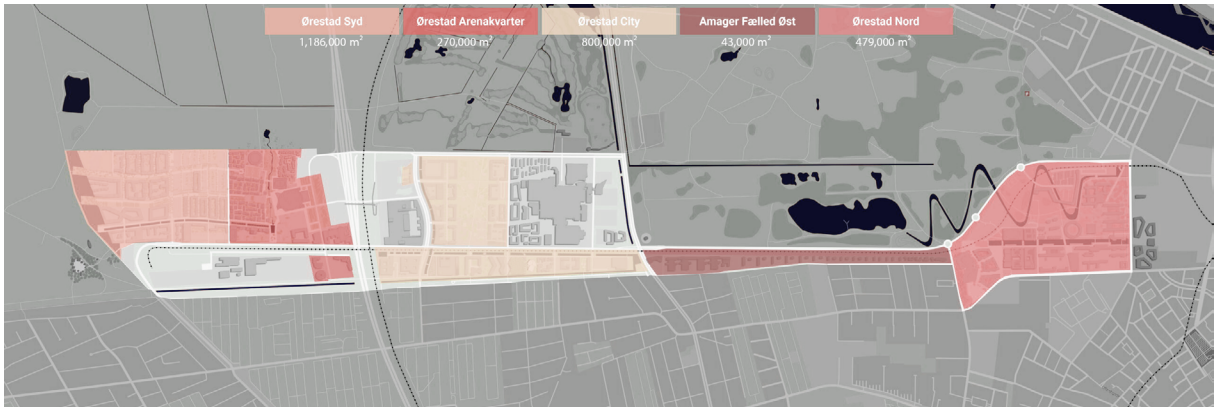


Figure 3.5 Ørestad neighbourhoods district

Source: By og Havn

3.2.2 History

The Ørestad development is the result of new UR policies in the late 1980s. The project alongside the Øresund bridge constitutes a new season of economic developments from the policies implemented earlier in Copenhagen after a period of financial crisis. The project gained importance in the abandoned greenfield area due to the adjacency to the expanded airport and Øresund bridge in the 1990s (Majoor, 2008). So the idea was to get the new Copenhagen district close to the Øresund connection. In 1994 Ørestad masterplan competition was held in which KHR and ARKKI studios' proposals were chosen (By & Havn, n.d.)

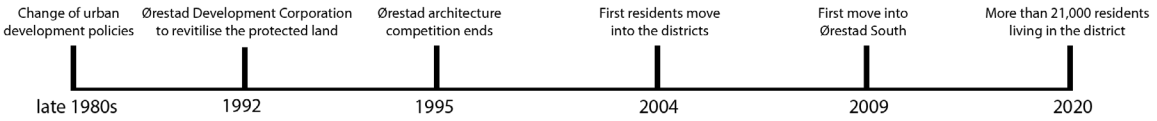
Figure 3.6 The greenfield of Ørestad before transformation.

Source: By og Havn

Figure 3.7 The aerial photos of Ørestad South and Ørestad City.

Source: By og Havn

Key Dates



3.2.3 Outcomes

Ørestad has played a pivotal role in the UR of Copenhagen after the economic recession in the 1970s. In general, Ørestad had two major impacts: first, as a significant economic setting in the Øresund region. Second, as a new UR model to finance a new UR transport system (Majoor, 2008). Furthermore, the success of the project was proved by attracting several investors to boost the economy in a dense blue and green district (Jensen and Myklestad, n.d.). This shows the importance of attracting investors to the UR of brownfields. The role of the metro, accessibility to the Øresund bridge, and mobility are other significant reasons to promote the regeneration of brownfields.

Figure 3.8 8-House building in Ørestad south neighbourhood.

Source: Maria Gonzalez

Figure 3.9 Modern buildings in Ørestad.

Source: Failed Architecture, by Olsson (2013)

3.3 Århusgade neighborhood (Inner Nordhavn)

Source: Cobe

Figure 3.10 Arhusgade neighbourhood and Nordhavn district.

Source: Produced by the thesis author

Figure 3.11 The location of Arhusgade in Denmark

Location: Østerbro, Århusgade, Copenhagen

Brownfield type: Industrial harbour

Architects: Cobe, SLETH, and Polyform

Budget: 97.5b DKK total Nordhavn (59.8b DKK excluding metro) of which app. 7.310b DKK dedicated for Århusgade

Net Floor Area: 330,000 m^2

Stakeholder: CPH City & Port Development (By & Havn)

Activity: Housing 165,000 m^2, commercial, education 140,000 m^2

Sustainability highlight: The most sustainable urban district in Copenhagen, DGNB[1] certificate

Figure 2.1 1 DGNB – the abbreviation (in German) for the German Sustainable Building Council.

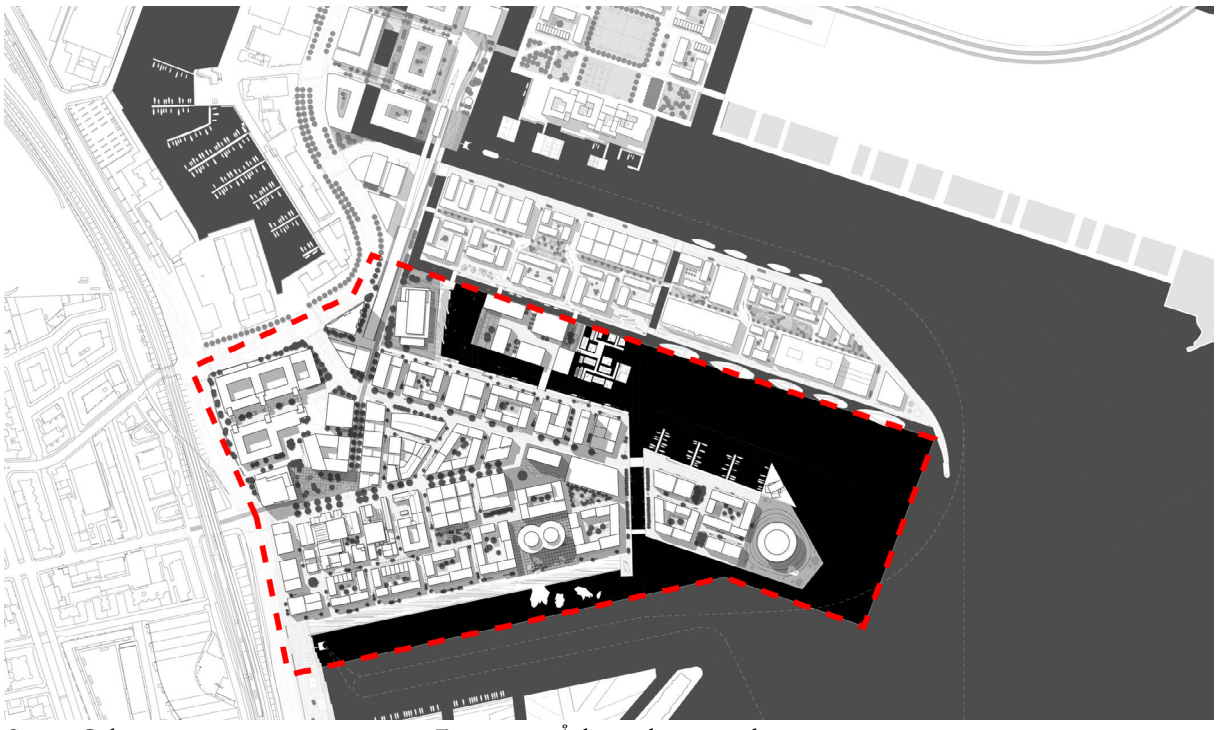
3.3.1 Description

The development of Århusgade is part of the Nordhavn development and transformation that there were former industrial harbour sites. It is located on a peninsula and highlights the significance of the neighbourhood by connecting to the Øresund and also being north of the city centre.

Figure 3.12 The location of Århusgade neighbourhood in Copenhagen

Source: Produced by the thesis author

The master plan for the development of the whole Nordhavn district is expected to be completed by 2050, when 40,000 inhabitants with 40,000 workplaces will reside there, of which there are 165,000 m² and 140,000 m² of residential and commercial space, respectively, in Århusgade. The plan's objectives were based on six categories titled "The Vision: The Sustainable City of the Future": 1. A futuristic eco-friendly city 2. A vibrant city 3. A city of sustainable mobility 4. A dynamic city 5. A city for everyone 6. A waterside city. These attributes contribute to the concept of the sustainable city, which is "a sustainable city is not only a matter of environmental responsibility but also of social diversity and the addition of value." which constitutes Nordhavn, the most sustainable district in Copenhagen (City and Port Development, 2012). One of the project's main challenges was how to reuse and redevelop leftover industrial areas as a result of the post-industrial process on an urban scale (Cobe, n.d.).



Source: Cobe

Figure 3.13 Århusgade masterplan

3.3.2 History

The construction of the port started in 1891, and by 1894, the port became open for docks and ships. Different companies constructed many buildings between 2004 and 2006, but in 2009 a competition to transform the industrial harbour district was held in which Cobe's proposal was nominated. The significant developments, including the transformation and expansion of the harbour, started in 2012 and are expected to be finished by 2050 (By & Havn *et al*., 2012).

Figure 3.14
Source: By og Havn, 2012

Figure 3.15 Industrial buildings of Århusgade before transformation.

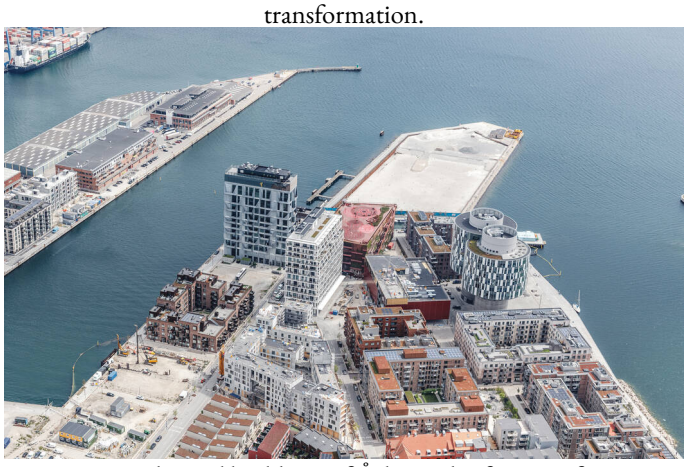
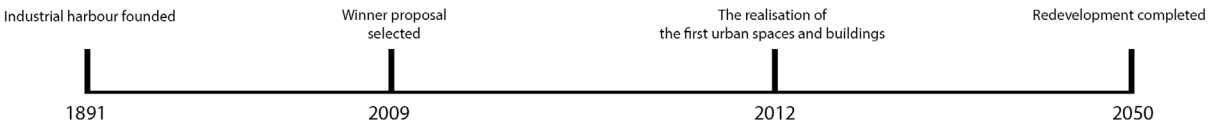


Figure 3.16 Industrial buildings of Århusgade after transformation.
Source: Cobe

Key Dates



3.3.3 Outcomes

While the area had its own identity courtesy of a mix of old factories, warehouses, silos, etc., the main challenge was to preserve this identity and incorporate brand new buildings, which resulted in an architectural identity where old and new elements are co-existent. The planners of the district, while providing the master plan, were in close dialogue with stakeholders, residents, and future users. Subdividing the district into smaller areas is also the continuation of the existing basin concept, which emerges from the cultural identity of the harbour. This idea also activates another function on an urban scale, where canals are considered public recreational for swimming. The urban greenery, including green areas, promenades, and public spaces, acts as recreational areas and promotes a sense of belonging in the urban environment. Separating the district makes it possible to develop and grow the islets to meet the district's unforeseen future demands. Due to the location of the district close to the city centre and the connection to the Baltic Sea, cities and countries nearby, it is predicted that it will attract more visitors and businesses from the entire city, which will also result in economic growth.

Overall, it is evident that the Århusgade neighbourhood attempts to follow sustainable development goals by which providing housing and a range of activities that indicate that Århusgade in Nordhavn is one of the most sustainable districts in Denmark and Europe.

Source: Cobe

Figure 3.17 Regenerated Århusgade district

3.4 The Silo

Source: Produced by the thesis author

Figure 3.18 The location of The Silo in Denmark

Figure 3.19 The transformed Silo

Source: Cobe

Location: Østerbro, Århusgade, Copenhagen

Brownfield type: Grain silo

Architects: Cobe

Budget: n.d.

Net Floor Area: 6,720 m^2

Stakeholder: Unionkul Holing A/S and NRE Denmark

Activity: Residential 5,600 m^2, resturants 1,120 m^2

Sustainability highlights: Recycled concrete and preserving 380 tons of CO2

3.4.1 Description

The project is part of the redevelopment of the post-industrial district called Nordhavn. The concrete structural element was reused, which resulted in saving 380 tons of CO2. The large 17-story industrial building, a grain silo, was transformed into residential apartments and public functions (restaurants). The aim was to preserve the structural identity and heritage while inviting inhabitants and urban activities, which ensure that the building is permanently active.

Figure 3.20 The location of The Silo in Copenhagen

Source: Produced by the thesis author

Upon reactivation of the aim, the main challenge was articulating the blank facade. As Cobe founder - Dan Stubbergaard - says, "we wanted to retain the spirit of the old building as much as possible, both in terms of its monolithic exterior and concrete interior, by simply draping it with a new overcoat." The choice of galvanized steel for the façade retained the harbour's characteristics and the district's industrial identity. In addition, a gallery and restaurants on the ground floor and the roof with an observation deck overlooking the city, harbour, and Sweden, which are accessible to the public, activate the urban functionality in the district (Cobe, n.d.).

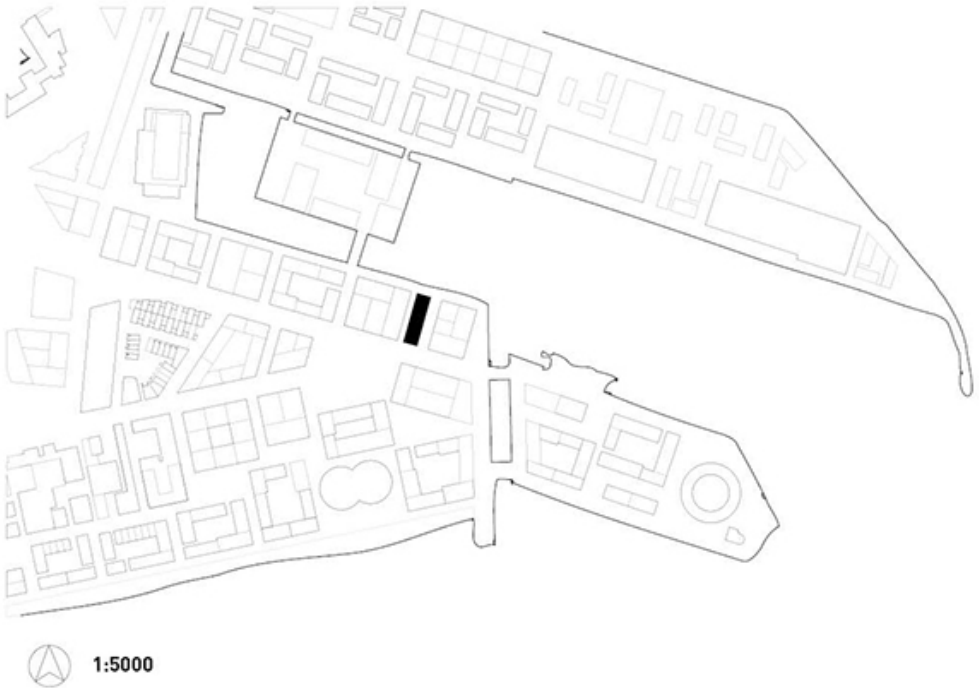


Figure 3.21 The Silo site plan.

Source: Cobe

3.4.2 History

The building constructed in the 1960s was the first to store grain, but with the decay of the dockyard, the silo got abandoned. The project is part of the redevelopment of the post-industrial district called Nordhavn. The redevelopment started in 2013 and took four years to be completed in 2017 (Cobe, n.d.).

"We wanted to retain the spirit of The Silo as much as possible... The aim was to transform it from the inside out in such a way that its new inhabitants and the surrounding urban life would highlight the structure's identity and heritage. Hence, the use of galvanized steel for the facade, which patinates in a raw way and retains the original harbour character and material feel, lending a roughness and raw beauty to the area, as in its industrial past."

Dan Stubbergaard, architect and founder, Cobe

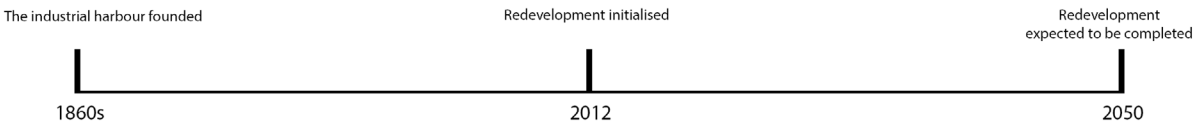
Figure 3.22 The Silo before transformation

Source: Cobe

Figure 3.23 The Silo in waterfronts before regeneration

Source: Cobe

Key Dates



3.4.3 Outcomes

The project highlights the importance of reusing existing buildings to cut costs and achieve maximum cost benefits while increasing public space activities for residents and visitors. Preserving the original structure constitutes the retention of the identity in an aesthetic image while playing a crucial role in that way and positively affecting the environment by preserving a considerable amount of CO2.

Figure 3.24 The Silo building before transformation
Source: Cobe

Figure 3.25 The Silo building during transformation
Source: Cobe

3.5 Paper Island

Figure 3.26 The regenerated Paper Island *Source:* Cobe

Source: Produced by the thesis author
Figure 3.27 The location of Paper Island in Denmark

Location: Trangravsvej, Copenhagen

Brownfield type: Industrial factory

Architects: Cobe

Budget: 1b DKK

Net Floor Area: 45,000 m^2

Stakeholder: CPH City & Port Development (By & Havn), CØ P/S (Danica Ejendomsselskab, Unionkul Ejendomme, Nordkranen), NCC

Activity: Residential (36,557 m^2) and commercial (8,448 m^2)

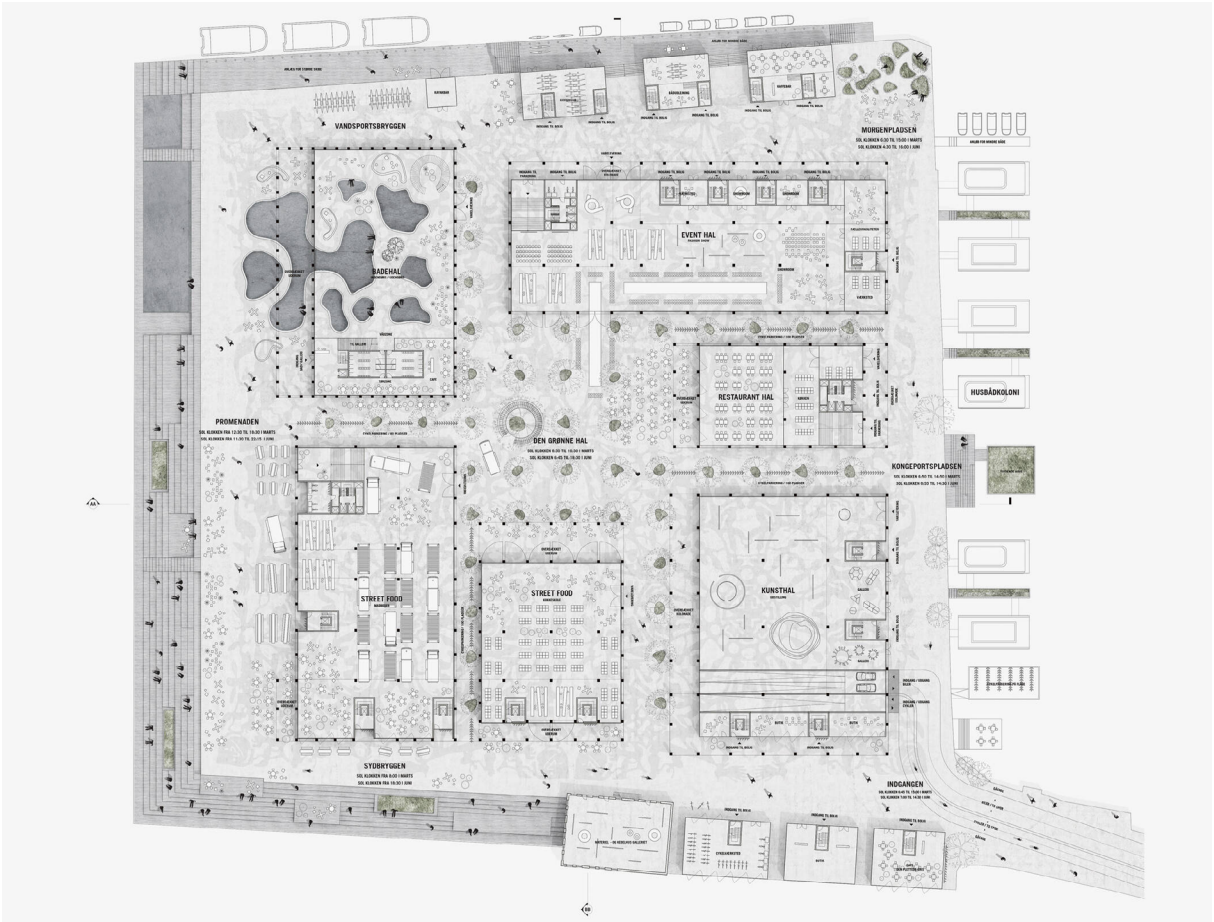
Sustainability highlight: Creating lively open space for the public, preserving architectural identity

3.5.1 Description

Source: Produced by the thesis author

Figure 3.28 The location of Paper Island in Copenhagen

Paper Island is an example of how Copenhagen is transforming from an industrial city to a place for people. When the Paper Island first was re-programmed from industry to food market, it soon became the fourth-most visited tourist attraction in Denmark. Learning from this success, developers then turned the area publicly accessible and robust architectural type of the industrial hall as a programmatic premise for the redevelopment of Paper Island into a sustainable setting for a vibrant culinary culture (Cobe, n.d.). With splendid waterfront views, the site could hardly be more tempting or profitable as a place to build new homes or offices. But when new owners By & Havn—itself co-owned by the municipality and the Danish national government—suggested redevelopment, the city's response was interesting. Copenhagen, the municipality decided, needed some freer, more creative spaces to keep the city interesting—even if the arrangement was only temporary. So Paper Island was granted a five-year interim period during which its warehouses could be let out affordably to "creative" businesses. (O'Sullivan, 2016).



Source: Cobe

Figure 3.29 Paper Island situation plan

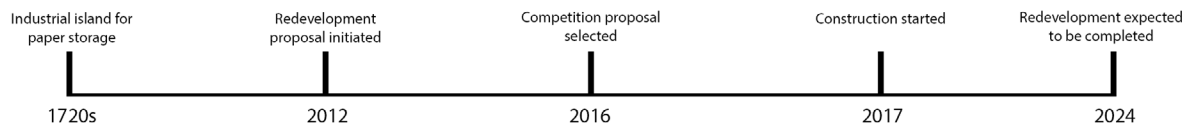
3.5.2 History

For 300 years, Paper Island was not accessible to the public. The old industrial halls had many purposes. From paper storage to X Factor events, summer parties, band nights and furniture showroom (Cobe, n.d.). In 2012, the city of Copenhagen received a plan to redevelop a chunk of its most valuable real estate. The site was called Paper Island, also known as Christiansholm, a warehouse-covered islet in the city's inner harbour that had only just been vacated by the printing industry (O'Sullivan, 2016). The new development is historically inscribed in a very unique location on the border between the former navy island of Holmen and Christianshavn, Copenhagen's old industrial warehouse district, expected to be completed in 2024 (Cobe, n.d.).

Source: Cobe

Figure 3.30 The Paper Island before and after transformation

Key Dates



3.5.3 Outcomes

The Paper Island is one of the most successful waterfront redevelopment project in Copenhagen. The location is attractive enough to be able to promote ambitious programmes both in an urban and architecture scale. On the other hand, other potentials such as the opera house in the north, the world famous resturant in the south increase the attraction of the site. While the car-free routs in the neighbourhood making the district more accessible for the flow of more passers-by, the lively district became a great potential for businesses and commercials to gain the maximum economic profit. Therefore the importance of waterfront brownfields regeneration, architecural identity, and high accessibility in the accelarating economy are obvious in this case study.

Source: Cobe

Figure 3.31 The regenerated Paper Island

3.6 Havnestad

Figure 3.32 The location of Havnestad in Denmark
Source: Produced by the thesis author

Figure 3.33 Havnestad regenerated buildings
Source: ULI Development Case Studies (2003)

Location: Havnestaden, Copenhagen

Brownfield type: Industrial land (oil mill and vegetable oil refinery)

Architects: PLH Arkitekter

Budget: 225m DKK

Net Floor Area: 2.171 m^2, (200,000 m^2)

Stakeholder: Municipality of Copenhagen, DSI (Dansk Sojakagefabrik)

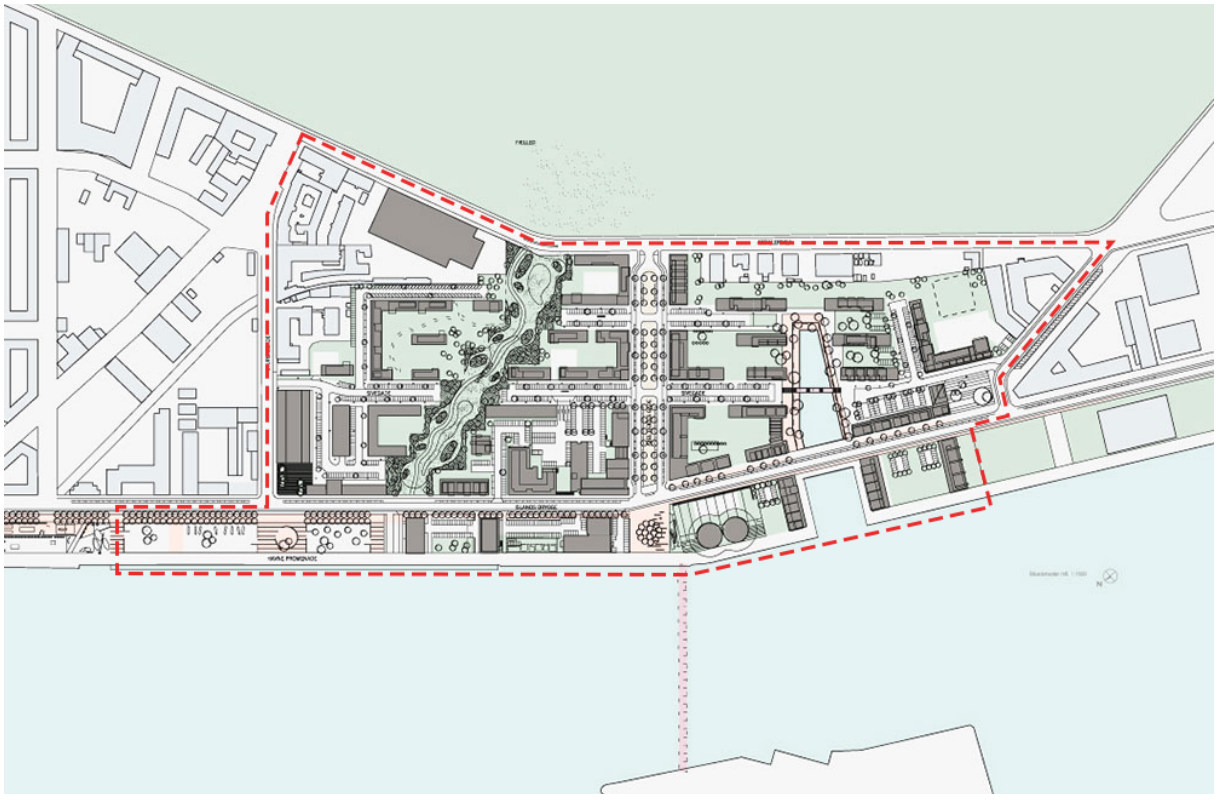
Activity: Housing 812,000 m^2 est., office 384,000 m^2 est., commercial 975,000 m^2

Sustainability highlight: Reuse of buildings and decontamination of the land

3.6.1 Description

Figure 3.34 The location of Havnestad in Copenhagen
Source: Produced by the thesis author

PLH prepared the master plan for revitalizing the 200.000 m^2 industrial area into a new urban environment with an attractive mix of uses in new and old buildings. The location's fundamental qualities are found in three key elements; the green (wildlife preserve), the urban (city), and the blue (harbour) PLH received the urban planning award "Byplanprisen 2003" for the realized master plan (PLH, n.d.). The goal was to build a large recreational area. The percentage of the built-up area is formed by 50 % of houses. Also, a new bridge for pedestrians and bicyclists was built to link the Havnestad to the city on the other bank. The area provides access to open green space, waterfronts, high-quality housing, and public realm and physical recreation opportunities. The master plan also includes a green belt, linking the area to an adjacent natural park, and a water basin, linking the area to the waterfront. The main features of the neighbourhood are; the attractiveness of the site (area accessible to open green space and waterfronts), transport links (excellent connection to the city centre), and the social status of the locality (area of newly developed housing, redevelopment to modern standards) (TIMBRE Project, n.d.).



Source: PLH Arkitekter

Figure 3.35 Site plan of Havnestad region

3.6.2 History

The former oil mill and vegetable oil refinery DSI (Dansk Sojakagefabrik) was established in 1909 by EAC (The East Asiatic Company) as an oil mill and vegetable oil refinery. In the 30s, the factory also started with chemical products like chlorine, caustic soda, and hydrogen. Due to the dissatisfactory results during the 1980s, it was decided to stop production, and the plant was closed in 1991 (TIMBRE Project, n.d.).

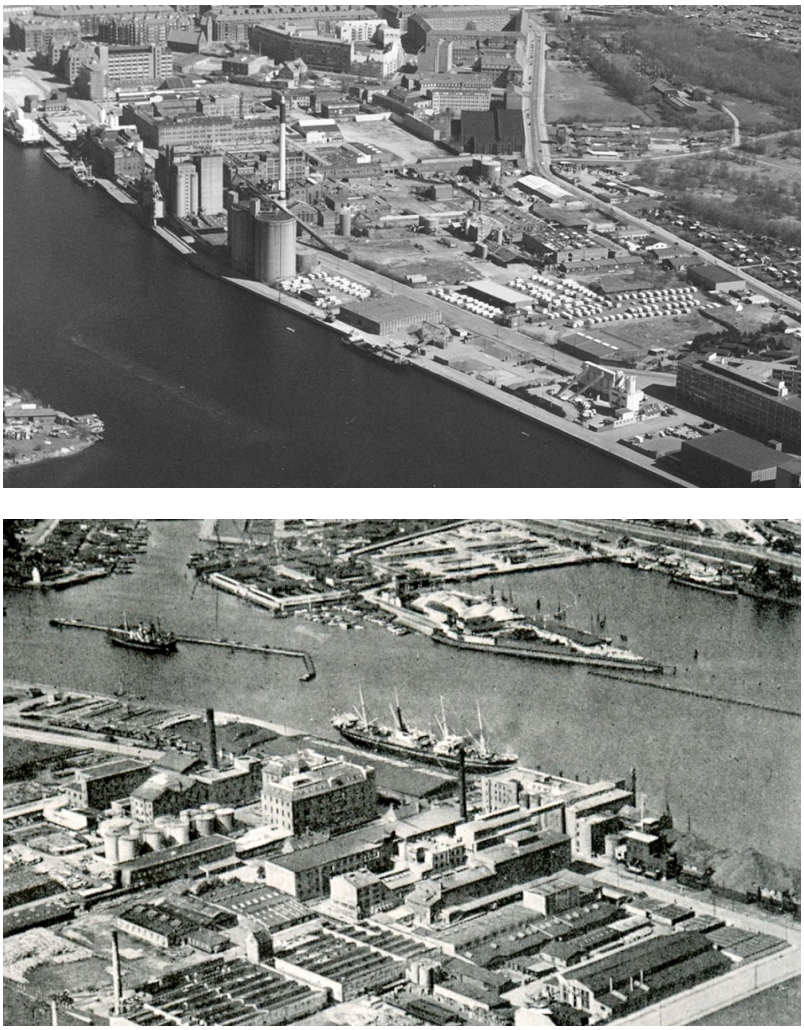
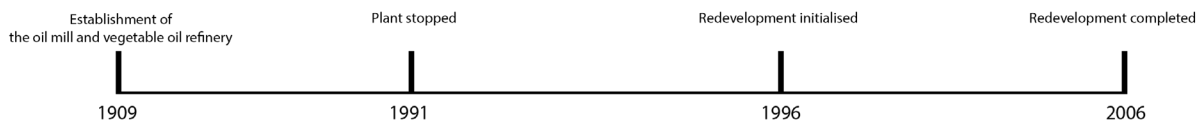


Figure 3.36 Havnestad region before and after regeneration
Source: PLH Arkitekter

Key Dates



3.6.3 Outcomes

• The location of the neighborhood and its great accessibility had a crucial role in the redevelopment of the former industrial site.

• The highlighted role of housing activity in the development of the district.

• The project does not include the demolition of buildings. Reusing existing buildings, besides the construction of new ones, results in developing the industrial site.

• By preserving existing and important buildings, the district's identity is preserved in the new transformation.

Figure 3.37 Havnestad during and after transformation
Source: ULI Development Case Studies (2003)

3.7 Frøsilo

Source: MVRDV Figure 3.38 Frøsilo/Gemini residence regeneration

Figure 3.39 The location of Frøsilo in Denmark *Source:* Produced by the thesis author

Location: Islands Brygge, Copenhagen

Brownfield type: Industrial factory

Architects: MVRDV

Budget: 132,400,000 DKK

Net Floor Area: 10,700 m^2

Stakeholder: NCC Construction Danmark A/S

Activity: Residential

Sustainability highlight: Maximum re-use of existing infrastructure

3.7.1 Description

Figure 3.40 The location of Frøsilo in Copenhagen

Source: Produced by the thesis author

"The Frøsilo is a radical waterfront conversion located in the old harbour area of Copenhagen. Whereas a warehouse is a more or less complete structure, which requires modest adaptation to allow it to function as housing without losing its original charm, silos are different: they are very basic and bare structures, they are incomplete. This bareness and incompleteness comprise the challenge of this project. However, this structural limitations of the silo hold the solution to the design. The apartment floors are hung on the outside of the silo creating two 'supershafts' which contain all obstructing objects and lobby areas whilst allowing each room to profit from maximum views and flexibility. In this way, the silo literally forms a new core for the project: all the useable space, every room, profits from its unique location" (MVRDV webpage). The Frøsilo later on was renamed to Gemini Residence.

Figure 3.41 Frøsilo aerial photo

Source: Produced by the thesis author, adapted from Google Earth

3.7.2 History

The building was originally a soybean processing plant, established in the Islands Brygge area in 1909. It produced oil and animal feed and grew to be the largest employer in the area in the 1950s, employing 1,200 mainly local workers. The two silos, now converted into Gemini Residences, were built in 1963. After the plant closed in the 1990s, the area was redeveloped into a new district with residential and office buildings. Later, as Copenhagen's waterfront was redeveloped, the conversion of the two silos was carried out between 2002 and 2005.

Source: MVRDV Figure 3.42 Frøsilo before, during, and after transformation

Key Dates

3.7.3 Outcomes

- Creative architectural solution for the conversion of the silos.

- Maximum usability of the existing structure with the least intervention.

- Combination of the old and new elements creating the identity of the neighbourhood.

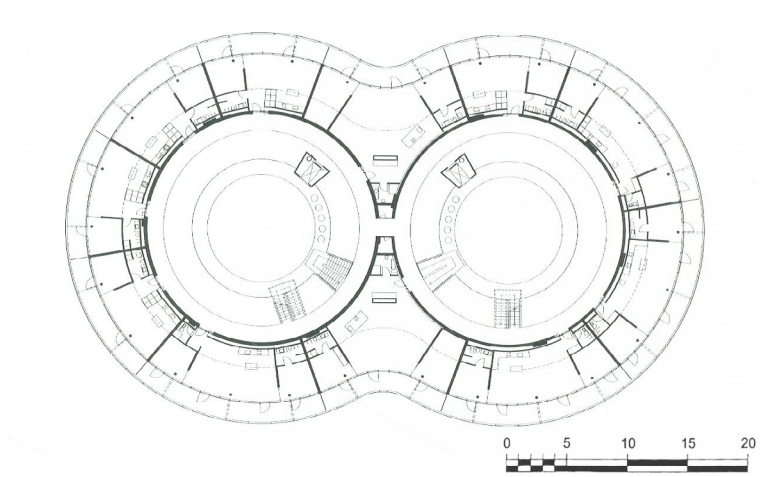


Figure 3.43 The Frøsilo floor plan

Figure 3.44 Regenerated Frøsilo

Source: MVRDV

3.8 Carlsberg City

Figure 2.45 Preservation of cultural heritage in the regeneration of Carlesberg

Source: Retail development plan for Carlsberg Byen

Source: Produced by the thesis author

Figure 3.46 The location of Carlsberg in Denmark

Location: København V, (Vesterbro, Copenhagen)

Brownfield type: Brewery

Architects: Entasis, C.F. Møller Architects, Gehl Architects

Year: 2007

Budget: 7.354b DKK

Net Floor Area: 567,000 m^2

Stakeholder: Udviklingsselskabet Carlsberg Byen P/S

Activity: Residential 277,000 m^2, offices 70,000 m^2, commercial 253,000 m^2

Sustainability highlight: Promotion of cultural heritage identity

3.8.1 Description

Source: Produced by the thesis author

Figure 3.47 The location of Carlesberg district in Copenhagen

Perhaps the most important historical and industrial neighborhood in this district is Carlsberg Breweries, which has been home to different industrial art attractions and inviting artistic and cultural communities in recent years. According to the municipality information. The proposal is a result of an international competition held in 2007 with an emphasis on turning the site into an "active vibrant urban district in which the spirit of the place is a stepping stone for new urban experiences "

The competition brief was to utilize urban spaces as the winner's project name was "Our Spaces." It is claimed that the district will be fully developed by 2024, where homes, offices, retail, shops, cafes, restaurants, schools, and different activities will include 60,000 square meters of area. (Carlsberg Byn, n.d.)

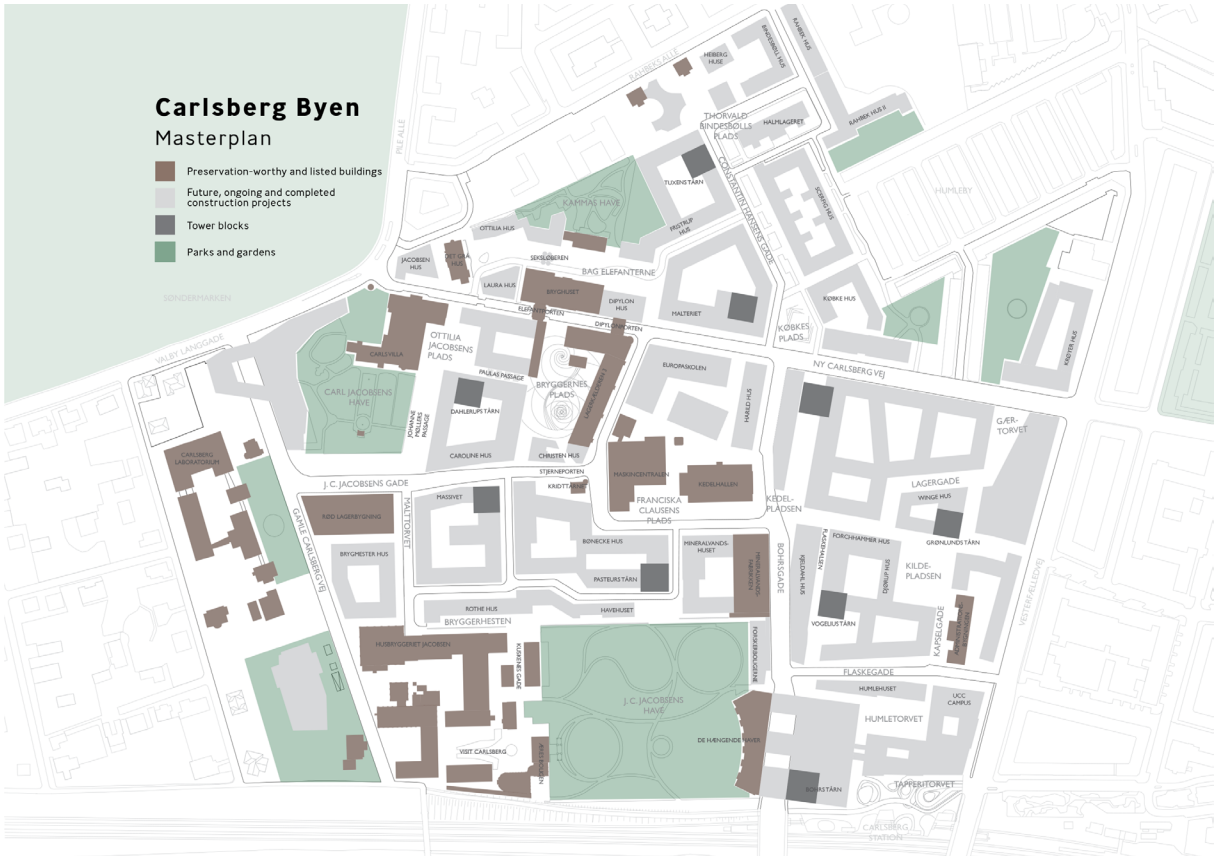


Figure 3.48 Carlesberg district masterplan

Source: Retail development plan for Carlsberg Byen

3.8.2 History

Carlsberg was founded in 1847 as a modern Danish brewing company. The industrial site has had a crucial impact on Danish culture due to its contribution to Danish academia and the arts. In 2006, Carlsberg company decided to relocate, so the old brewery remained abandoned for a while. (Carlsberg Byn, n.d.) The site was first selected as an Industrial Site of National Significance in 2007 and then was included in the heritage inventories. (Riesto, 2011) The development started in 2012 by listing worthy preserving buildings and promoting the liveability of the district. (Carlsberg Byn, n.d.)

Figure 3.50 Promoting cultural elements in Carlsberg

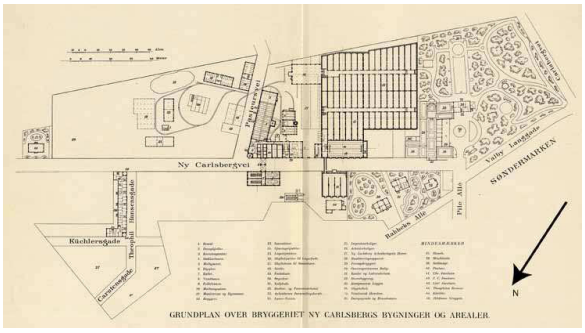


Figure 3.49 History of Carlsberg industry

Source: Finding Industrial Space: Contested Spatial Concepts for Carlsberg Square, Copenhagen, pp. 30-40, by Riesto (2011)

"The many listed buildings, with their architectural and historical value, constitute a unique asset for the many residents, companies and visitors who move in Carlsberg City."

Jens Nyhus, CEO, Udviklingsselskabet Carlsberg Byen P/S

Key Dates

3.8.3 Outcomes

The transformation of Carlsberg was followed by four elements, including art, culture, production, and science, enabling the district to embrace different unique social scenes in spaces. Research centres, educational institutions, public spaces, and art galleries invite more city visitors. In addition, the brand Carlsberg, with its history, seems to authenticate and certify the heritage and culture in the heart of the district. This can show the importance of culture and heritage in promoting the city's social activities. By consideration of meeting people's demands in the city, it could be concluded that social sustainability was the priority of developing the project.

However, it is argued that this development was undertaken to attract a specific class of people rather than all groups involved in the economy, thereby showcasing the district and encouraging innovation. In other words, the existence of different activities, students, and artists was to attract the specific class and follow strong enterprises, leading to an increase in real estate prices in the district. Overall, it should be noted that the cultural heritage of Carlersberg is the pivot of the lively district where a range of social activities and recreational spaces are gathered together, and urban planners could successfully highlight it in the district, leading to economic growth.

Figure 3.51 Regenerated Carlsberg district

Source: Retail development plan for Carlsberg Byen

3.9 The Timberyard

Source: Gehl People

Figure 3.52 The Timberyard regeneration

Source: Produced by the thesis author

Figure 3.53 The location of The Timberyard in Denmark

Location: Daugbjergvej, Aarhus

Brownfield type: Industrial site

Architects: Gehl People, Henning Larsen Architects

Budget: 2b DKK

Net Floor Area: 70,000 m^2

Stakeholder: Pension Denmark

Activity: Residential 56,000 m^2 and offices 14,000 m^2

Sustainability highlight: Pre-certified DGNB Platinum Urban Neighbourhood

3.9.1 Description

Source: Produced by the thesis author

Figure 3.54 The location of The Timberyard in Aarhus

As a foundational principle in Pension Denmark's property strategy, Sustainability was the driving ambition for the development of the 36,000 sqm former industrial plot to a mixed-used urban neighbourhood. Located on the banks of the River Å and close to Aarhus's city centre, the site is on the fringe of the inner city and the open green corridor along the river. This fantastic location provided a strong rationale behind its vision – to be a place that generates a community and a 'place' that is loved by its residents and is in its own right worth visiting by locals and visitors alike. As part of the vision and masterplan development, temporary interventions have contributed to the collection of opinions and the qualification of ideas and concepts. The northside festival allowed the project team to have face-to-face civic engagement, collecting 260 interviews on sustainability and community building that influenced the final plans. A series of outdoor furniture installations helped draw people to the riverside area and served as a natural talking point for the new development. (Gehl, 2021.)

Source: Gehl People

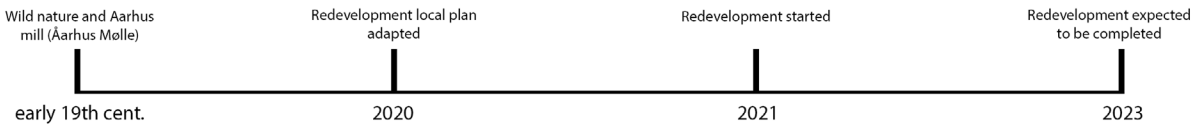
Figure 3.55 Paper Island situation plan

3.9.2 History

The Timberyard has its heart by the river, which at the beginning of the 20th century was a social meeting place by the water. Throughout the history, the river has always been an important resource for the local manufacturers - but also for the city's residents, who have used the water as a meeting point for social activities, association life and recreation. There are four elements that The Timberyard has been shaped by, including Industry, production and craft, resource awareness, connection between city and nature, and recreation by the river. Until the beginning of the 19th century, there was wild nature here, and Aarhus Mølle ground flour and malt for the city's farmers. Later, the areas were drained, and what we know today as Vesterbro and Godsbanen grew out of Mølleengen (Pension Denmark, 2022).

Source: Gehl People Figure 3.56 The aerial photo of The Timberyard district

Key Dates



3.9.3 Outcomes

- The project enjoys recycled materials and wooden materials saving considerable amount of CO2 which led to receiving DGNB certificate.

- The project involved inhabitants participation in the redevelopment process.

- In addition to the district is dedicated for social housing, providing 500-600 homes, it offers places for people to meet and socialise. This also result in a vibrant and lively district while meeting objectives of the redevelopment of the area.

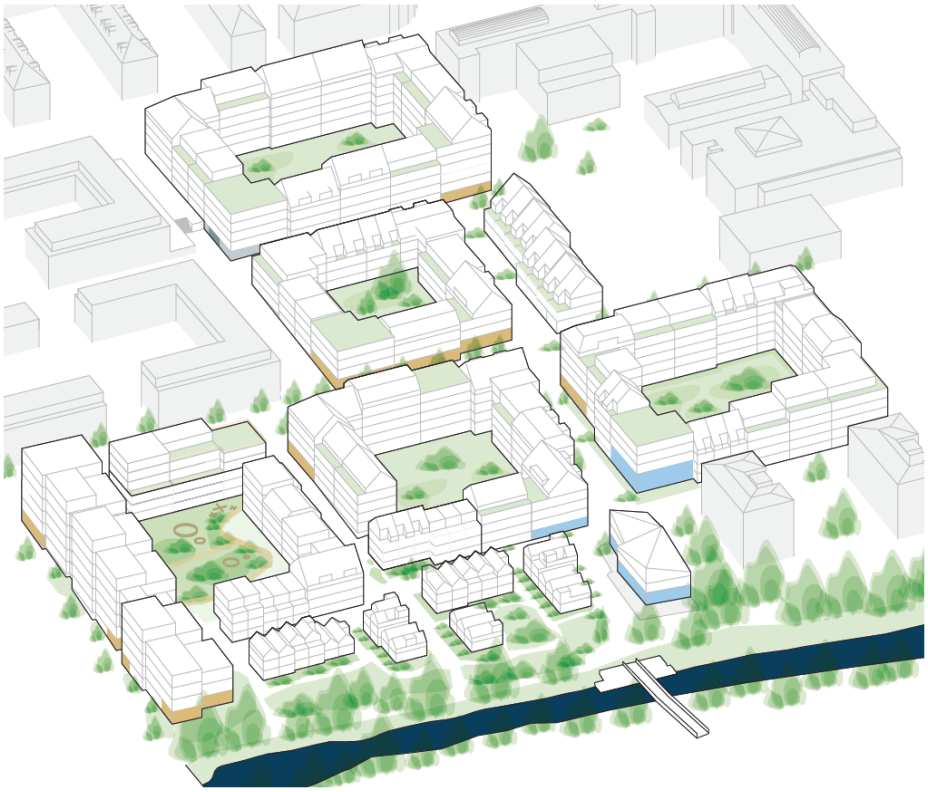


Figure 3.57 Architectural diagram of The Timberyard transformation

Source: Gehl People

3.10 Valby Maskinfabrik

Figure 3.58 Valby Maskinfabrik district

Source: valbymaskinfabrik.dk

Figure 3.59 The location of Valby Maskinfabrik in Denmark

Source: Produced by the thesis author

Location: Valby, Copenhagen

Brownfield type: Industrial factory

Architects: Henning Larsen Architects, Entasis, CF Møller Architects, Gehl Architects

Budget: 98,188,927 DKK

Net Floor Area: 6,915 m^2

Stakeholder: DFE (Association for Real Estates), FLSmidth A/S

Activity: Residential

Sustainability highlight: Promotion of social activities, reuse of warehouses

3.10.1 Description

Source: Produced by the thesis author

Figure 3.60 The location of Valby Maskinfabrik in Copenhagen

The transformation of the abandoned industrial site under competition occurred, and Hennin Larsen Architects' masterplan was selected, later developed by Gehl Architects in 2011. The new development was based on nine principles, which make the district vibrant and active through the presence of residents, where there are urban spaces for informal meetings, green spaces for pleasant microclimates, and different facilities for different age groups to invite people. In the heart of the neighbourhood there used to be an old factory called *Montagehallen* (The Assembly Hall), which is the case study, is now transformmed into residential houses as a symbol of the three symbol of the area, including housing, business, and space for living. The regeneration of the Valby neighborhood shows the importance of outdoor spaces as a part of the social environment (Valbymaskinfabrik, n.d.).

1. Workshop district
2. Canteen district
3. Foundry district
4. Manufacturing square
5. Assembly hall district
6. Packing district
7. Montagehallen (case study)

Source: valbymaskinfabrik.dk

Figure 3.61 Valby maskinfabrik district areas and the case study building

3.10.2 History

Valby district has seen a historical industrial factory since 1882. The industrial factory, which formerly used for the production of cement was stopped production in 1990. The building and its surroundings were abandoned until 2011 the proposal for the site's redevelopment was offered. The construction process lasted four years, between 2014 and 2018 (valbymaskinfabrik, n.d.).

Source: valbymaskinfabrik.dk

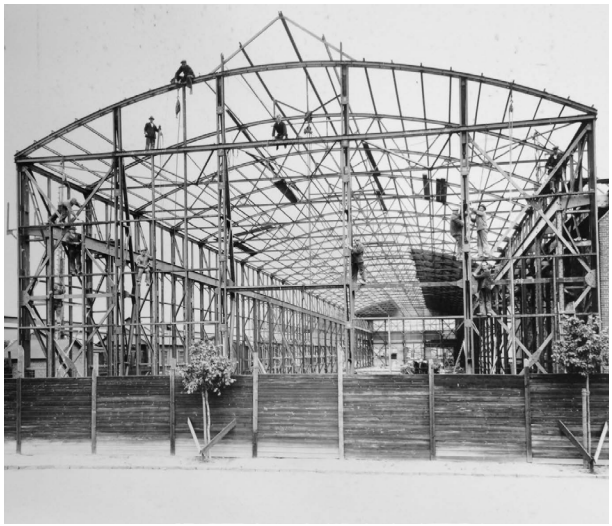


Figure 3.63 History of Valby Maskinfabrik

Source: valbymaskinfabrik.dk

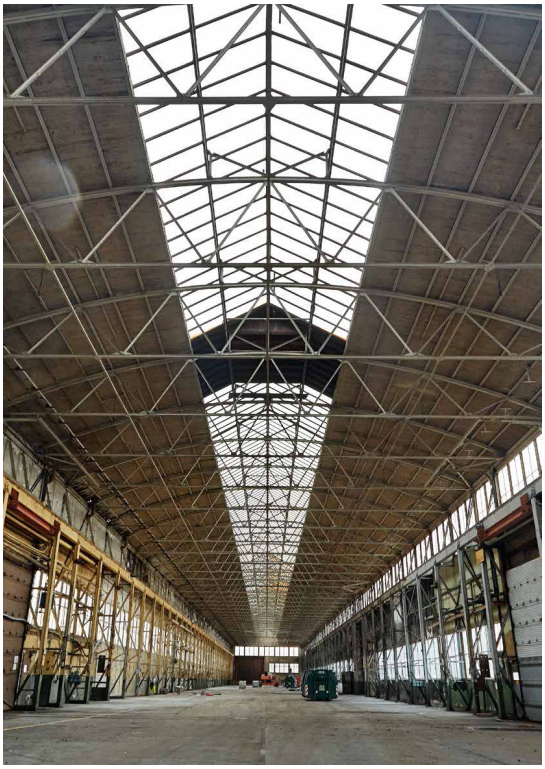
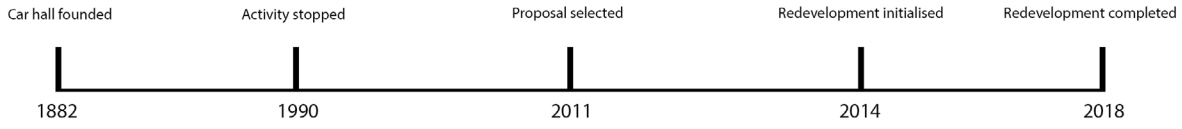


Figure 3.62 Transformed Valby Maskinfabrik

Key Dates



3.10.3 Outcomes

In the transformation of the district, where it reflects the past and present, it tried to retain its identity by preserving details as much as possible. As strong symbols, the district has gathered three main elements: residents, the business community, and open spaces. For instance, the red steel farm creates a sense of history and revitalizes the industrial theme of the place. This shows the importance of the industrial heritage when it constitutes an asset to enhance economic growth and social activities. As a result, residents' needs are met, and it creates a range of attractions and open green spaces for everyone for a lively neighborhood. Valby Maskinfabrik is an excellent example of how a former industrial site can be furnished with a robust and diverse social life by preserving Danish industrial history for more excellent sustainable UR.

Figure 3.64 Green area and meeting places of Valby Maskinfabrik

Source: valbymaskinfabrik.dk

3.11 Torvehallerne (The Market Halls)

Figure 3.66 The regeneration of Torvehallerne
Source: Arkitekturvaerkstedet

Source: Produced by the thesis author

Figure 3.65 The location of Torvehallerne in Denmark

Location: Indre By, Copenhagen

Brownfield type: Public square and open market

Architects: Arkitekturværkstedet, AI-Gruppen A/S

Investment: 120m DKK

Net Floor Area: 6,600 m^2

Stakeholder: Jeudan A/S, Municipality of Copenhagen

Activity: Commercial

Sustainability highlight: Revitilising the land as the spot for the public in the city centre making the space more lively.

3.11.1 Description

Hans Peter Hagens designed TorvehallerneKBH, and Arkitekturværkstedet and the AI Group have been the engineers responsible for construction and installation. The project is an open market that acts as a public space in the city's heart. The other key features of the project include the social status of the locality (historical tradition of a market); an attractive environment for leisure (there are several parks and the river) (TIMBRE Project, n.d.).

Source: Produced by the thesis author

Figure 3.67 The location of Torvehallerne district in Copenhagen

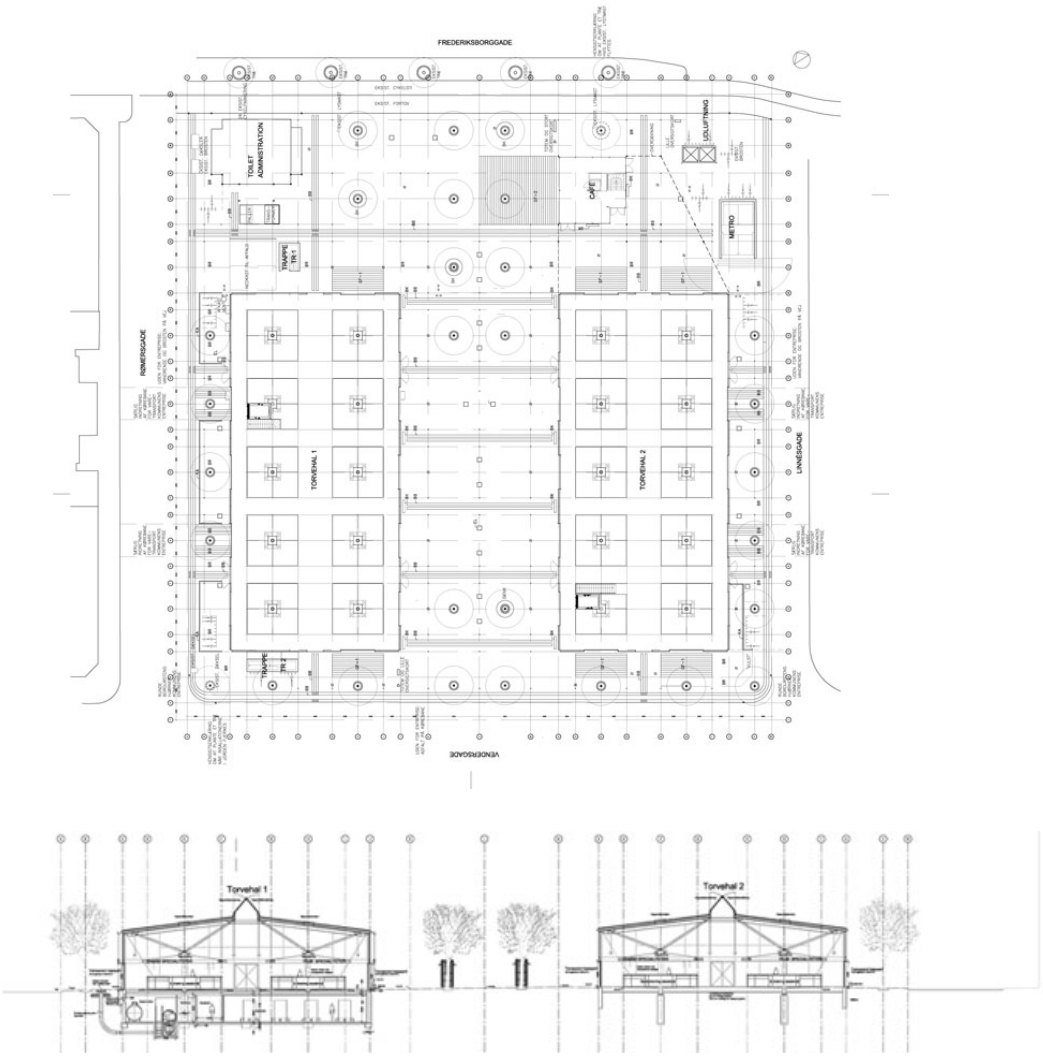


Figure 3.68 Architectural documents of Torvehallerne

Source: Arkitekturvaerkstedet

3.11.2 History

The market used to serve as a place where people came to sell their goods, usually vegetable products. This place has been working since the second half of the 20th century. In 1968, the square was renamed to Israel Square to mark the 25-year chase Jew in Denmark. In 1980, there was a first attempt to change the place into a new market, but the project was not realized. In 1997, architect Hans Peter Hagen presented his dream of the market halls of Israel Square. He was working on the project and trying to manage investors for this project. His effort was to find some private financing, but it failed, and the proposal was sent to the local plan. In 2006, the project of architect Hans Peter Hagen was sent to a European Union tender. One year later, the Central Plan was included as an investor and operator of the coming market halls, and an opening was scheduled for May 2008. Finally, in 2009, Jeudan signed an agreement with the City of Copenhagen on the takeover of the concession (TIMBRE Project, n.d.).

Figure 3.69 Torvehallerne before regeneration

Source: Arkitekturvaerkstedet

Key Dates

3.11.3 Outcomes

- The location enjoys an importance in the city centre and accessible to people; thus, the redevelopment reactivated the life in heart of the city.

- The highlighted role of marketplace to increase social activities.

- Revitilising the site by new infrastructure to attract more people to favour the economy growth of the open marketplace.

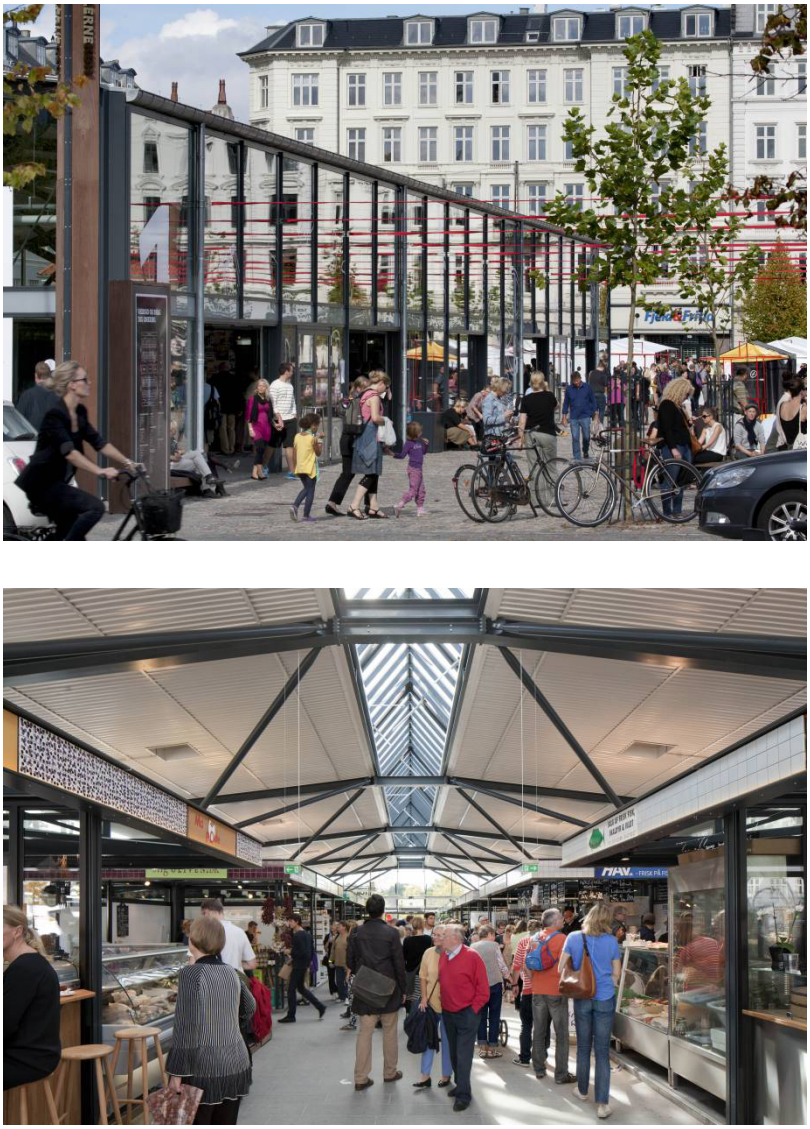


Figure 3.70 Re-managed Torvehallerne after regeneration

Source: Arkitekturvaerkstedet

3.12 Vestas Wind Systems

Source: Produced by the thesis author

Figure 3.71 The location of Vestad Wind Systems in Denmark

Figure 3.72 Vestas Wind Systems regeneration

Source: C.F Møller Architects

Location: Nakskov, Lolland

Brownfield type: Shipyard harbour (transportation site)

Architects: C.F Møller Architects

Investment: 743.8m DKK

Net Floor Area: 46,000 m^2 + 150,000 m^2 open storage

Stakeholder: Municipality of Lolland, Danish Government, European Union

Activity: Industrial

Sustainability highlight: Reuse of the land to revitilise the place to reactivate economic growth of the industry

3.12.1 Description

The redevelopment started after the shipyard closed down for a while. A local committee, counting the Mayor, the Chief Executive, and a few civil servants from the technical area, started searching for enterprises in need of adequate harbour capacity. The first contract was made with Vestas Wind System. The town had to clean up all the places for the possibility of the new use. This cost around 50m DKK. The site has a total of 1.2 million square meters, of which 700,000 square meters are destined for new industry, and a further 2 million square meters are designated as agro-industrial areas.

Source: Produced by the thesis author

Figure 3.73 The location of Vestas Wind Systems site in Nakskov

The Vestas Wind Sistem built their factory in 1999 by C.F. Møller architects and provided a lot of new jobs for workers. The total area of the Vesta Wind System is around 20% of the total redeveloped area after the shipyard (TIMBRE Project, n.d.).

Figure 3.74 The aerial image of the Vestas Wind Systems site

Source: Produced by the thesis author, adapted from Google Earth

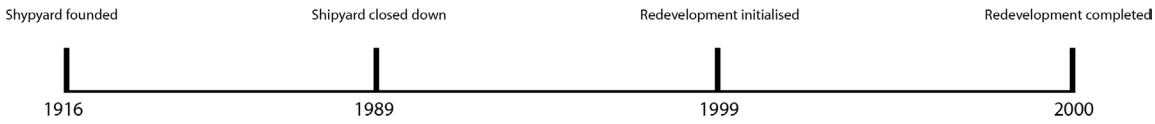
3.12.2 History

The place is located at the border of the town of Nakskov and is well connected to the city. The Nakskov's shipyard was founded in 1916. The harbour employed many people around 2000. The problems started in 1970 when the harbour had to lay off 800 of its 1900 employees. In 1986, the shipyard closed down its production. After that, unemployment rates in Nakskov and the western part of Lolland rises to more than 25%. Lolland has become one of the poorest regions in Denmark (TIMBRE Project, n.d.).

Figure 3.75 The Vestas Wind System before regeneration

Source: arkiv.dk

Key Dates



3.12.3 Outcomes

• The critical role of brownfield redevelopment and land reuse in the revitalization of industrial economic growth.

• The redevelopment of brownfields resulted in providing workplaces and jobs, which shows its impact on the social and economic aspects.

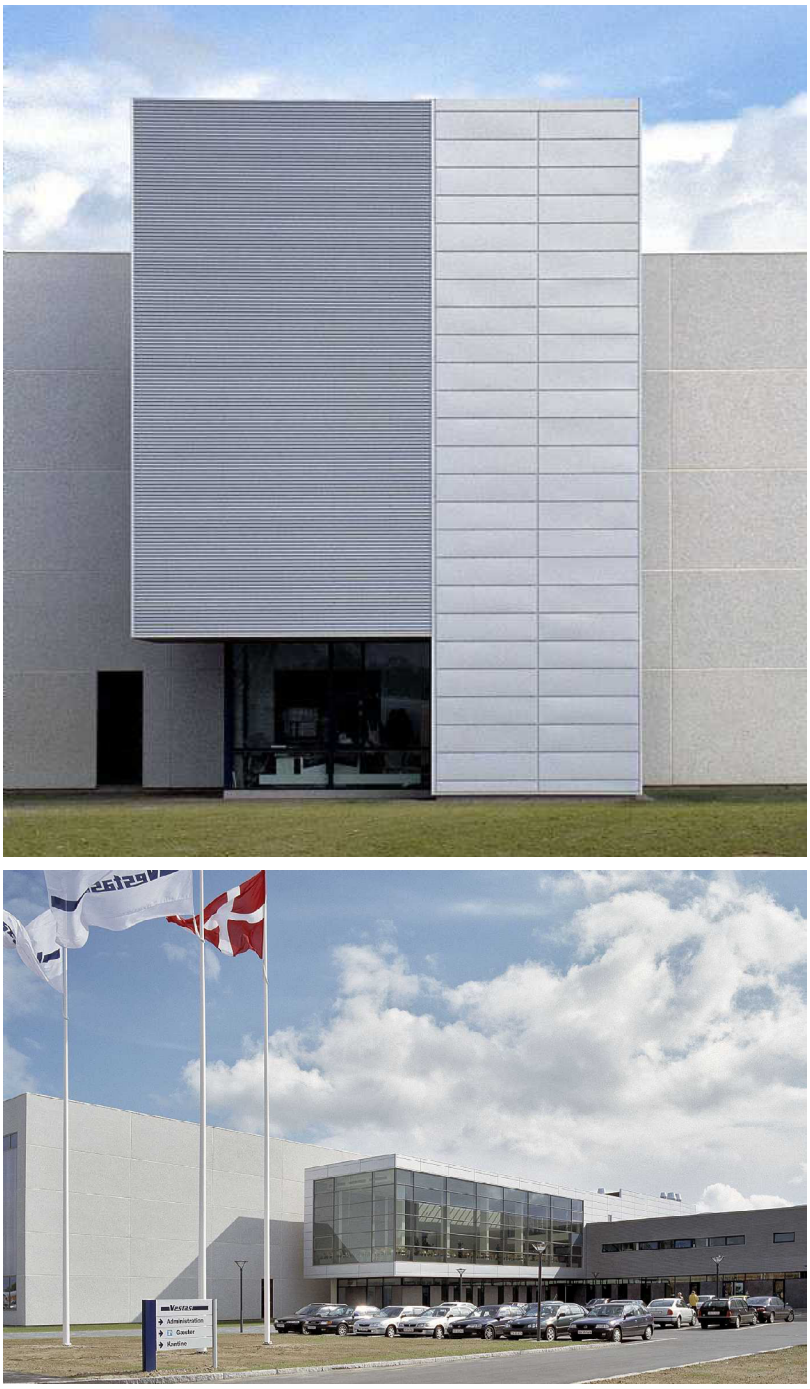


Figure 3.76 Regenerated Vestas Wind Systems brownfield

Source: C.F Møller Architects

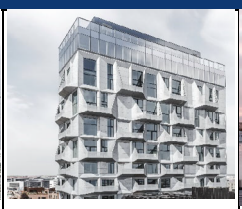
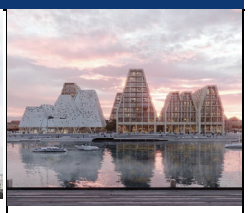
CHAPTER 4 CASE STUDIES ANALYSIS

4.1 Compilation and Analysis of Case Studies

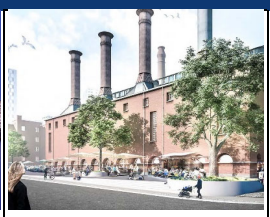
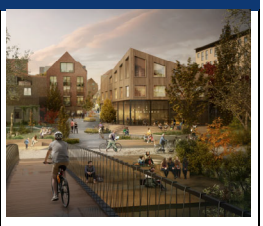
After an overview of the case studies in this chapter, I reviewed and compared them. The main aim of this analysis is to check and understand how much developers spent on the regeneration of brownfields and which kinds of functions were popular for transformation. To do so, I first made a compilation of case studies to give a recap of the case studies. Then we go on with the analysis per square meter on a yearly basis and analysis per activity. Ultimately, we will have a partial conclusion from the investigations I did. All of the data for this analysis are gathered from chapter three. Information about the project, such as the project size, net floor area, and budget, was collected either on the developers' website or by contacting them.

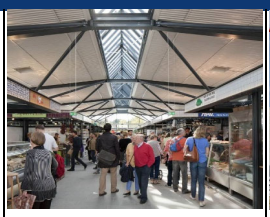
To clarify and simplify the compilation of case studies, I introduced categories for the size and price of the projects. The size of the projects was classified as S, M, L, and XL, where S<10.000, 10.000<M<100.000 m^2, 100.000<L<1.000.000 m^2, and XL>1.000.000 m^2. Brownfield types are categorised from A to D, where A ranges harbour/waterfront brownfields, B for industrial sites (a combination of different factories, warehouses, etc.), C stands for production infrastructures (such as silo, brewery, etc.), D signifies shipyards, and E is for abandoned urban site. Needless to mention, there were two projects, namely The Silo and Havnestad, which could not find the budget amount; therefore, they were excluded from the latter price per square meter analysis.

Table 4.1 Compilation of case studies

Case Studies	Ørestad	Århusgade	The Silo	Paper Island
Project				
Location	Amager Vest, Copenhagen	Østerbro, Århusgade, Copenhagen	Østerbro, Århusgade, Copenhagen	Trangravsvej, Copenhagen
Description	• The first major Copenhagen's economic and urban development	• Attractive perspective location for investors	• Public and private residence • Less intervention, maximum profitability	• Attractive location and high car-free accessibility of the public • Providing 270 to 340 homes
Sustainability feature	• One-third for greenery • Jobs for 60,000 people	• The most sustainable Copenhagen district • DGNB certificate	• Recycled concrete and preserving 380 tons of CO2	• Lively space for the public • Preserving architectural identity
Brownfield type	E	A	C	A
Activity	Residential, office, commercial, education	Residential, office, commercial, education	Residential, café and resturants	Residential, commercial
Plot size (m²)	XL	L	S	M
Net Floor Area (m²)	XL	L	S	M
Budget (DKK)	13,700,000,000 kr.	7,310,000,000 kr.	n.d.	1,000,000,000 kr.
Remediation required	Yes	No	No	Yes
Price (DKK)/m²	4,914 kr.	22,152 kr.	-	22,222 kr.
Year of setting up	1995	2009	2012	2012
Year of completion	2020	2050	2017	2024

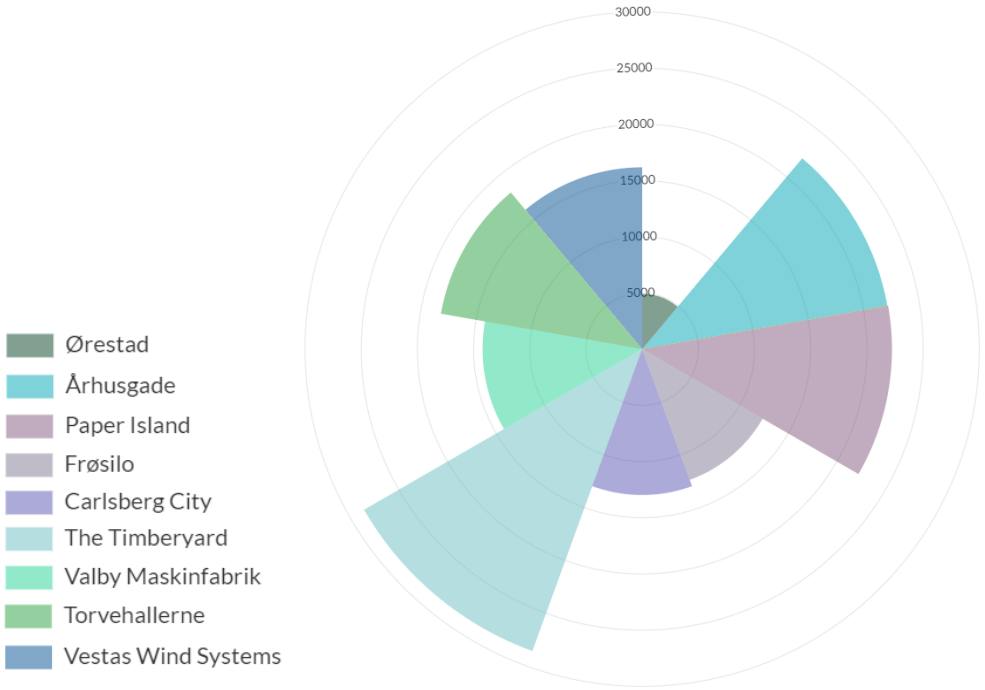
Source: Produced by the thesis author

Havnestad	Frøsilo	Carlsberg City	The Timberyard
			
Havnestaden, Copenhagen	Islands Brygge, Copenhagen	Vesterbro, Copenhagen	Daugbjergvej, Aarhus
• Crucial accessibility to the surroundings in the city	• Combination of the old and new elements, resulting in preserved architectural identity	• Developing cultural, social, and art features to attract investors	• Providing 500-600 homes • Participating residents in the regeneration process
• Reuse of buildings • Decontamination of the land	• Maximum reuse of the infrastructure	• Promotion of cultural heritage identity	• Pre-certified DGNB Platinum Urban Neighbourhood
A	C	C	B
Residential, office, commercial	Residential	Residential, office, commercial	Residential, offices
L	S	L	M
XL	S	L	M
n.d.	132,400,000 kr.	7,354,000,000 kr.	2,000,000,000 kr.
Yes	Yes	No	No
-	12,374 kr.	12,970 kr.	28,571 kr.
1996	2002	2012	2021
2006	2005	2024	2023

Valby Maskinfabrik	Torvehallerne	Vestas Wind Systems
		
Valby, Copenhagen	Indre By, Copenhagen	Nakskov, Lolland
• Reflects history and cultural heritage	• Revitalised square to attract more people to favour economic growth	• Providing jobs and regeneration of industrial activities
• Promotion of social activities • Reuse of warehouses	• Revitalising the land as a hub in the city access to the public	• Reuse of the land to revitalise the place to reactivate economic growth of the industry
B	E	D
Residential, office, leisure	Commercial	Industrial
S	S	L
S	S	M
98,188,927 kr.	120,000,000 kr.	743,800,000 kr.
No	Yes	Yes
14,199 kr.	18,182 kr.	16,170 kr.
2014	2002	1999
2018	2011	2000

4.2. Socio-Economic Analysis
4.2.1 Cost per Square meter

The compilation of case studies helped extract data regarding the cost of projects and other facts. Such data and the types of activities could provide facts about the socio-economic situation of projects. The first analysis of the case studies, as seen in the chart below, compares the price per square meter of case studies for regenerating brownfields. It is evident that The Timberyad project cost the most, and a minor budget was spent on Ørestad. It should be noted that the data regarding the cost of projects includes the construction cost, and we lack information on projects about the price of the property or the land traded in the market. In addition, the project The Silo and Havnestad are also excluded from analysis due to the impossibility of accessing further information.



Source: Produced by the thesis author

Figure 4.1 Cost per square meter comparison

The cost per square meter over the year is categorised on a cost basis. This analysis is divided into two parts; the year that regeneration started and the year that regeneration completed. The main aim of conducting this analysis was to determine if the price fluctuation is chronologically related.

The first graph shows the cost per square meter of projects over the year since the development was initiated. These are classified from A to G, where A represents Ørestad as the lowest cost project and G The Timberyard as the most expensive one. The cost per sqm. of projects from B to F constitute medium-cost projects. What becomes interesting is that the cost trend over the year of initialisation has been increasing, which might be due to more complexity of construction, demands, and prices over the years.

Figure 4.2 Cost per square meter over initiated years

A. Ørestad
B. Valby Maskinfabrik
C. The average between Frøsilo and Torvehallerne
D. Vestas Wind Systems
E. The average between Carlsberg City and Paper Island
F. Århusgade
G. The Timberyard

Source: Produced by the thesis author

In the following chart, the cost per square meter comparison based on the completion year is sorted out from A to H. The first category is A, including Ørestad, the low-cost project, among other case studies. Categories B to F are medium-cost projects, and the cost per square meter varies between 10.000 and 20.000 DKK/m². The last categories, G and H, constitute high-cost projects compared to the other case studies over the years. In addition, there is a trend for the project costs which has been increasing somehow over the years since 2000. The chart below clarifies that the Ørestad project was the least and The Timberyard project was the most expensive redevelopment project.

Figure 4.3 Cost per square meter over completed years

A. Ørestad
B. Frøsilo
C. Paper Island
D. Valby Maskinfabrik
E. Vestas Wind Systems
F. Torvehallerne
G. Århusgade
H. The Timberyard

Source: Produced by the thesis author

Another analysis was the comparison between the price per square meter and the urban population density. This was done to determine any possible relationship between the density and cost. Since most of the case studies were chosen in Copenhagen, the result would be the same if the density of Copenhagen city was considered; therefore, the density of Copenhagen districts of the brownfields was used. For other locations outside Copenhagen, such as Aarhus, the city's density was considered because there was only one project in that city.

As it is shown in the chart below, Ørestad has the least amount of density and is the lowest-cost project. While high-dense projects such as Carlsberg and Torvehallerne are considered average-cost projects, some redeveloped brownfields like The Timberyard and Århusgade, despite massive regeneration investments, failed to attract a significant number of people as the other same-budget projects. On the other hand, this could be because these projects are ongoing and will be finished in the future, and once they are completed, the density of the area and surroundings may increase.

The cost per square meter analysis was also made concerning the total net floor area of the projects. This comparison clarified the relationship between project size and costs and showed how cost-effective projects are for the net floor area they offer. Looking at the chart below, it is quite clear that the Ørestad project is the most cost-effective with the size of the net floor area provided. In contrast, The Timberyard has the worst scenario in providing a smaller net floor area and the highest budget.

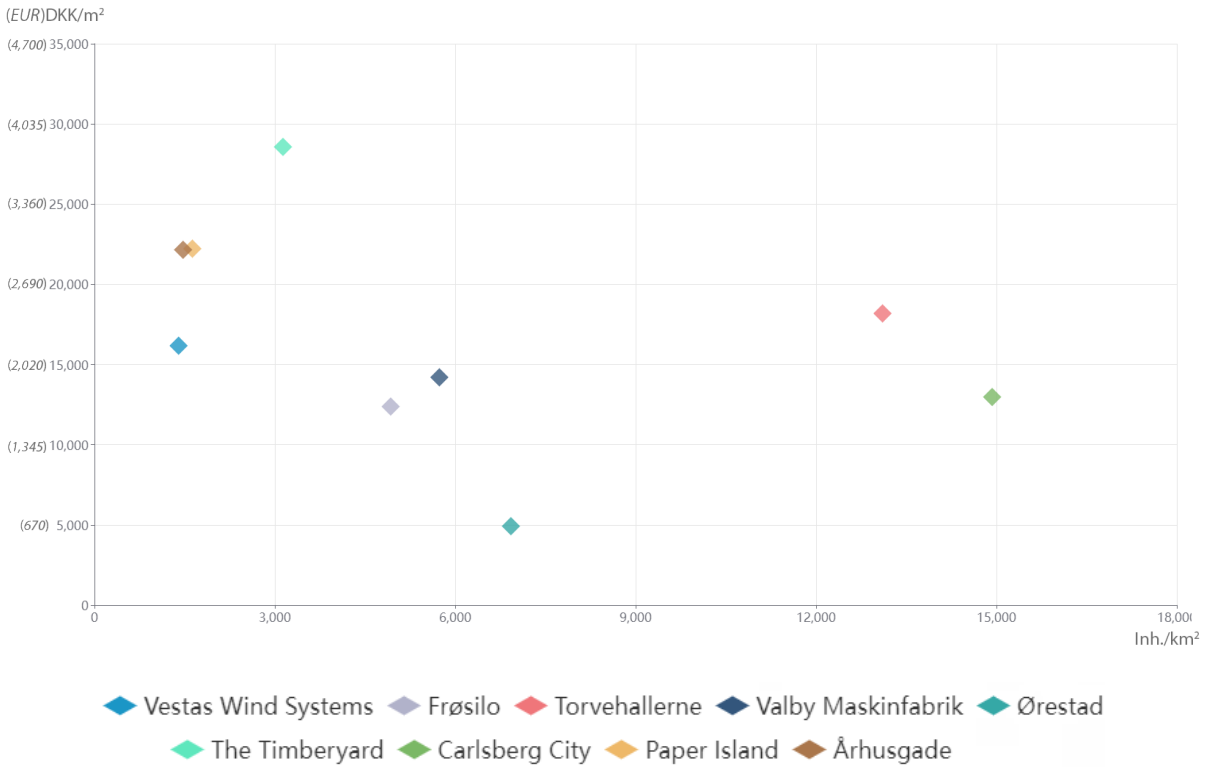


Figure 4.4 Cost per square meter with number of inhabitants per km² in the district/city

Source: Produced by the thesis author

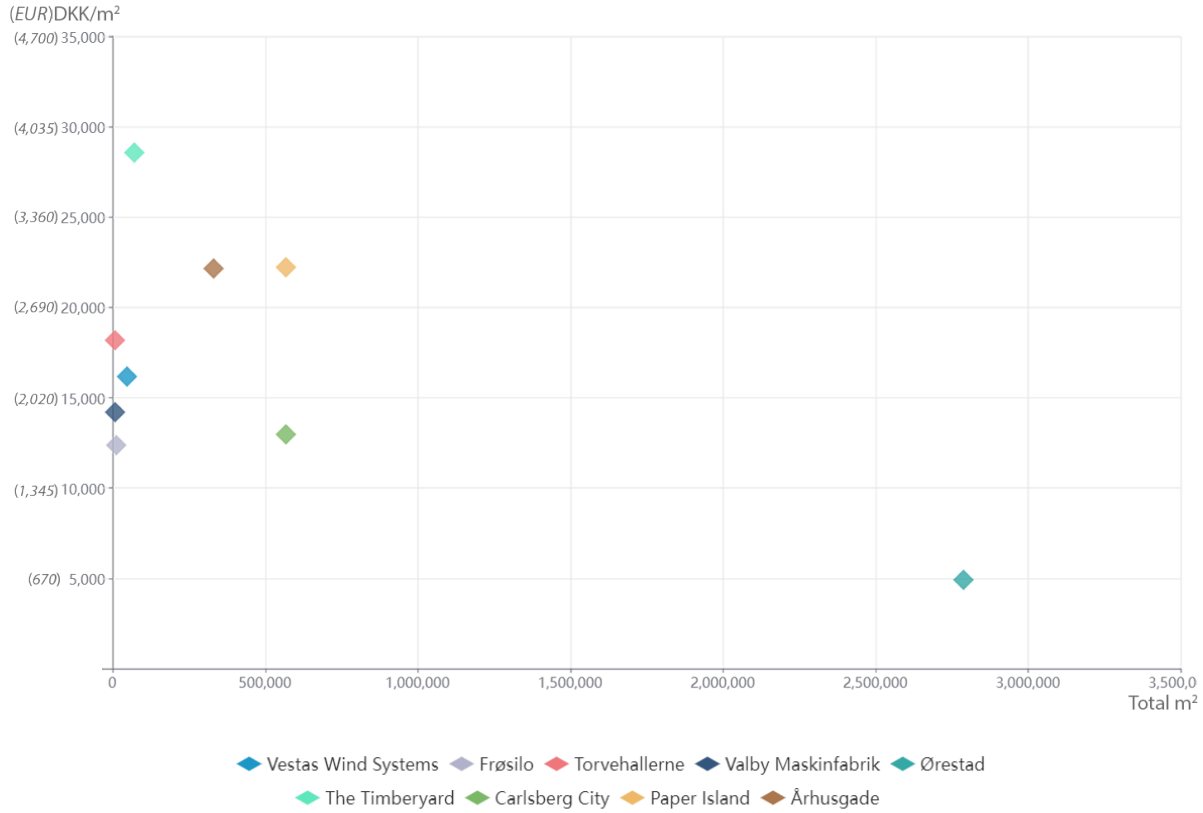


Figure 4.5 Cost per square meter the total net floor area

Source: Produced by the thesis author

4.2.2 Analysis Per Activities

The analysis of activities per square meter helps to find out and compare how much is spent on each activity of brownfields. However, before starting the analysis, a comparison between brownfield

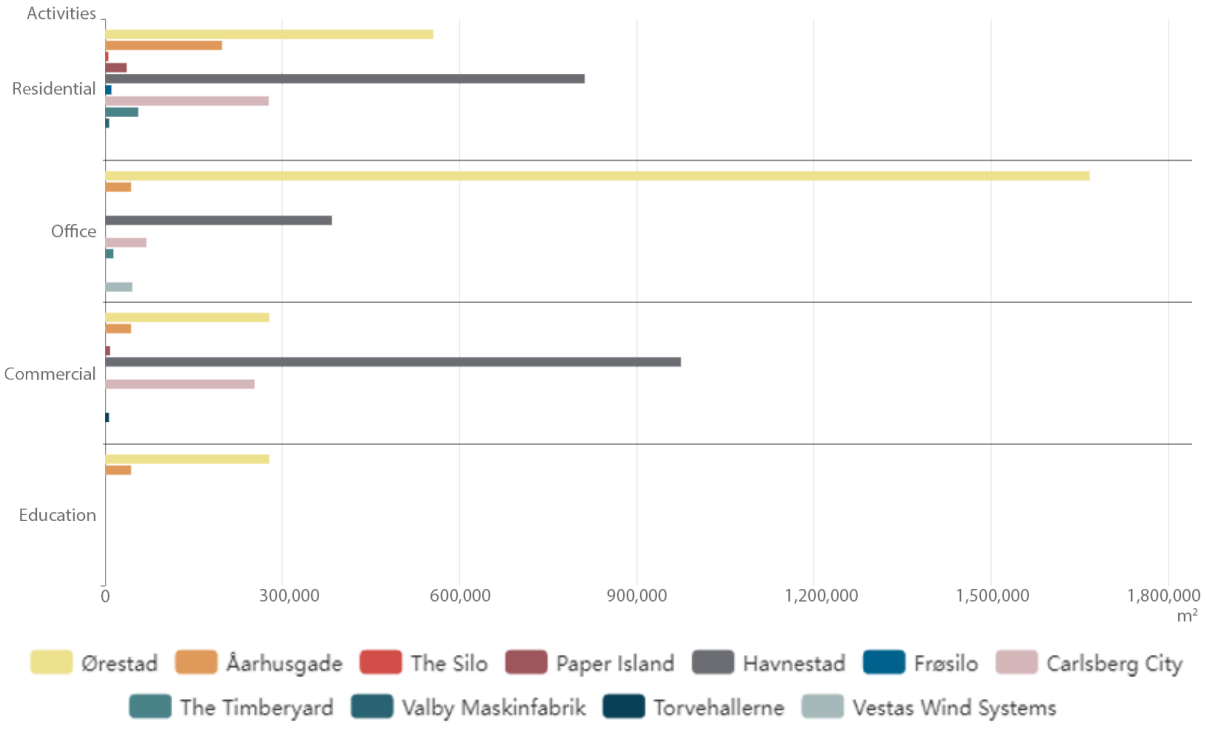


Figure 4.6 Chart 5. Total net floor area of activities

Source: Produced by the thesis author

activities per square meter was made to understand better the size of activities in comparison with each other. The analysis of the chart below clearly shows that Ørestad offers far the greatest size of office programme among the other case studies. In addition, Havnestad has the largest size of residential and commercial space. In contrast, The Timberyard, which has been the most expensive project, provides quite a smaller size of programmes by comparing with other brownfields. In the following charts, the analysis was made on three main common functions of projects, including residential, office, and commercial areas. However, it should be noted that since most projects are large-scale, they offer different programmes simultaneously. Therefore, the size of their specific activities was considered for the analysis.

Residential

Regarding residential costs per square meter, The Timberyard is again considered the highest-cost project among the other case studies offering residential functions. In this vain, Ørestad constitutes the least expensive project by offering more than 1.6m m2 residential programme, which has the largest housing area among all case studies.

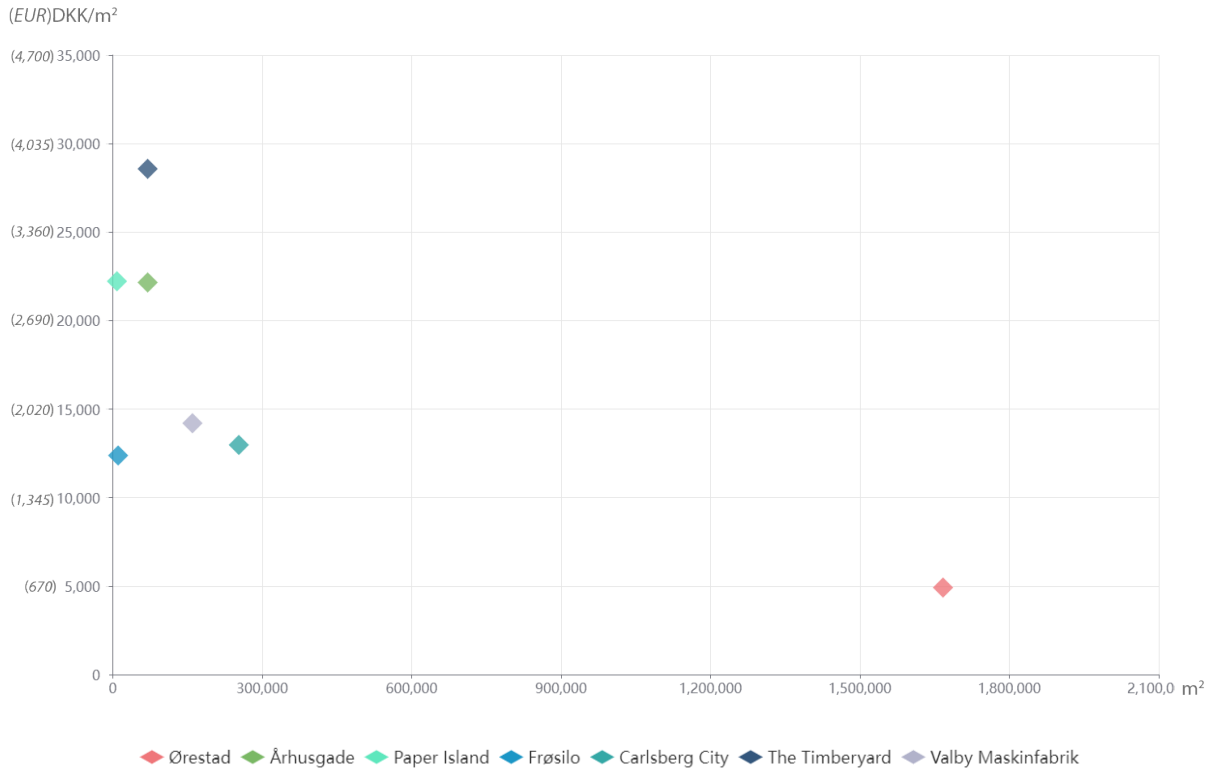


Figure 4.7 Chart 5. Cost per square meter to the residential net floor area

Source: Produced by the thesis author

Office

In the next chart, the analysis of cost per square meter by offices square meter is carried out. The analysis discovers that Ørestad is still considered the largest office in square meters and has the lowest cost per square meter. On the other hand, the cost per sqm. of Åarhusgade and Paper Island are close to each other by offering almost similar sizes of office areas.

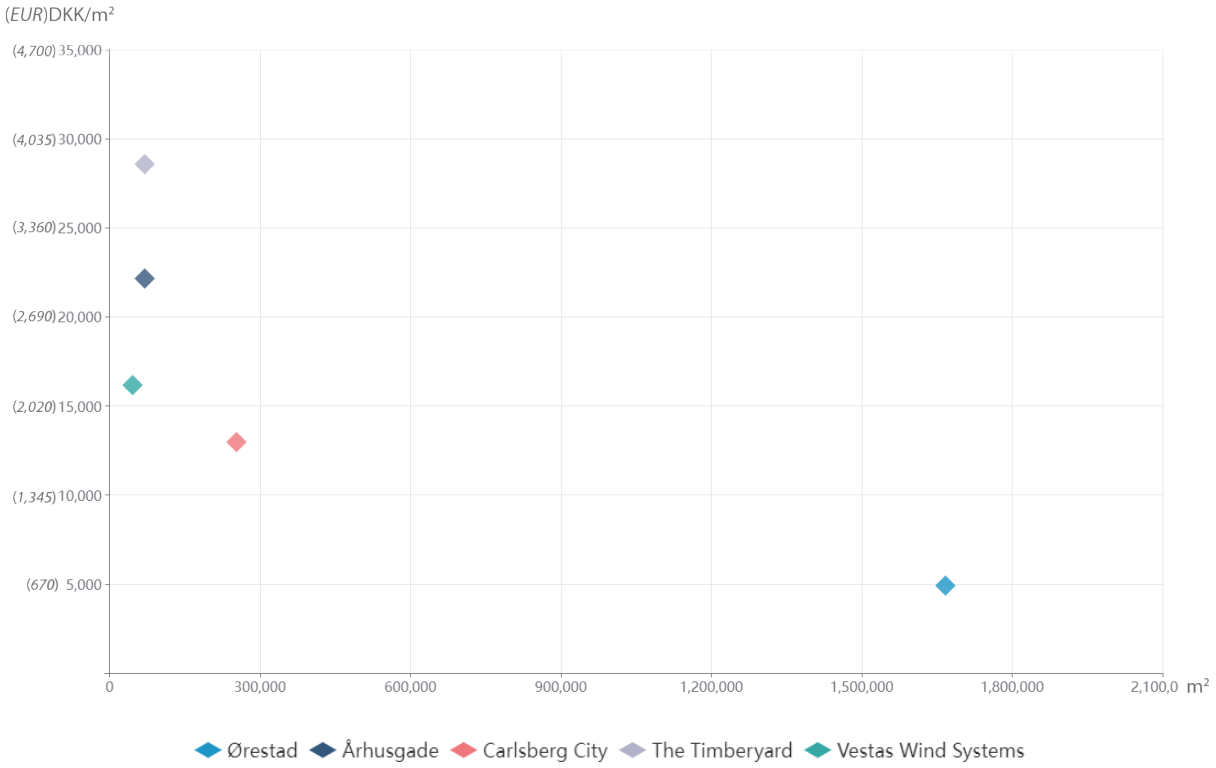


Figure 4.8 Cost per square meter to the office net floor area

Source: Produced by the thesis author

Commercial

Finally yet importantly, the cost per square meter of commercial areas is analysed. The comparison between case studies offering commercial functions shows that The Timberyad hits the most expensive project among the rest of the projects, while Ørestad is the lowest-cost project.

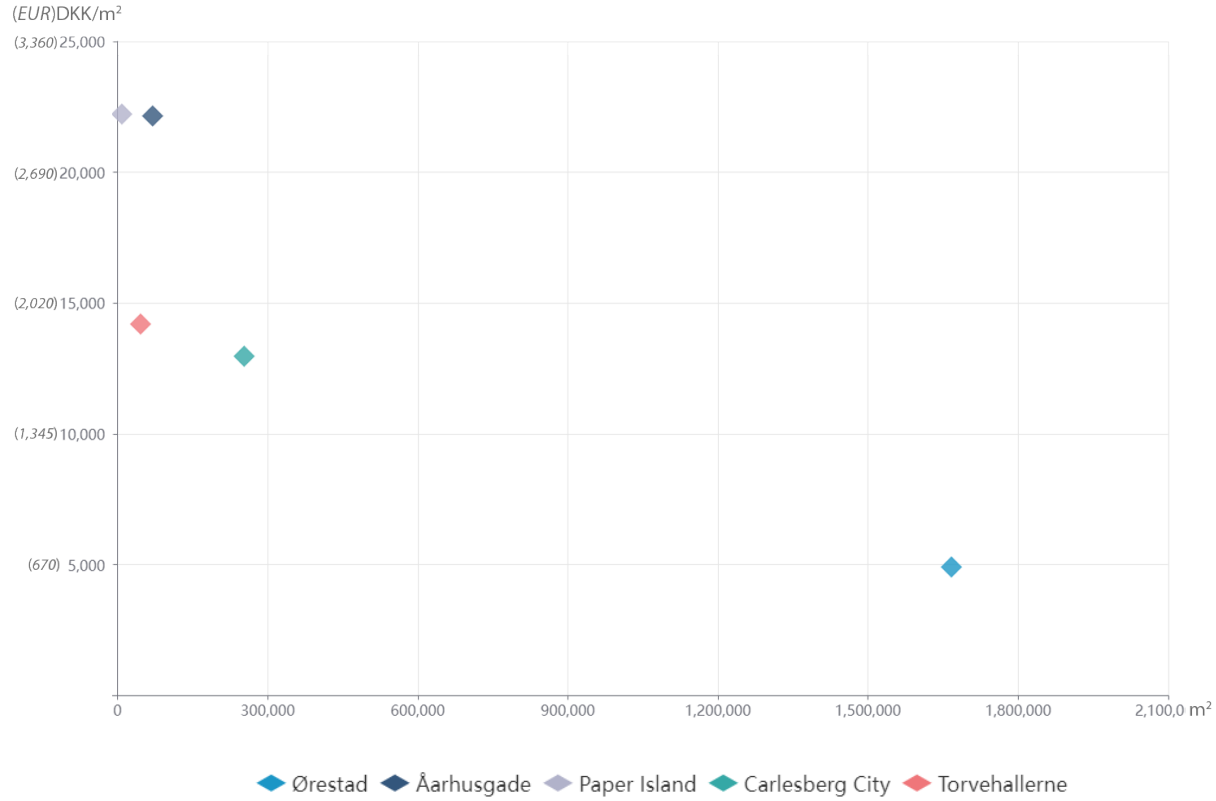


Figure 4.9 Cost per square meter to the commercial net floor area

Source: Produced by the thesis author

4.3 Partial Conclusion

The comparison between the cost per square meter of case studies could pave the way to understanding quite a few points in regenerating brownfields. First, the cost per square meter of regenerating brownfields may vary according to the different locations in Denmark and Copenhagen. This also shows that the locations with higher costs, probably regenerating brownfields, have been more crucial for developers. Thus, the importance of locations is highlighted, and then the price of properties in real estate can increase in the future.

Another underlying fact for varying prices could be chronological relation issues. In other words, in chart 2 it is crystal clear that the cost per sqm trend has been growing over the years. Although this trend is proven if the year since the regeneration began is considered, in case of considering the year of completion, the trend is not essentially increasing. Regarding sorting according to activities, it seems that projects offering commercial activities are less expensive than those providing office and residential areas.

An overview of the whole analysis is shown in the table below, indicating the lowest and highest amount. Overall, it is quite clear that despite the Ørestad project offering the largest size of activities, the regeneration cost stood at the lowest compared to other case studies. This possibly might be due to the year the project was constructed as it was one of the significant primary brownfields regeneration since the urban redevelopment started in Copenhagen, which is explained more in chapter five. On the other hand, while The Timberyard project is comprised of the most costly project, it does not offer the largest or lowest size of activities. The only reason could be that it is the most recent project among the rest.

Table 4.2 Overview of case studies analysis

	Chronological Basis (Started)	Chronological Basis (Completed)	Total Floor Area	District Density Inh./km²	Residential /m²	Office/ m²	Commercial /m²	Cost /m²
Ørestad	×		○		○	○	○	×
Århusgade		○						
The Silo								
Paper Island					×		×	
Havnestad								
Frøsilo								
Carlsberg City				○				
The Timberyard	○							○
Valby Maskinfabrik								
Torvehallerne			×					
Vestas Wind Systems		×		×		×		

Source: Produced by the thesis author

○: Highest/Youngest
×: Lowest/Oldest

PART II
CHAPTER 5 COPENHAGEN URBAN AREA AND BROWNFIELD DEVELOPMENT POLICIES

5.1 Copenhagen Urban Area – from Misery to Prosperity

Copenhagen as a residential city, has always taken advantage of the presence of government, military, and navy. The city of Copenhagen has seen dramatic changes in urban development (UR) and the economic situation throughout the last 50 years. This chapter presents a summary of what the urban and financial situation was like in the late 70s and how transformed abandoned industrial harbours enhanced and new policies improved Copenhagen in terms of UR and the economy.

Historically, Copenhagen saw urban growth in light of the rise of the first nation-state and later industrialisation. The population in the capital grew until the mid-1970s when around 1.75 million inhabitants lived there. Between the late 1970s and the end of the 1980s, there were no active urban policies with significant initiatives and urban renewal schemes for the municipality to follow. For the first time after the World War II, many new urban policies were to take place. The so-called reform policies according to Kidokoro *et al*., (2008) urban policies related to mitigating the condition consisted of quite a few elements as following:

1. A guiding principle to connect different urban parts into one administrative unit.
2. Decentralising major parts of central government competence as well as financial resources to the local municipal.
3. Maintaining principles for those who decide to pay to maintain financial responsibilities.
4. The local level must have a certain minimum size to obtain economic efficiency.
5. Distinguishing between the division of work and spatial dimensions among municipalities, counties, and the state.

This reform policies led to the reduction of 1,200 perishes to 275 municipalities and cities previously connected to perishes disappeared as administrative units. The policies had also another major negative impact, as unifying urban areas into one administrative unit was not followed in the capital (Kidokoro *et al*., 2008). Moreover, the industrial sector was restructured during the 1980s, which caused the highest unemployment rate in the central parts of Copenhagen (Andersen & Jørgensen, 1995). The unemployment rate reached 17.5 percent (Katz & Noring, 2017) which caused a significant decline of the population from 721,000 to 466,000 residents (Kidokoro *et al*., 2008), and according to Jyllands-Posten (1998), 65 former industrial sites in the Copenhagen metropolitan area had been abandoned and had fallen into decay. In addition, 38 of them were located within eighteen municipalities of Copenhagen, and 9 of them were particularly threatened by decay and pollution.

Basically, the economic situation and well being of the city went bankrupt in the early 1990s. Many believe that this was as a result of the national policy of decentralisation which took away investments in infrastructure, health and education sectors in metropolises like Copenhagen (Kidokoro *et al*., 2008).

Therefore, the emerged variety of economic, industrial, and social problems in Copenhagen means they need an urgent need to restructure the economic base, the labour market, etc. In this way, urban policy and spatial planning practices have been highlighted. The scheme needed to embrace spatial and economic growth, which Copenhagen lacked in the late 1970s (Andersen & Jørgensen, 1995). To revive the city, a coalition of national and local officials resulted in the Copenhagen (CPH) City & Port Development Corporation. It was a primary step toward being a 21st-century model for global urban renewal (Katz & Noring, 2017).

5.1.1 First Phase

5.1.1.1 Regional Plans

The mid-1950s mark the beginning of regional urban planning innovations. Four regional plans for Copenhagen were prepared, among which the Finger Plan 1947 and the Regional Plan 1989 are worth mentioning. These new policies and planning paved the way to restructure UR together with economic prosperity in light of the regeneration of abandoned harbours and brownfields.

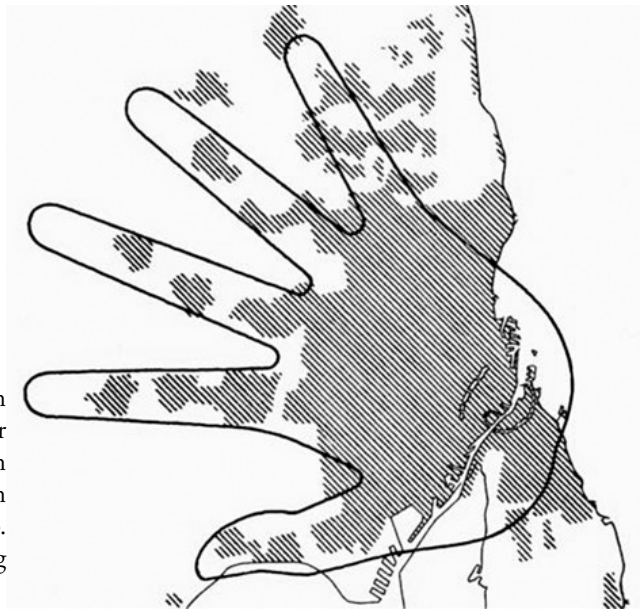
Finger Plan 1947

The Finger Plan was of the utmost importance in Copenhagen's primary steps of UR. It was based on suburbanisation and recommended a radical structure. This was mainly for transport reasons to increase accessibility between suburbs, rural areas, and the city (Andersen & Jørgensen, 1995). It is also claimed that the Finger Plan was introduced to manage the growth of the city and suburban areas resulted by the de-industrialisation. The idea of the Finger Plan was strong that it remained in the priority for the urban planning of the municipality until 2019.

One of the main principles of the Finger Plan indicates that the layer-by-layer growth should stop and that most future cities should be developed in narrow town fingers along existing and future railways (Jørgensen, 2008). The primary finger plan indicated the following elements:

- The establishment of suburban connections.
- The UR concerning the fingers and railways.
- Preserving green space between fingers.

The finger structure helped ensure lighter traffic in the Copenhagen urban area and was the best solution for public investment in traffic infrastructure. This structure also helped prevent urban sprawl, and guaranteed areas between the fingers remained for enough recreational areas and access to all inhabitants (The Danish Nature Agency, 2015).



Source: The Copenhagen metropolitan 'Finger Plan': a robust urban planning success based on collaborative governance, p. 226, by Sørensen & Torfing (2019)

Figure 5.1 Copenhagen The Finger Plan 1947

The Regional Plan 1989

This plan was a reaction to the termination of urban expansion. While at first glance it seems to be a modernized version of the Finger Plan 1947, it differs from the previous one in the following ways; (1) Many retail centres, public and private services, and employment have been improved in the suburbs. (2) A balance between the employment rate and housing in local areas which reduces pressure on existing infrastructure. (3) The newly changed economic and industrial assumptions prepare for reusing land and stopping urban sprawl (Andersen & Jørgensen, 1995). It was clear that the regional plan, for the first time, attempted to enable the redevelopment of abandoned industrial sites and transform them into different facilities. In addition, the need for a massive amount of office space made it possible to take advantage of existing industrial lands in the city. In this vein, the plan suggests a new rail tunnel underneath the harbour and redeveloping abandoned sites in the harbour. At the same time, constructing a new urban area along a new rail from the city centre to the airport Ørestad. This would result in investors gravitating toward such an attractive location (Andersen & Jørgensen, 1995).

5.1.1.2 Ørestad Development and Its Role in Regeneration Process

The idea of the establishment of Ørestad Development Corporation (ODC) in 1992 was to regenerate the abandoned land formerly used by the Danish military. As explained in the previous chapter of case studies, the location importance of the 3.1-square-kilometer area was strategic due to the closeness of the airport and being in Sweden's connection axis. ODC, which was co-owned by Copenhagen Municipality (55%) and the Danish Ministry of Finance (45%), was responsible for the development of the development of state-owned brownfield in Ørestad district in Copenhagen (Andersen, 2003; Katz & Noring, 2017; Bruns-Berentelg *et al*., 2022). The Finger Plan structure helped ensure lighter traffic in the Copenhagen urban area and was the best solution for public investment in traffic infrastructure. This structure also helped prevent urban sprawl and guaranteed

areas between fingers for enough recreational areas and access for all inhabitants (The Danish Nature Agency, 2015). was dedicated to commercial, education, retail, and housing options.

The project's significance was manifested once the metro was constructed, which links commuters from downtown to the airport. So the area's development was significant due to the construction of two metro lines. To cope with the economic issues of the project, the corporation took out a loan against the value of the land assets to fund the construction (Katz & Noring, 2017). Another solution was to finance the metro was to use the revenues gained from land sale and pay off liabilities for UR projects (Andersen, 2003).

The complete development is expected in 20 to 30 years when 25,000 inhabitants live alongside 20,000 students and 60,000 workers (Katz & Noring, 2017). According to By&Havn, by 2020, the resident population reached 21,400, which, compared to 2011, will become more than three times higher. The project became a turning point and a role model for the later brownfield redevelopment in Copenhagen.

5.1.2 Second Phase

5.1.2.1 Abandoned Harbours Transformation

"*Industry was moving out of Copenhagen, and everybody kept waiting fo better times and for industry to move back in. But it never happened! The turning point came in the beginning of the 1990s, when a brand-new, massive commercial building in the harbour stood empty for several years and everybody recognised that something had to be done.*"

Jens Kramer Mikkelsen, CEO of CPH City & Port Development and former lord mayor of Copenhagen (1989–2004)

Harbours in Copenhagen were used for industrial activities and container terminals. They became derelict and unused caused of de-industrialisation and inefficient management. As far as the transformation of harbours is concerned, the port management sold abandoned lands to developers. The construction of the Øresund Bridge (the connection to Sweden) was estimated to reduce harbour traffic in Copenhagen ports by 25% (Katz & Noring, 2017).

The transformation of the harbour waterfront was affected by the political agenda in Copenhagen. The Danish State, the municipality of Copenhagen, harbour authorities, and several private landowners owned the waterfront. By initiating the redevelopment of harbours, there was fierce competition to transform areas and buildings into new facilities, which led to an increase in the rent or market value of the area. Many redevelopment options mainly refer to housing and public uses. Interestingly, commercial developments were suggested for the areas close to train stations. While many of the dreamy projects did not come true, there was an unprecedented view of building cranes

across the 42 kilometres of Copenhagen's wharves and quays that Copenhagen had seen so far (Andersen & Jørgensen, 1995).

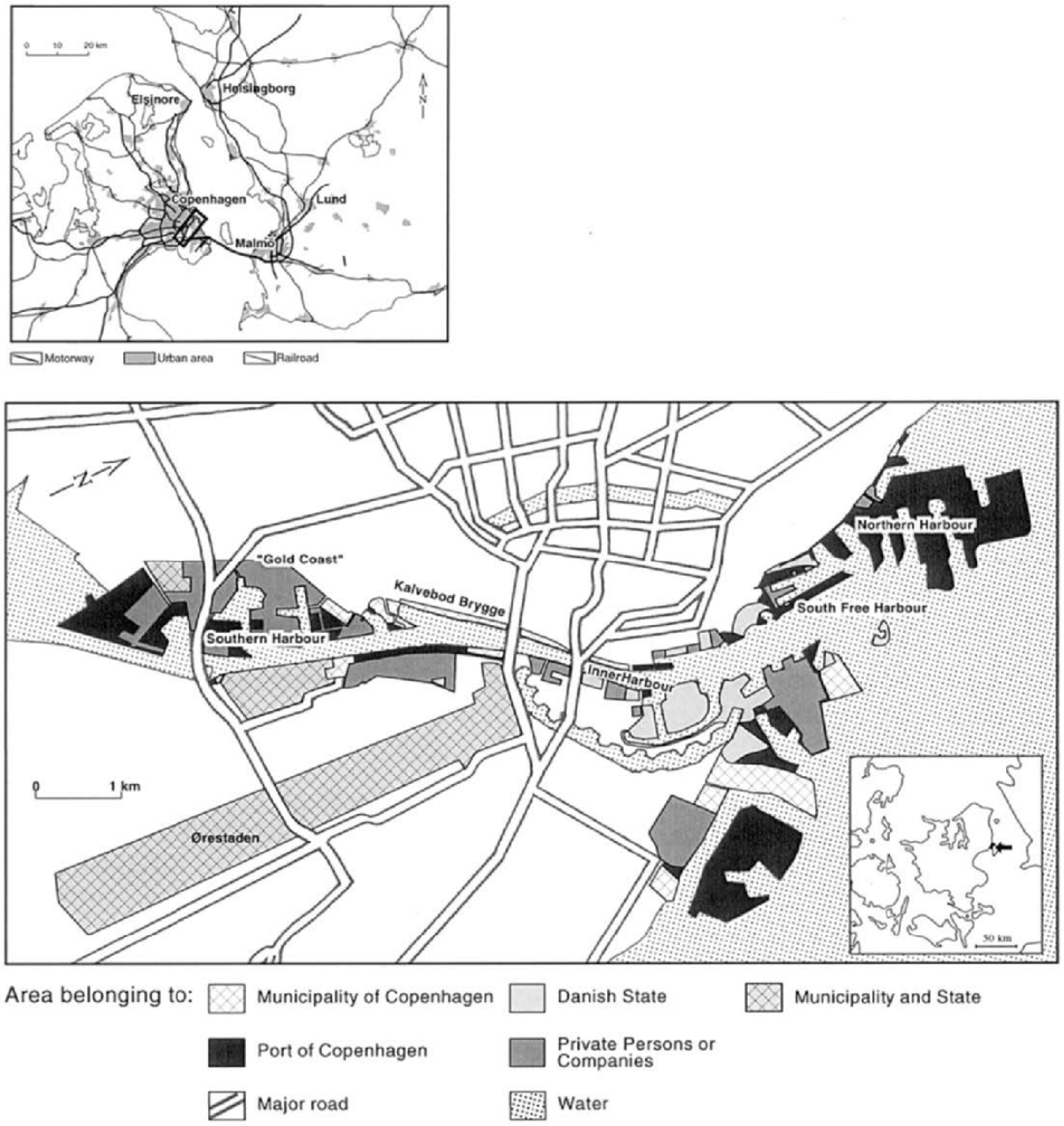


Figure 5.2 Principle landowners of Copenhagen's waterfront in 1996 before waterfront redevelopment and a wave of investment hit in the harbours.

Source: Flexible urban governance. The case of Copenhagen's recent waterfront development, p. 483, by Desfor & Jørgensen (2004)

In the first year of the extensive redevelopment of the port, Copenhagen Malmö Port AB (CMP)—the stakeholder of the port—generated 15 million USD in profits. This was the first time throughout the century that such profits were made by efficient operations more cost-consciously (Katz & Noring, 2017), which casts light on the significance of waterfront brownfields on economic growth.

In 2007, the latter redevelopment of important areas, mostly brownfield areas, was shouldered to the CPH City & Port Development (CPD) or *By og Havn* entity. It was formed by the merger of two corporations: ODC, which developed the Ørestad district and built two metro lines, and Port of Copenhagen Ltd., which developed harbour and port operations. In fact, CPD as a result of merging different public corporations to shape the CPD made it possible to manage efficiently public assets, transfer of ownership, designating tasks and responsibilities under a united institution. In addition, this process resulted in an increase of the capital for transformative UR. This hybrid corporation also aimed at empowering both public and private sectors in the real estate. Kartz & Noring (2017) also believe that the close collaboration between the municipality for planning and permits is a notable point in the corporation. Likewise, the CPD gained public trust by funding metro which was vital for the development. The city of Copenhagen now has achieved an organisational system by which the transactions of "publicly owned and privately run corporations" more effectively through which the city is able to plan ambitious goals to meet growing urban needs (Katz & Noring, 2017). The success of CPD model applied in the next development urban project in Nordhavn — by rezoning land, increased land value, generated revenue and financing other infrastructure — enabled the state to reduce its ownership shares in the corporation by 5% and more accountabilities for CPD where the share of the municipality was around 95% (Bruns-Berentelg *et al*., 2022). This public-to-private transition would result in more freedom in decisions and economic growth in BR.

5.1.2.2 Regenerative Urban Policies

Major urban policies has always been based on urban regeneration policies in Copenhagen. Although urban regeneration started before World War II with the focus on the replacement of worn out districts, former stations where mostly located in the centre, with newer modern areas. Kidokoro *et al*. (2008) believe that reasons for regeneration were the existence of low-standard housing and low-level maintenance of social services as well as highly centralised area close to the existing central station and Town Hall. The area became abandoned after the reorganisation of the city's railway in the early 1900s. The area transformed into offices and hotel during 1950s and 1960s thanks to the public sector co-financing the project.

Urban regeneration focused on housing conditions since 1980s and embraced wider urban environment. Existent social and urban problems proved that there was a need to improve the circumstances. In this vein, many local programmes raised with an emphasis on housing conditions. As an example, Vesterbro Neighbourhood Scheme which involved 10,000 residents living in a former working class district in Vesterbro, Copenhagen. The programme basically was related to renovation of the detached houses which were in lack of maintenance in the densely populated district by the "third world immigrants, poor, and unemployed people". The scheme made houses renovated and thus the properties value raised. It was a primary successful urban regeneration programme in a dialogue between private rentals and shared or private ownership. In general, urban regeneration was interpreted as housing functions which non-profit "social" housing companies were willing to initiate new construction in the city. The overall plan had its pros and cons as shown in the table below (Kidokoro *et al*., 2008).

By learning from such experiences, new policies were introduced in Copenhagen in 1990s as mentioned earlier. The private housing scheme for sale was replaced with non-profit housing units. The programme in strategic unit was successfully implemented which a report shows that new 13,000 private houses would give the city with long-term economic sustainability. With the such a great number, young urban professionals were to be attracted to relocate to the city centre and increase the income level. There were two outcomes of this wave. First, a strategic search for areas for new dwellings in light of urban regeneration. Second, policies made a shift from the city priorities to a close partnership with the national government and private investors among which a project like Ørestad and the bridge construction to Sweden come (Kidokoro *et al*., 2008).

Table 5.1 Urban regeneration policies until 1990s

<table>
<tr><th colspan="2">Urban regeneration until 1990s as housing regeneration</th></tr>
<tr><th>Advantageous</th><th>Disadvantageous</th></tr>
<tr><td rowspan="2">Improving social dimensions; more possibilities for new housing in open areas for low-income individuals</td><td>Increasing low-income people, non-active in labour market, and immigrants</td></tr>
<tr><td>Higher social costs and less revenue from taxation</td></tr>
</table>

Source: Produced by the thesis author, adapted from Kidokoro *et al*. (2008)

Note: The urban regeneration policies regarding housing as indicated had more disadvantages than positive aspects. That is why urban and social dimensions failed and there was a demand for changes in the early 1990s.

The attitude of local politicians changed in 1990, so the city promoted urban revitalisation strategies, which are backed up by the municipality. In addition, the highlighted role of Eastern Europe in the economy and the EU membership of Scandinavian countries facilitated the development of increased spatial competition. This also paved the way for new forms of growth-oriented urban policies, such as massive investments in infrastructure and cultural regeneration strategies (Andersen & Jørgensen, 1995). Likewise, the importance of big cities such as Copenhagen in restructuring industries for development was clearly manifest to policymakers. Once the government called open debates on March 20th of 1990 to set up many initiatives, the capital city shifted from a problematic matter to a key platform for future welfare (Kidokoro *et al*., 2008).

The solution of spatial planning and urban policies in Copenhagen in 1990s was influenced by socio-economic conditions to overcome such problems. The idea was to attract public and private investments by regenerating public sites across the waterfront and in the city that had been left unused and abandoned. According to Anderson and Jørgensen (1995), urban policies and developments focus on the following points:

- The development of Copenhagen's harbour front;
- The Ørestad Development Corporation;
- Lunching the metro project connecting from Ørestad and the Town Hall;
- Collaboration between Denmark and Sweden governments for developing common benefit

projects, namely the INTERREG[1] programme, development in Øresund region promoted by the EU;

• Fixed railways and link to southern Sweden (Malmo);

• A new programme for improvement of districts backed by Vesterbro scheme for renovation of old housing and promoting private investments in housing sector;

• Cultural Capital of Europe in 1996 to modernise and expand musuems and national art galleries, and steps to attract investments for opening the Opera House;

• Improvement of the mobility transport network.

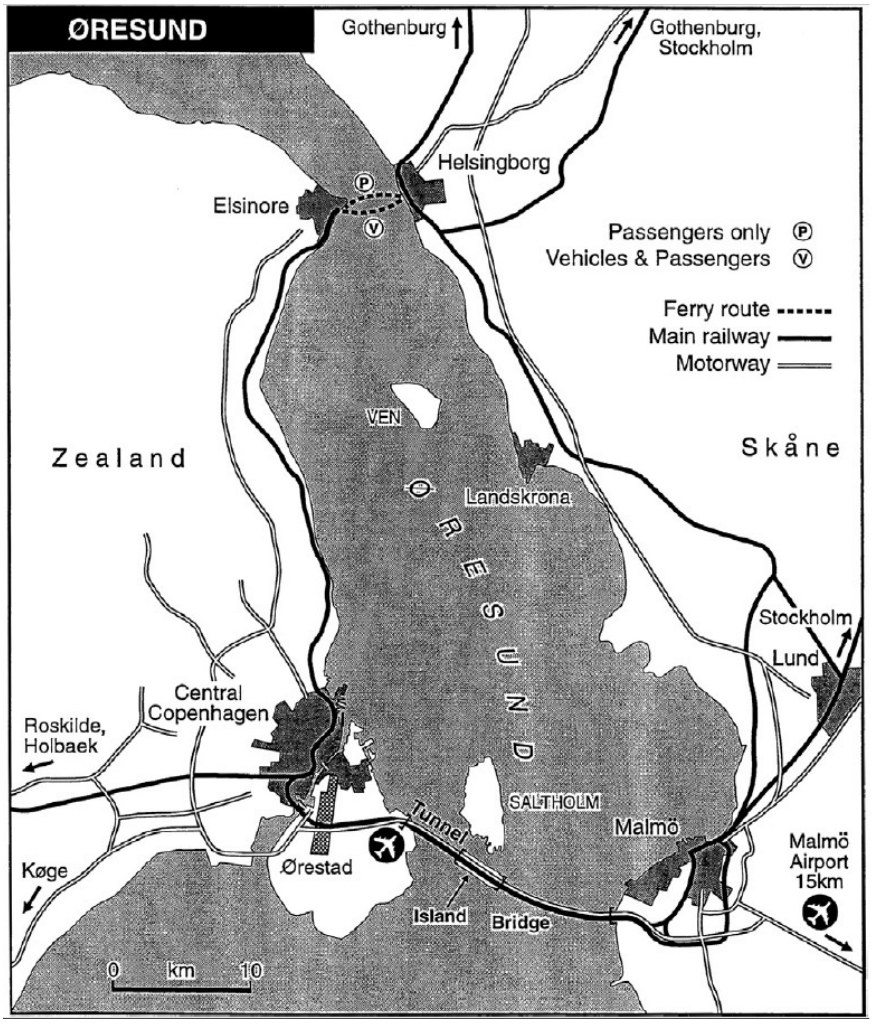


Figure 5.3 Øresund region embracing Copenhagen, Malmo, Ørestad, and the Øresund bridge

Source: Transit oriented development in Copenhagen, Denmark: from the finger plan to Ørestad, p. 255, by Knowles (2012)

Note: The Øresund region situation in Copenhagen and Malmo enlightening the significance of urban development to attract developers from Sweden.

These policies intended to maximise the value of derelict public sites by smart zoning and asset management to generate revenue for financing large-scale transit and urban infrastructure (Bruns-Berentelg *et al*., 2022). Since these projects were accepted at the local and national levels, the problem of Copenhagen became a "national interest," and significant developments needed investments that

1 INTERREG is a joint project of Scandinavian countries aimed at societal development, innovation, low-carbon economy, transport and employment. The programme addresses the Europe 2020 goals in Øresund region, involving four metropolitan areas of Copenhagen, Malmo, Gothenburg, and Oslo (Interreg Öresund - Kattegat - Skagerrak, 2017).

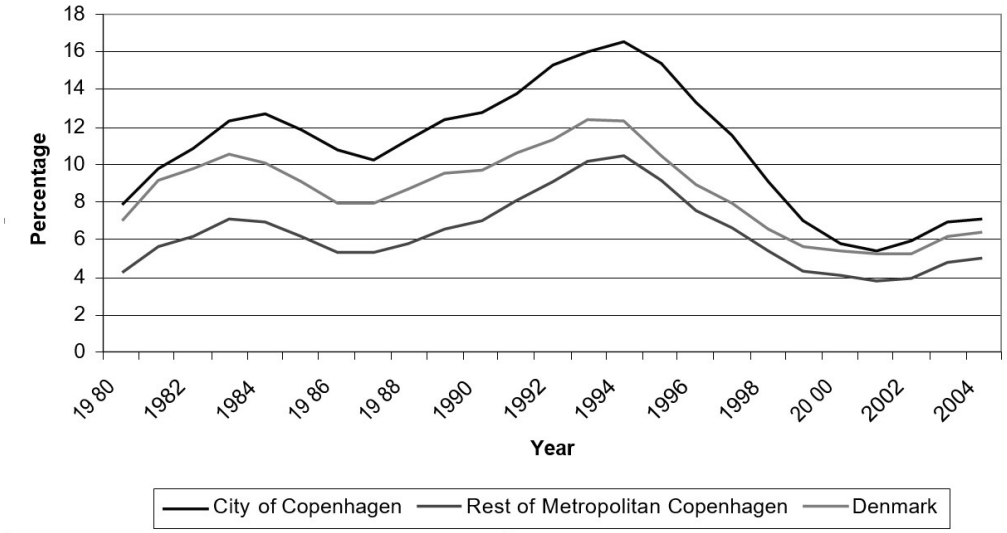


Figure 5.4 Unemployment in Copenhagen 1980 - 2004

Source: Statistics of Denmarkm adapted from, *Sustainable City Regions:: Space*, *Place and Governance*, pp. 209, by Kidokoro *et al*. (2008)

Note: The trend reduction of the unemployment rate in 1994 shows the positive socioeconomic effect of the policies introduced in the early 1990s.

were necessary to strengthen the national capital. This would lead to a boost in socio-economic conditions, generating employment and income. Such attempts were also resulted in a great decline in unemployment rate as shown in the figure below. One of the considerable effects of this policy change was to establish ODC for the development of the Ørestad district, which later on merged with the Port of Copenhagen and shaped the foundation of CPH City and Port Development (By & Havn) for other urban redevelopments of the city. Thus, the corporation acts as a strategic asset manager, overseeing the sale of lands and properties to maximize value (Katz & Noring, 2017).

5.1.3 Final Phase

5.1.3.1 Present and Future

By studying the urban planning and policies in Copenhagen for UR and BR, it could be mentioned that a few elements were influential in the success story of Copenhagen. The Finger Plan has acted first and foremost as a structural way in which Copenhagen's development has successfully passed. A plan in which the growth path of the city is clear was the primary step in the UR of Copenhagen.

Maintaining and further developing the city through The Finger Plan ensures significant urban regeneration and an extended city in the long-term perspective. In short, the finger city enables new buildings to be located in the core of the urban region, and they are in service to the population and employment (The Danish Nature Agency, 2015).

In addition, over the last decade, a range of brownfield transformations have been undergone under CPH City & Port Development. Such projects as, some of which were already mentioned in the previous chapter, include the Ørestad area, the former industrial area of Sydhaven (south harbour), Nordhavn (north harbour), and a brownfield called Paper Islands. CPH City & Port Development

is considered an innovative governance, finance, and operations model for the regeneration of brownfields in Copenhagen. Since 2007, the company has managed about half of all redevelopment projects in Denmark's capital.

According to Katz & Noring L. (2017), the development of brownfields policies that reaches economic benefits under the CPD model has been done through the steps below:

1) National and local government transfer assets to CPD.

2) Local municipality rezones the land for residential and commercial use.

3) An increase in land value.

4) CPD borrows (generally with loans on favourable terms from the Denmark National Bank) based on the increased value of the land.

5) This capital is either transferred to the metro construction company for broader transit investments and/or used by CPD to pay for local infrastructure that enables land development.

6) CPD facilitates development through various mechanisms, including land sales to or lease agreements with developers and, in a limited number of cases, development by the corporation itself.

7) This generates revenue that is used to pay off debts.

CPD has been as a result of an essential change in the organisational UR planning. The new model helps Copenhagen manage UR and BR much more effectively. The new management corporation also attract more developers and investments and by establishing a proper mutual collaboration between the state and private sectors, UR and BR have become promoted.

5.1.3.2 The Municipal Plan 2019 (KP19)

The municipality of Copenhagen published a comprehensive urban plan in 2019 that outlines the framework of Copenhagen's development over the next 12 years. It consists of three parts of the local development plan's political structure, guidelines, and framework. The Municipal Plan 2019 (KP19) is an essential document of overall plan visions for UR in Copenhagen and highlights potential development, perspective areas, and ongoing and upcoming areas for redevelopment (The Municipality of Copenhagen, 2020).

It is evident that the municipality has a long-term plan to accomplish such socio-economic goals in Copenhagen, given the ambitious goals of building 60,000 new homes for 100,000 new residents, a 2.4 million square meter business area, and 50,000 new private jobs by 2031 (The Municipality of

Copenhagen, 2020).

When it comes to UR, the municipality focuses on regenerating derelict industrial and harbour areas to modernize them with various functions (The Municipality of Copenhagen, 2020). The main important areas that have already been focused on development are Ørestad, Sydhavn, Valby South, Godsbaneterrnet, and Århusgade, as shown in the figure. Whereas Refshaleen, Klverparken, and some parts of Nordhavn are envisioned for development beginning in 2031, only a portion of Nordhavn is envisioned for development beginning in 2025. This highlights the importance of Nordhavn for UR in all three phases. In addition, it should be noted that potential recreational areas are located in both Sydhavn and Nordhavn, which again proves the great importance of the UR of these areas for the municipality.

The Municipal Plan ensures sufficient and well-located areas for UR. By using the natural and cultural-historical qualities of the regions in UR, diverse neighbourhoods with a strong identity must be created. Temporary use of buildings and urban spaces must help create an active urban life in existing city quarters and in older port and industrial areas.

In general, the Copenhagen Municipality aims to:

• Secure space for the construction of up to 60,000 homes and 2.4 million m^2 of businesses until 2031.

• Ensure that UR takes place mainly through the transformation and densification of abandoned industrial and port areas into modern, mixed-use city districts and urban neighborhoods.

• Ensure that UR of regional importance is coordinated with the expansion of Copenhagen's and the capital's overall infrastructure, including public transport in particular.

• Provide diversity and quality in UR by taking a holistic view that, among other things, including urban spaces, activities, institutions, cultural and leisure facilities, public transport, etc.

• Verify the historical and architectural values are actively used to create identity and quality in existing city quarters and UR areas.

• Enable sustainable UR through a holistic approach that includes long-term environmental, social, and economic community development.

• Assure that new high-rise buildings are placed close to the station where they can support the qualities of the city and the place and contribute to the area's urban life and identity.

One of the changes that the municipality has aimed since 2016 which has been also introduced in CPD is to ensure that newly built development districts having at least 30% affordable and

social housing. This is as a result of economic progress of Copenhagen which now social values are integrated with attraction of high-value residents and businesses. Although this makes developers to guarantee affordable and social housing under the maximum property cost, the financial burden of this socioeconomic goal is not shouldered on private actors; instead, the municipality to engage private actors to participate in "optimal material and spatial frameworks" to promote this objective (Bruns-Berentelg *et al*., 2022). This shows the municipality enthusiasm to improve social values alongside the economic growth, as seen in the municipal plan.

However, reaching this point might have some consequences stated by Niitamo (2021), who studied the BR through the lens of participation at the level of "constraining economic rationalism". The author argues that economic restriction comes with uncertainty, shaped by respecting suggested municipality participation aims. The case of Nordhavn is cited, where the municipality aimed at 25% social housing. This makes it challenging for developers to build a social mix and offers for middle and low-income citizens; on the other hand, highly expensive construction costs in the new attractive district and high land value. Although the enhancement of social development as an objective is prioritised in a social-democratic-based city like Copenhagen — by providing governmental subsidies on housing and improved citizen participation — homogenising a neoliberal context in urban policies might cause neglected social goals if not managed by policymakers (Niitamo, 2021). Therefore, rationalising municipal objectives by respecting urban social values to avoid economic barriers in the case of Copenhagen' Municipal Plan should be taken into account when regenerating brownfields.

5.1.4 Partial Conclusion

Strategic planning was of paramount importance to mitigate structural crisis in the late 1980s. Copenhagen's urban policies in the 1990s made the city shift from welfare planning to entrepreneurialism. This resulted in massive investments in infrastructure and determined generation policies, which was a turning point for the growth of interaction between the municipality and entrepreneurs in Denmark and Sweden since the 1990s (Andersen & Jørgensen, 1995). Furthermore, brownfield redevelopment in Denmark was accomplished through spatial planning at three levels: local and municipal planning in municipalities, regional planning in counties, and national planning coordinated by the Ministry of Environment and Energy (CLARINET, 2002). By integrating strategic zoning, land transfers, and revenue-generating mechanisms, the Copenhagen case helped prompt a remarkable transformation of Copenhagen over the last 25 years, from the depths of recession to one of the wealthiest cities in the world.

The Finger Plan of 1947 constitutes an essential document of urban planning in Copenhagen, which restructured urban growth and infrastructure and prevented urban sprawl. Later on, the Regional Plan of 1989 shaped the majority of today's urban infrastructure, and all the regional plans afterward were somehow followed by the city finger structure.

Moreover, developing the harbour waterfront helped increase residential and business growth, land

value, and tax revenue. It has turned Copenhagen into a vibrant industrial harbour, multi-purpose waterfront, and development to finance the construction of an expanded transport system (Katz & Noring, 2017). In addition, economic restructuring and technological advances have motivated the redevelopment of Copenhagen's waterfront. The Inner Harbour experienced such changes and growth earlier, which later expanded to the Southern and Northern Harbours (Desfor & Jørgensen, 2004). Political decisions and social changes helped Copenhagen regenerate and revitalize unused harbours and major abandoned sites to attract investments, create a "creative class," and make the city attractive to new citizens. In this way, the Ørestad development played a crucial role for the attraction of international investments.

OCD as an independent organisation, 45 percent co-owned by The Ministry of Finance and The Ministry of Transport and 55 percent co-owned by the city of Copenhagen (Andersen, 2003; Katz & Noring, 2017; Bruns-Berentelg *et al*., 2022), re-managed the development of the Ørestad district and Port of Copenhagen Ltd., which successfully redeveloped Copenhagen port and waterfront, merged together, and shaped the foundation of CPH City & Port Development, which was an initial step for developing and financing the regeneration of other critical areas and brownfields in Copenhagen (Katz & Noring, 2017).

The development in the Øresund region, thanks to the credit gained from the EU, as well as the improved unban infrastructure with an inclusion of brand-new metro lines, afterwards, facilitated to alter the urban planning visions of Copenhagen and was redefined, by proposing mater plans in a fiercely competitive region. The development of Ørestad, as a part of the Øresund region development, acted as a driving force for urban growth. This was a substantial transition towards a new urban regeneration framework from the former Danish regional policies, which had been based on a centralisation system over the allocation of public infrastructure which caused obstacles for development and other investments deficits. It is argued that the Ørestad Development was a system of publicly controlled while sufficiently automated which enabled to operate efficiently. It was predicted that the project would provide 50,000 jobs and attract 10,000 high-income households, to have a positive impact on the return. This though would increase the risk of polarisation by affluent and less-affluent forces (Andersen, 2003).

The Ørestad Development as an urban megaproject that gravitated huge investment, like any other large-scale urban projects, is conceived as a "necessity", for progressing urban social and economic pillars (Majoor, 2015). The model also proposed a solution for funding large urban infrastructure such as metro expansion. Managing development sites like zoning land and selling them to developers generated revenue to finance other urban infrastructure projects (Bruns-Berentelg *et al*., 2022). The corporation introduced a new entrepreneurialism approach in the city was as a turning point in the growth of the capital region. The privilege of the entrepreneurial strategies, primarily, were integrated in some fundamental social democratic practices and economy foundations and it enjoyed social services, welfare provision, and strong public sector privileges (Andersen, 2003).

There are some critics arguing that the Danish UR was clearly represented with regards to existing

planning instruments by prioritising "market-led development" solutions, which caused some controversy fundamentally. Although private investors at the beginning showed an unwilling feeling to take part in the redevelopment, the project was funded with the state and the governmental loans. This made some critical controversy that the incorporation of an independent private stakeholder company with a public/private partnership with financial means, underwritten by the state funds for 850 million Euro (Andersen, 2003).

Likewise, ODC lacked of "both effective democratic and transparent economic management". Another challenge was the low contribution of private investment in the project once it was planned to be independent from public funds. This changed the cost balance of the project later by massively using public loans and public investments, estimated between 1 and 2 billion Euro, which the payback period was unclear. Though many believe that the reason was that original economic assumptions were "too optimistic" and the debt continued for a decade so that in 1999 it was calculated that the sold land was merely 3.3 percent of the total initial estimated revenue (Andersen, 2003). The role of externalities should not be ignored in the Ørestad criticism, as Majoor (2015) believe that the financial crisis of 2007 worsened the situation than the past and brought about more uncertainties about the future of the project. While the crisis dropped housing prices in Copenhagen for 25-40%, the developers of about one-third of the sold land became insolvent.

Table 5.2 Public investment in Ørestad

Project	Public investment in EUR
Copenhagen University	228,000,000
IT University and Research Park	48,000,000
Research Park	46 ,000,000
The National Archive and Royal Library	202 ,000,000
Danish Broadcasting Corporation (DR)	269 ,000,000
Copenhagen Hospital Corporation (HS)	5 ,000,000
Opera House	40 ,000,000
Total	838 ,000,000

Source: Gambling politics or successful entrepreneurialism? The Orestad project in Copenhagen, p. 102, by Andersen (2003)

The side effects of Ørestad were to the extent that by Majoor (2015) divided them into pre-crises and post-crises at four levels of organisation, showing mismanagement in the development. The compilation studies the importance of administration integration, organisational mechanism in the development, inflexibility to the master plan changes and new real estate programming, and the inclusivity or exclusivity of the programme to broader urban aims. The author would suggest adopting the "ambidexterity" idea as an organisational topic to experiment in the management of UR projects.

Table 5.3 Differences between the predicted and actual results of financial values the Ørestad Development

	Site development costs		Administration costs		Interest payment	
	Forecast	Result	Forecast	Result	Forecast	Result
2002	236	306	67	71	396	457
2003	149	140	65	65	448	478
2004	88	345	61	54	484	648
2005	75	119	54	62	203	710
Total	548	910	247	252	1531	2293
Difference	+66%		+2%		+50%	

	Railway operation profit		Sales of land profit		Property tax	
	Forecast	Result	Forecast	Result	Forecast	Result
2002	-93	-20	583	362	40	18
2003	99	-76	210	199	26	22
2004	153	10	498	222	34	21
2005	167	-66	348	639	42	28
Total	326	-152	1639	1422	142	86
Difference	-146%		-15%		-60%	

Source: Progressive planning ideals in a neo-liberal context, the case of Ørestad Copenhagen, p. 110, by Majoor (2008)

Note: The huge gap between forecast and actual results are based on too much optimistic assumptions on the project.

In spite the fact, it should be admitted that the Ørestad Development was a radical unique solution within an "explorative" approach, backed with economic development plan, to follow up ambitious long-term UR. Although the planning system of Ørestad resulted in an urban evolution, it has not successfully been achieved through a balanced approach. Main Ørestad challenges manifested when changing in building programmes and global financial crisis in 2007 started, though "explorative and exploitative learning" as a solution was able to mitigate the situation (Majoor, 2015).

It seems that Danish developers learned lessons from the Ørestad experience to avoid in the next large-scale BR project in Nordhavn. The new corporation "CPH City and Port Development" (CPD), which was formed by merging ODC and Port Development Corporation, seems that the main model of ODC was re-applied. According to Bruns-Berentelg *et al*. (2022), the state generated revenue about 450 million USD from the land sale in Nordhavn which was more than the primary estimation in 2007. The revenue was reinvested in the metro construction in Nordhavn, facilitating forthcoming UR in the neighbourhood. The capital gained from Nordhavn development and reinvested was estimated 15 billion USD, of which 5.8 billion USD were injected into metro construction, while CPD must pay off the debt of 2.4 billion USD borrowed for funding infrastructure.

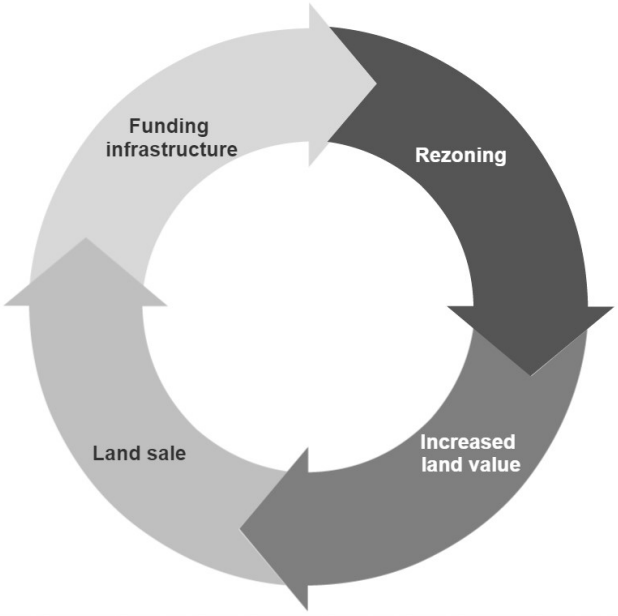


Figure 5.5 The financial solution for urban development from The CPH City and Port Development model

Source: Produced by the thesis author on the basis of the data collected from Bruns-Berentelg *et al*., 2022

Note: The economic cycle model proposed by CPD intended to minimise public investment for mass urban development projects.

Last but not least, it is worth mentioning to conclude the organisational management of Copenhagen's UR model by citing Katz & Noring L. (2017) as follows:

Transparent public ownership

One of the reasons for the CPH City & Port Development is to understand the ownership of properties and the market value of these assets.

Bundle assets by merging public entities

Political will at the national and local level was adopted in Copenhagen and shaped one specific objective for such development.

The local and government collaboration encouragement

The evolution and management of CPH Port & City Development requires effective collaboration between national and local authorities.

The isolation of development from political interference

The model of the Copenhagen development operation represents successful insulation from political interference, and the success of this model depends on the adaptability of changing market demands.

Long-term perspective and stewardship

The case of Copenhagen has indicated a critical shift to pursuing ambitious UR goals managed by both the corporation and private financial and partners. It avoids using public assets to address short-term budget deficits.

5.2 Urban Analysis of Copenhagen Metropolitan Area
5.2.2 Population and Density

The metropolitan area of Copenhagen houses a population of 2 million inhabitants, of whom 1.25 million reside in Copenhagen, the capital region, which is considered the most populated city in Denmark.

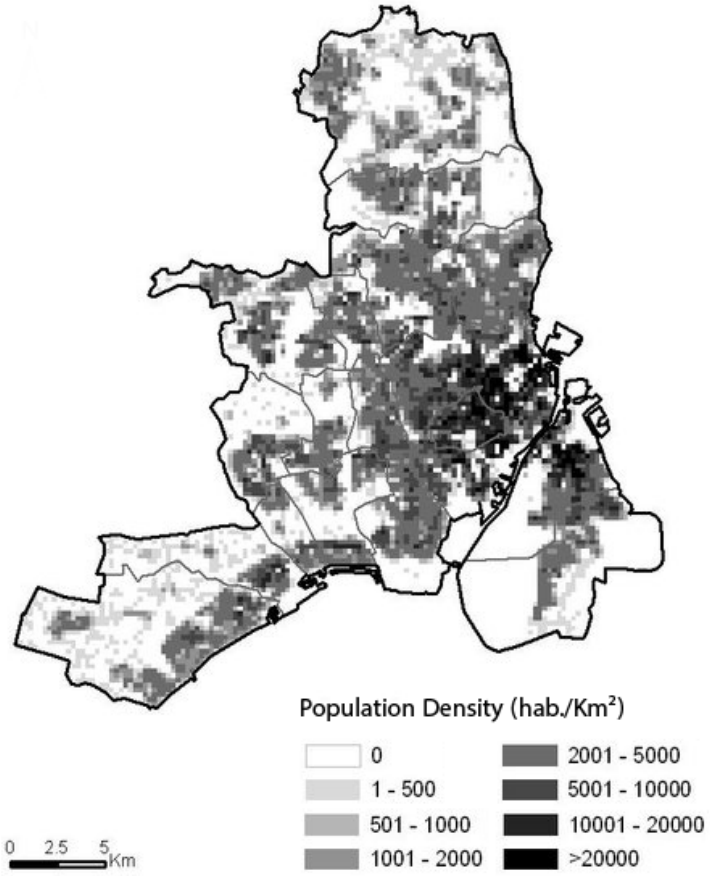


Figure 5.6 Population density in Greater Copenhagen

Source: How urban structure constrains sustainable mobility choices: Comparison of Copenhagen and Oporto, p. 216, by Silva *et al*. (2014)

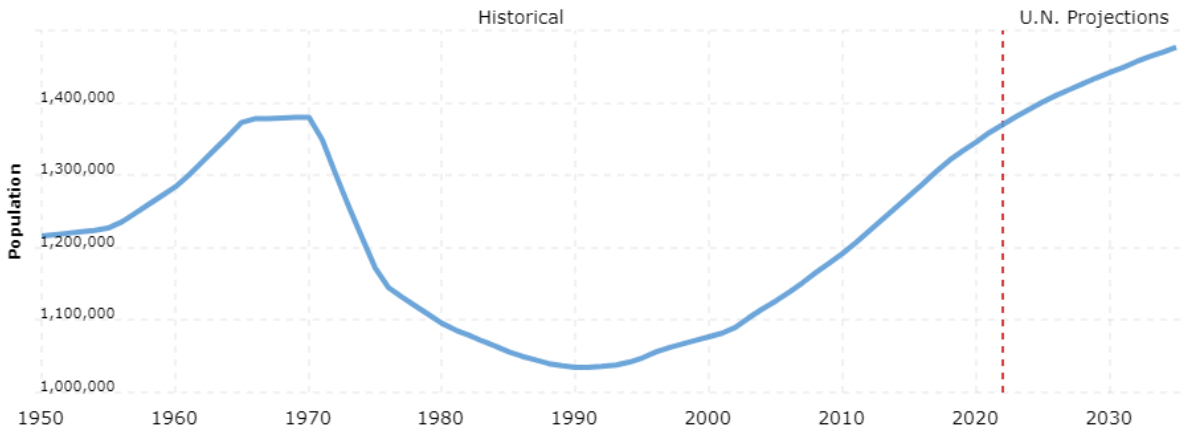


Figure 5.7 Population trend of Copenhagen between 1950 and 2022

Source: MacroTrends

However, the population trend has not been stable over the past decades. By comparing the population trend and the UR, it could be interpreted that the population grew by developing the city since the early twenty-first century, which is predicted to increase by 2050.

5.2.2 Danish Strategic Urban Planning System

The urban planning act for the first time was legalised in 1925, however, the crises between 1920s and 1930s made the government to introduce a new planning system in 1938 which resulted in general plan for the whole municipality to guide and control future urban planning. Although local governments to achieve developments made action plans until 1950 and the first municipal plan was created in the early 1980s, the Finger Plan 1945 was a great successful plan for managing future urban growth. The efficiency of urban planning system until 1960s was relatively low and there was a need for land development. A new planning system by the end of 1960s on national planning was agreed on the parliament in which all local planning has to be in accordance with regional planning. The government's priorities were proposed every four years since the mid 1990s. The planning system fit within the governmental guidelines and was based on the relation between the government and regional counties. However, this governmental-dependent system brought about some negative results. Since there was low income gained from taxation to finance infrastructure, working class districts in need of public services faced economic crisis. The system produced challenges in the structure of the city in the 1980s and caused trouble like unemployment, lower incomes, and then economic recession (Kidokoro *et al*., 2008).

As the great reforms started in the early 1990s, the Greater Copenhagen Council (GCC) was abolished due to inefficiency and steady weakness. In response, Copenhagen Capacity and Wonderful Copenhagen were established to promote tourist and business investments. The governmental dominant in which it was governed by the municipalities interests and put them in power, was finally abolished in 2006 and left Copenhagen with 35 municipalities which individually develop their local strategies, albeit not coordinating. The new local government reform introduced 98 municipalities in Denmark in 2007 and the planning legalisation was transformed and regional plan was not required. It is worth mentioning key elements of strategies and planning system that delivered UR in 1990s.

Today, urban planning system in Denmark consists of three levels: the national government, 5 regional government, and 98 local municipalities. Each regional councils may object to local planning proposals, conflicting with regional plans. In Greater Copenhagen metropolitan area, local councils can object with each other. This is to facilitate the dialogue between the national, regional, and local interests.

National Planning Report: On the national level, the Minister for the Environment, on behalf of the government prepares a national planning report after each parliament election. The plan is prepared is based on the government's long-term perspective for spatial planning in Denmark. In addition, the ministry is responsible to cover 'national interests' in physical planning and report National Interest in Municipal Planning every four years. The ministry is also responsible to provide

national planning directive for overall planning in Greater Copenhagen metropolitan area and can establish special rules for planning certain activities (OECD, 2017).

Regional Planning: Regional governments are mainly in charge of strategic development planning with an emphasis on regional economic development. They provide Regional Growth and Development Strategies which are adapted with different stakeholders alongside the common vision for the region. They must prepare Regional Raw Material Plan (OECD, 2017).

Municipal Strategies: Municipalities are the most significant part for land-use planning. They are responsible for providing extensive strategic planning for territories and prepare detailed municipal and local plans which structure land use in cities. Local municipalities can revise the entire or part of the plan such as a topic or a district and adopt the rest of the plan or leave them unchanged (Danish Ministry of The Environment, 2012).

Municipal Plans: The Municipal Plan is the most complex plan in the Danish planning system. It actually integrates different goals of higher levels into an extensive policy document in which overall objectives are specified within guidelines and a general land-use framework for the municipality. Local Plans are the next level of land-use plans providing more detailed information and regulations in larger scales such as between 1:10,000 and 1:1,000. Local Plans usually are prepared for major development projects (OECD, 2017).

Local Plans: Local plans are considered as the local law for local areas which offer comprehensive detailed development plans, and are legally binding for property owners. Local plans are flexible and regulate many factors such as the size and location of buildings, roads and paths, and architectural features of an area. Local plans consist of reports, provisions, and maps which could be applied either on buildings or a urban districts (Danish Ministry of The Environment, 2012).

Spatial and land-use plans: Denmark takes advantage of a hierarchical spatial planning framework which could be characterised either for development plans and strategies or land-use plan. While The National Planning Report provides visions for spatial development in Denmark, Regional Growth and Development Strategies focus on economic development by embracing stakeholders. Municipal Strategies for Planning also provide either framework on the land use or prepare local development strategies (OECD, 2017).

Regulations: The legalisation of the framework in which the planning system is defined is contained in the Planning Act. More details on planning and development are contained in the Building Act which determine requirements for buildings permit. It is worth-noting that the Valuation Act structure properties and land value and taxation (OECD, 2017).

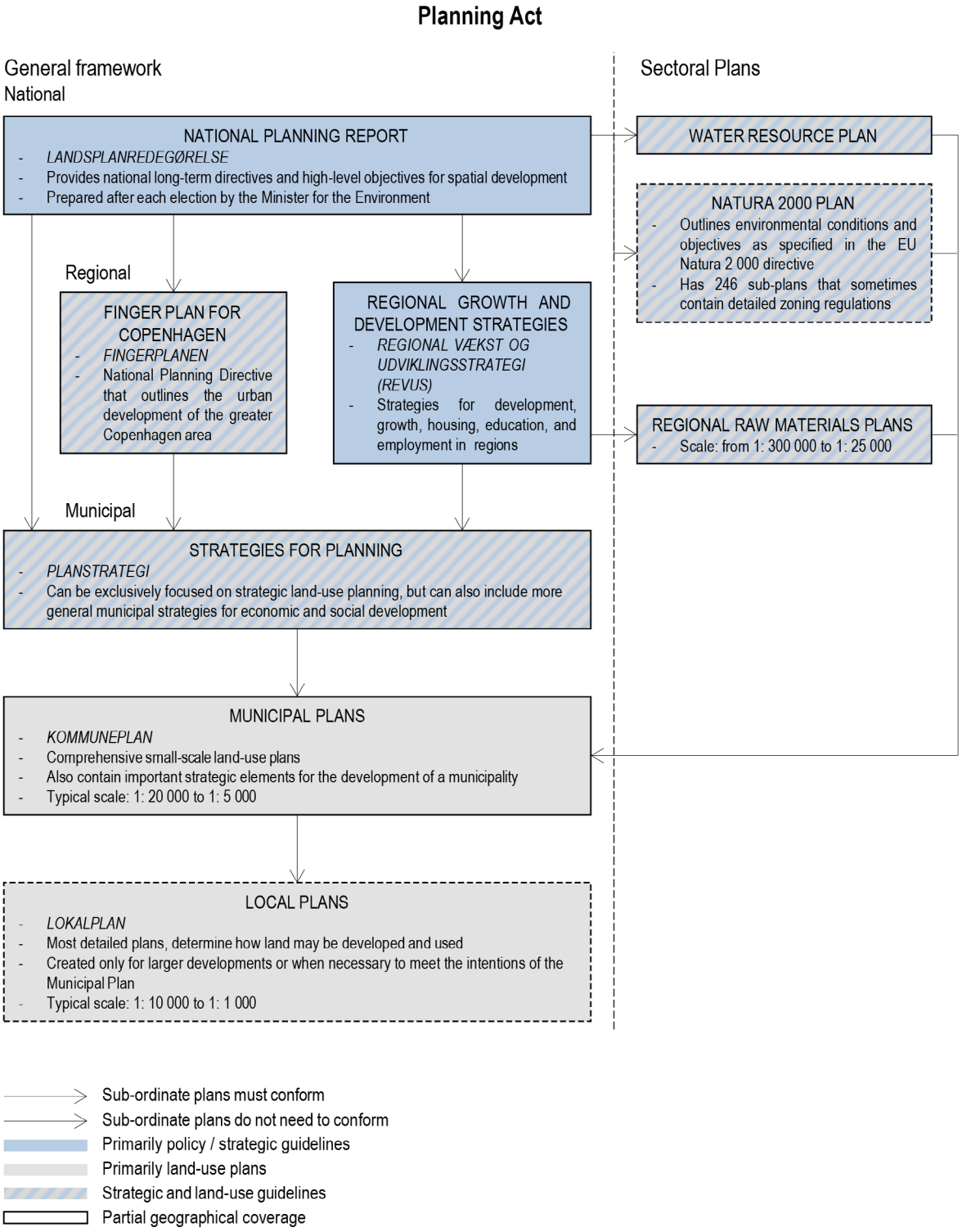


Figure 5.8 The organisation of spatial and land-use planning in Denmark

Source: Land-use Planning Systems in the OECD: Country Fact Sheets: Denmark, p. 82, by OECD (2017)

Note: The urban organisation structure involves different sectors from government to the local actors to regulate comprehensive urban policies

5.2.2.1 Finger Plan 2019

Another important system is the Finger Plan 2019, shown in the figure below, is binding National Planning Directive for Greater Copenhagen, containing strategies for growth and development of the metropolitan area. Since 1947, the finger plan has helped to ensure many of the qualities that make the metropolitan area a well-functioning and attractive metropolitan area and the latest updated version of this plan was published in 2019. The plan determines, among other things, where new homes and businesses may be built, and where there must be larger green areas with space for nature and outdoor activities. With the Finger plan 2019, the government maintains precisely those qualities, while at the same time that municipalities, companies and citizens now have more flexible opportunities to create growth and development locally. Based on Ministry of Industry, Business, and Financial Affairs (2019), The Finger Plan 2019 embraces the following elements

• Dedication of room for an addition 200,000 citizens by 2030 and expansion of the metropolitan area at Herfølge, Køge, Solrød, Roskilde, Høje-Taastrup, Hillerød and Helsingør.

• Expansion of green wedges for more than 400 hectares of which 170 hectares should be dedicated for recreational areas.

• The development opportunities for businesses around the stations in the five market towns of Helsingør, Hillerød, Frederikssund, Roskilde and Køge are being strengthened as well as in Høje-Taastrup.

• Three new special location areas for business by adding office buildings for knowledge-intensive companies are designated at Nærum, Kvistgård and Vallensbæk.

• Opportunities for developing Køge Bugt Strand park into a recreational beach area.

In the following pages some illustrations of the Finger Plan 2019 are shown and explained.

5.2.3 The Municipal Plan 2019 Elements

In order to study the urban analysis of the Copenhagen metropolitan area, it is referred to one of the primary resources published by the municipality, namely The Municipal Plan (KP19), which is the most recent municipal plan published by the municipality in 2019. The Municipal Plan acts as a connector between local plans and regional planning which all embraces national interests defined by National Planning Reports. Some information from this document is exported, such as framework areas, development areas, urban renewals, population, and density. The KP19 contains various information about an overall vision of urban redevelopment, guidelines, and a framework

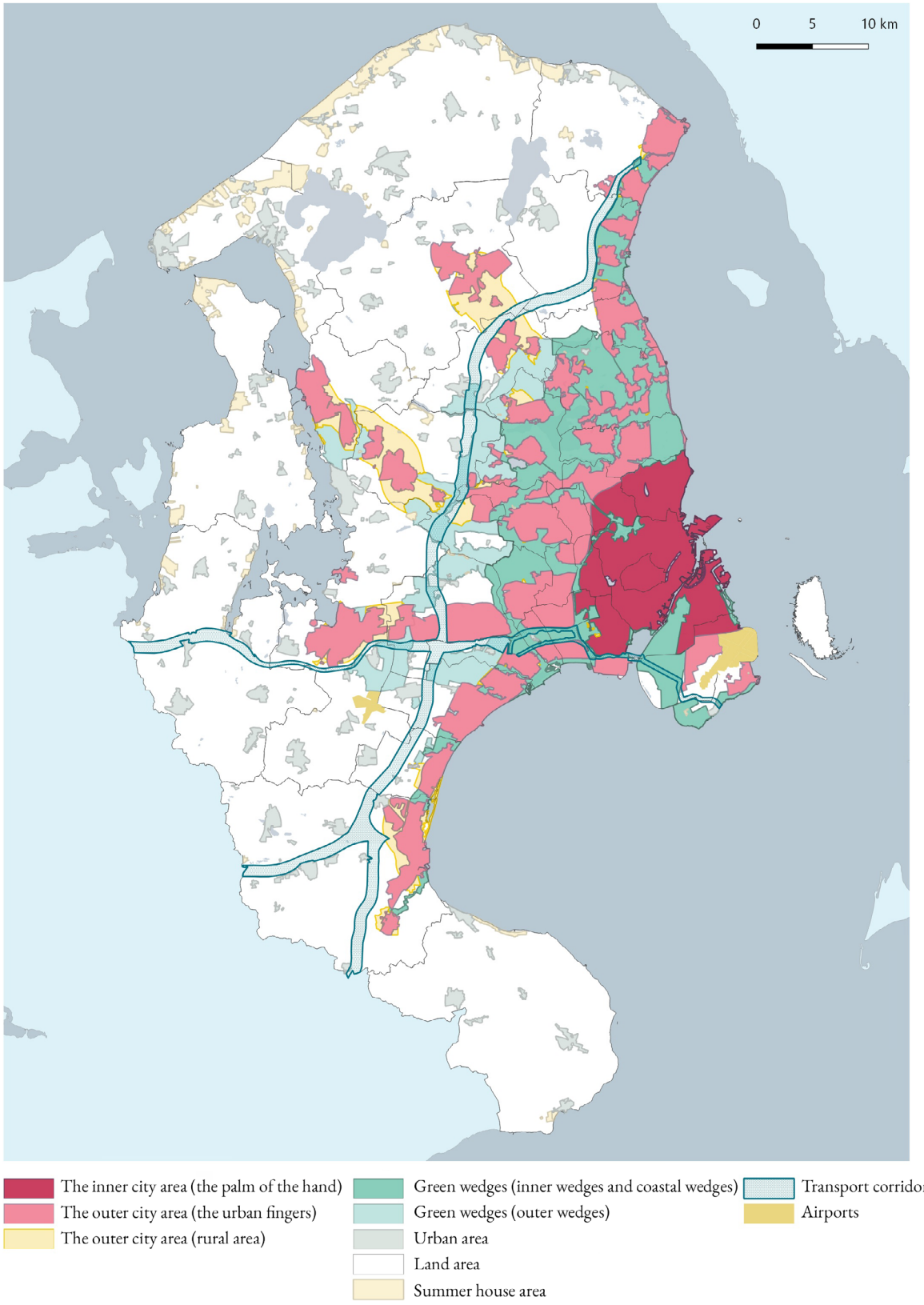


Figure 5.9 The capital area and geographical area types

Source: Ministry of Industry, Business, and Financial Affairs (2019), p. 36

Note: Municipal planning in the Finger Plan area must ensure that UR is planned with respect to a core urban region ("the palm of the hand"), the peripheral urban region ("the city fingers"), the green wedges ("between the fingers") and the rest of the Greater Copenhagen area. Special attention is given to opportunities for strengthening public transport services and to avoiding urban growth in the green wedges.

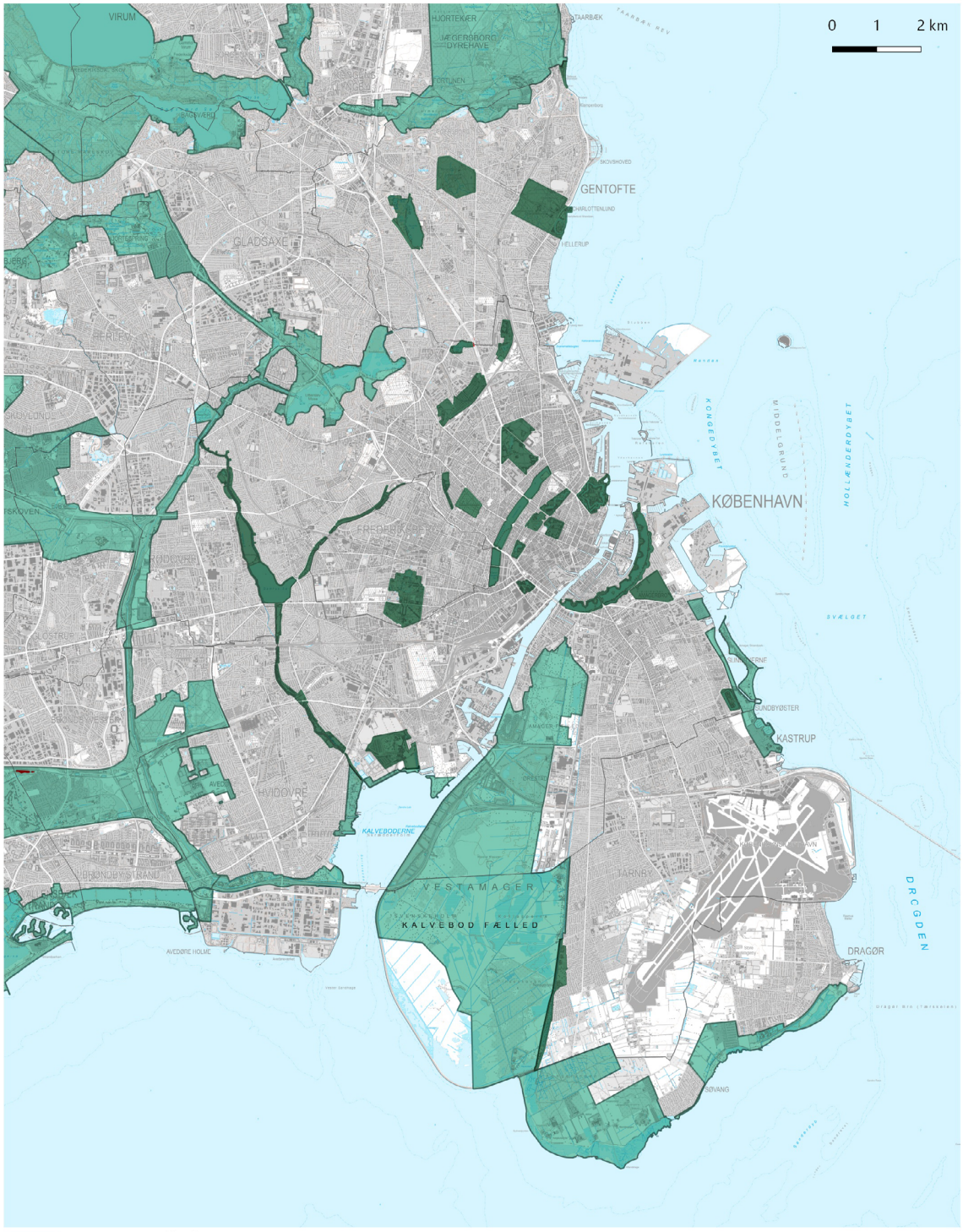


Figure 5.10 Copenhagen and green urban wedges

Source: Ministry of Industry, Business, and Financial Affairs (2019), p. 41

Note: The Copenhagen green areas constitute publicly accessible green spaces, where green areas include garden facilities, parks, nature areas, small parks and areas, sports facilities, allotments and cemeteries. The map represents a high ratio of greenery in the city.

for the local plans until 2031. With the help of this document and the municipality's objectives, it is also possible to extract information about brownfield regeneration (BR) areas and understand their importance for UR. In the following maps, such information is illustrated on the map.

The socio-economic study of the city based on KP19 is considered according to analysing several factors. It mainly refers to the income and education rate, unemployment rate, non-western ethnic groups, social housing, etc. In the following, in the urban analysis of selected brownfields, parameters like income, no-education and unemployment rate are considered due to the availability of data of those areas.

Household income: it is calculated based on two methods; the gross income per person who is at least 18 years old and the disposable family where at least one person is 18 years old. Accordingly, the incomes are divided into low, medium, and high income categories. The income categories are calculated based on the median, where low incomes are at least 25% below the median, high incomes are at least 25% above the median, and where the rest are defined as middle incomes. Low gross incomes amount to a maximum of DKK 162,000 per year, while high gross incomes are DKK 270,000 or more. The median income for gross income is DKK 216,000.

Unemployment: the rate refers to residents between 16 and 66, divided into the categories outside and inside the labour market. The category of unemployment includes those who are outside the workforce, while the other category embraces employed and who carry out training and the ones who are temporarily outside the labour force.

Education: it mainly assesses the education of 16-64-year-old people divided into the categories of no-education, under education, upper secondary education, vocational education, short higher education, medium higher education, and long higher education. The category of no registered education includes people who either have primary school as the highest completed education or no education. Secondary education will primarily mean either upper secondary school or vocational education. Short higher education typically lasts 2-3 years, such as a dental or laboratory technician. Medium-term higher education typically lasts 3-4 ½ years, while long higher education typically lasts 5-6 years.

5.2.3.1 Framework Areas

The framework area is one of the main essential data of KP19 with the goal of structuring retail trade. The map indicates the primary use, area type, and provisions regarding use and development options.

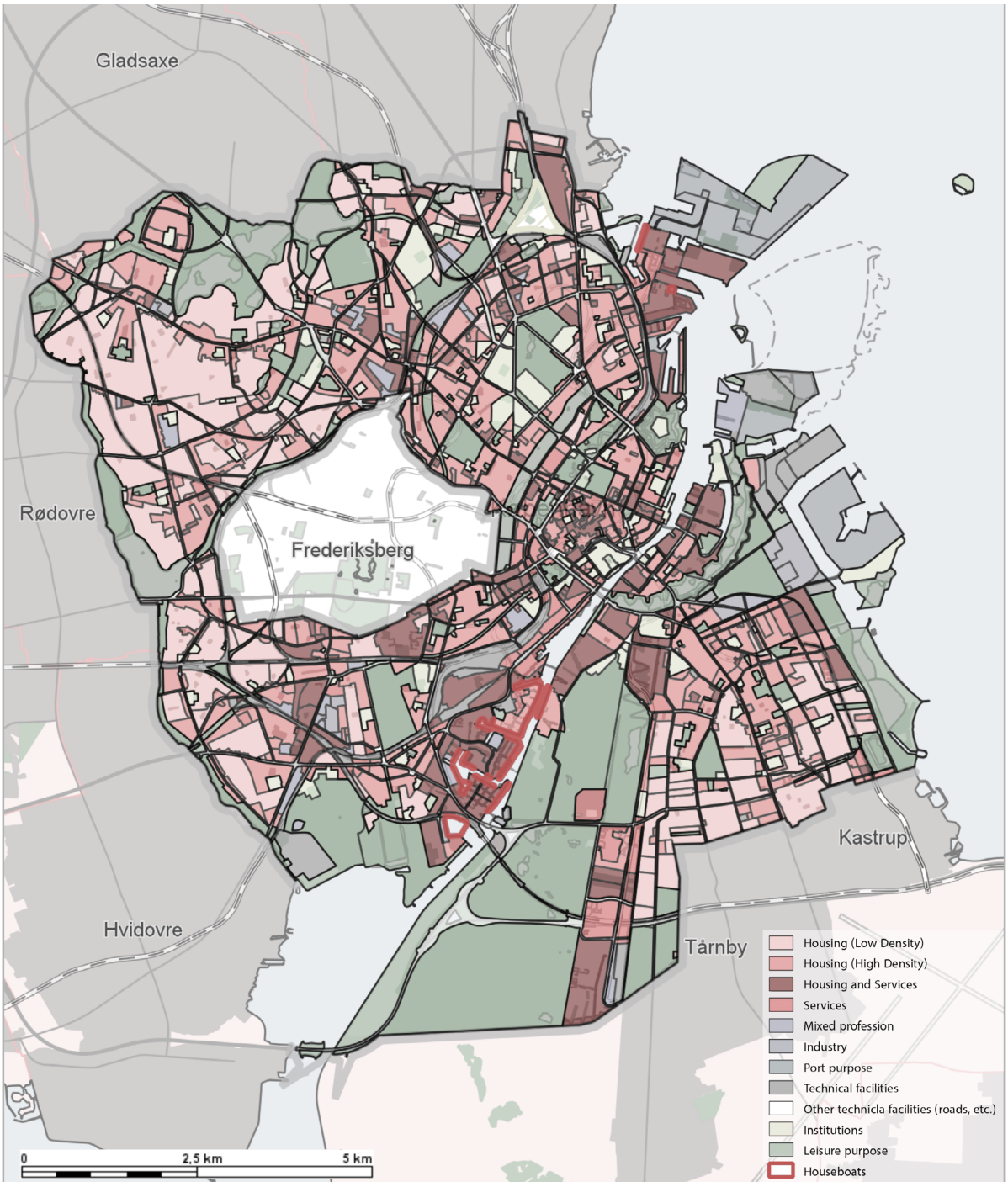


Figure 5.11 Framework areas of KP19

Source: The Municipality of Copenhagen Map (2019)

5.2.3.2 Urban Development Outlook

Copenhagen's UR sequence ensures that all development phases are coordinated with expanding infrastructure, public transport, and municipal investment in public services. Moreover, special urban transformation areas mainly focus on gradually transforming former industrial and port areas into new urban purposes, while noise pollution and technical facilities are to be reduced.

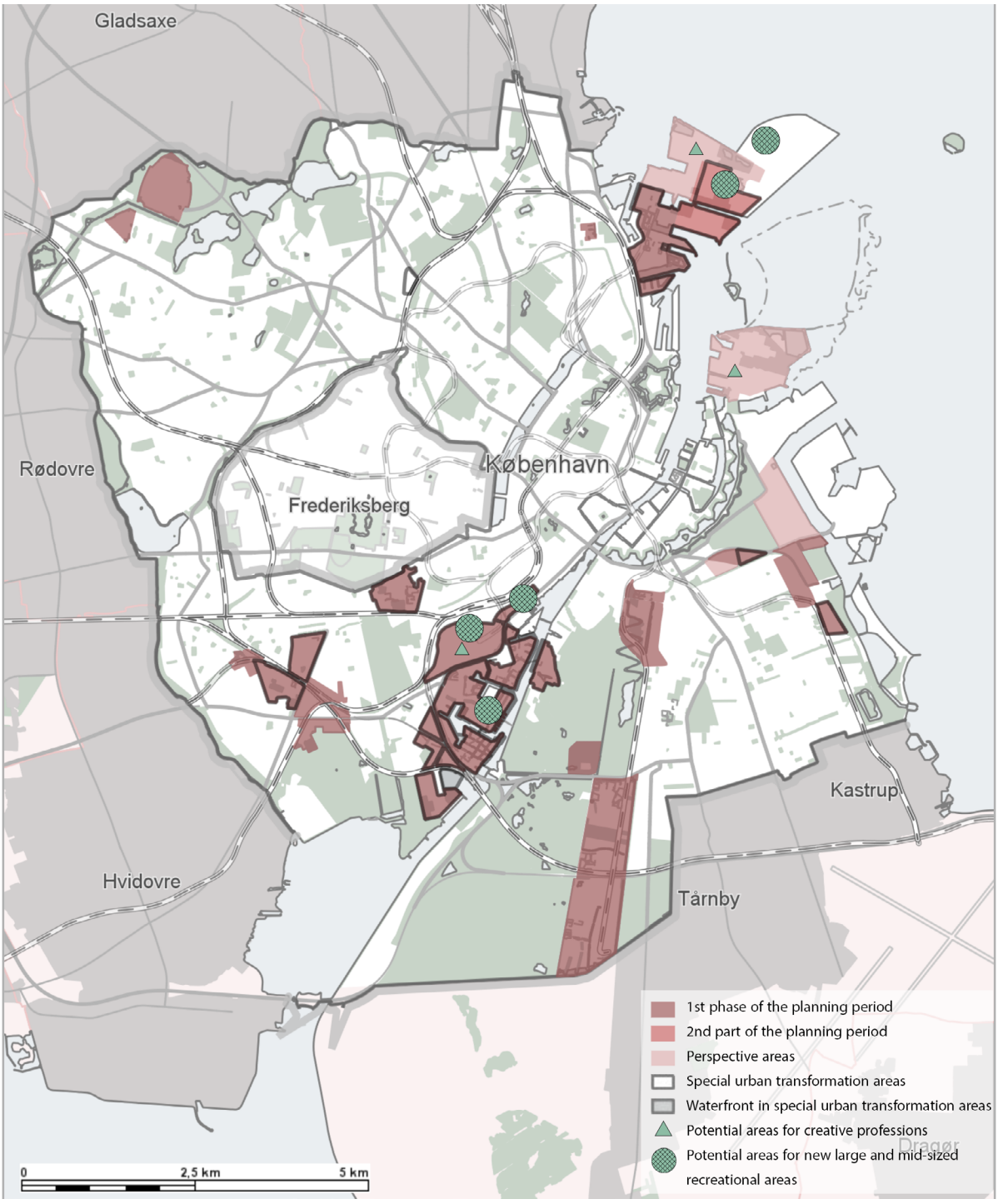


Figure 5.12 Urban development perspective of KP19

Source: The Municipality of Copenhagen Map (2019)

5.2.3.3 Urban Renewal Areas

The Planning Act stipulates that UR and transformation in the Municipality of Copenhagen occur within the existing urban zone. There can only be minor adjustments to the boundary between city and water in connection with harbour conversions. Minor adjustments can be made in municipal planning, while slightly larger but still minor adjustments require a national planning directive.

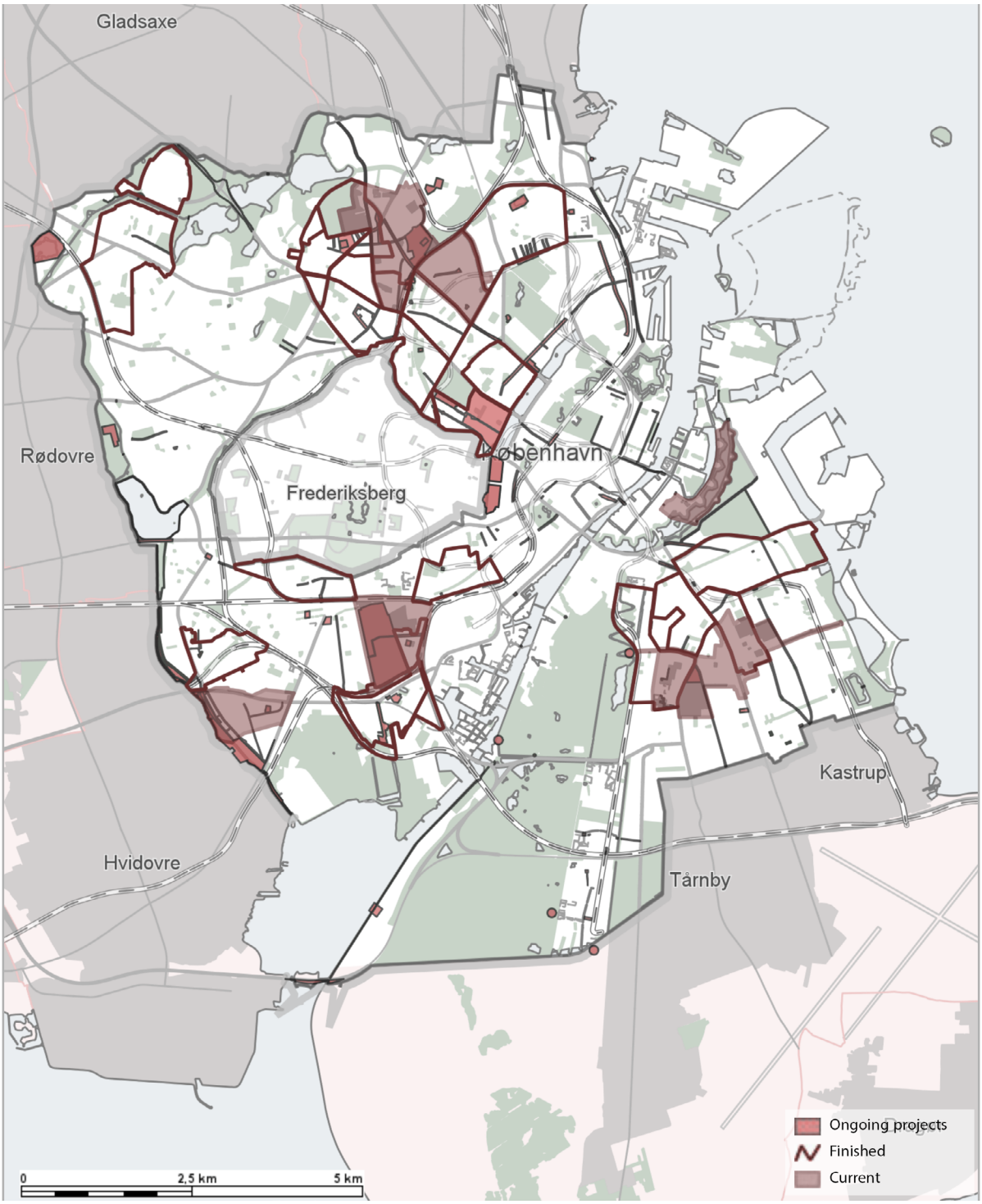


Figure 5.13 Urban renewal areas of KP19

Source: The Municipality of Copenhagen Map (2019)

5.2.3.4 Local Plans

Local plans determine what the UR should be like in a particular area. Once a proposal for the local plan is submitted, people are also invited to participate in the proposal through citizens' meetings, sending a consultation response, or contacting the local committee.

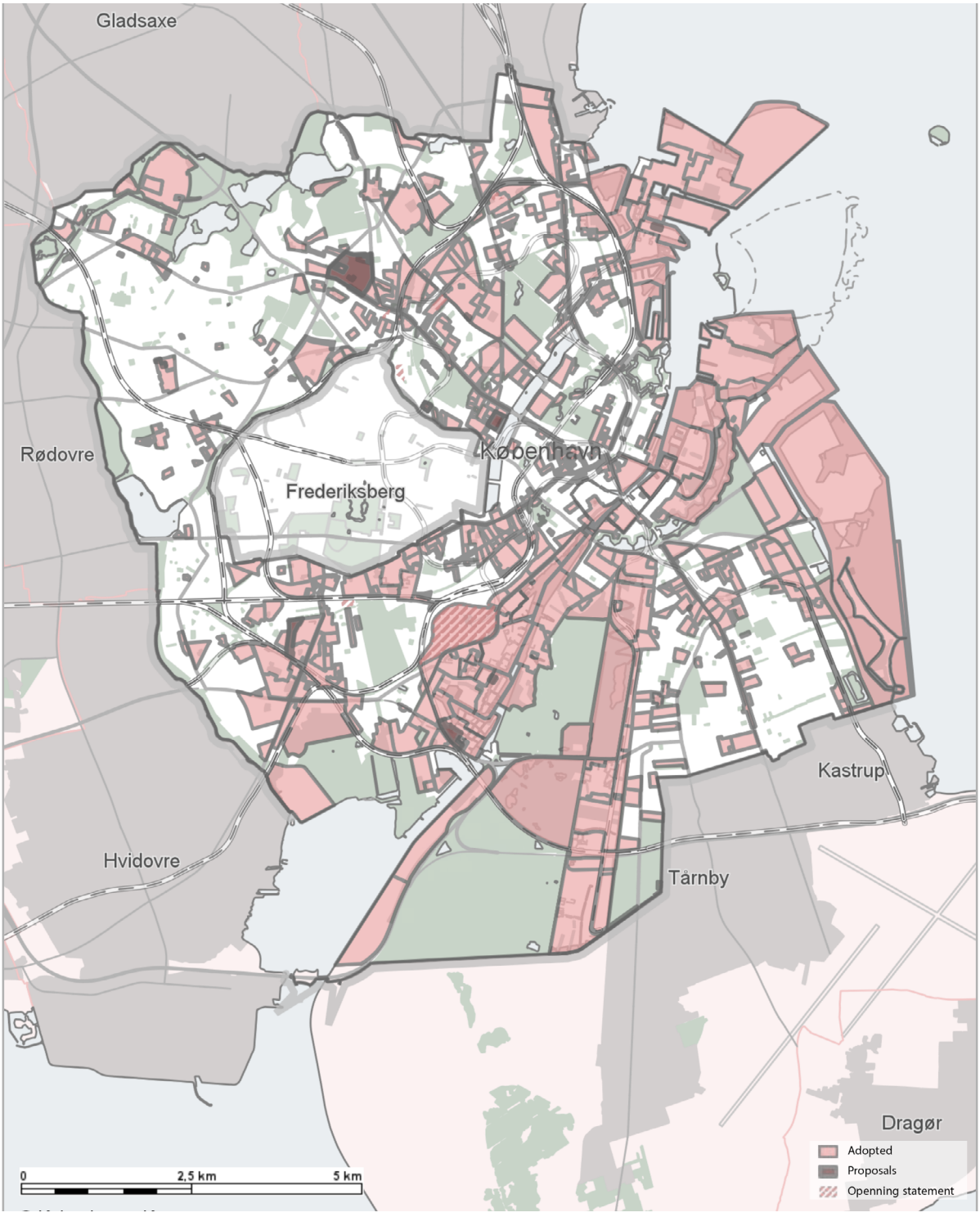


Figure 5.14 Local plans of KP19

Source: The Municipality of Copenhagen Map (2019)

5.3 Selected Brownfields
5.3.1 Choice of Reason

By studying essential documents of the municipality, KP19 mainly, urban analysis, and UR areas in three phases of completed, ongoing, and upcoming, two major brownfield areas were identified in Copenhagen. The two sites were also mentioned in the email communication made with the municipality of Copenhagen, The Economic Administration Centre for UR, as the significant future development of brownfields in Copenhagen. While the two sites are *Jernbanebyen* (The Railway Town), located in Nordhavn (the northern harbour), and *Tunnelfabrikken* (The Tunnel Factory), situated in Sydhavn (the southern harbour), they constitute critical locations in the north and south of Copenhagen, with the size of 365,000 m² and 80,100 m² respectively.

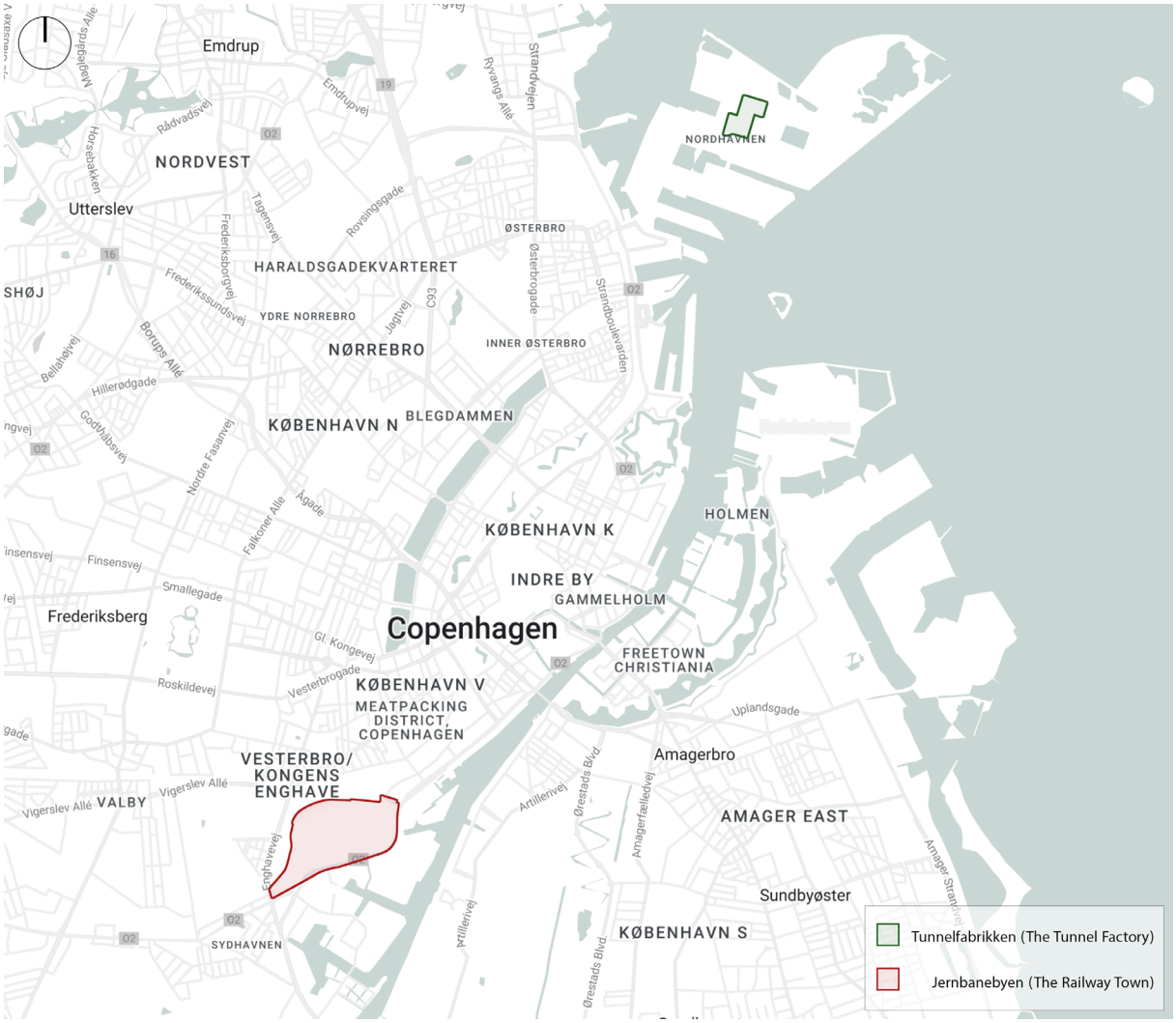


Figure 5.15 Selected brownfields in Copenhagen map

Source: Produced by the thesis author

5.3.1 Jernbanebyen (The Railway Town)

Figure 5.16 The Location The Railway Town in Copenhagen

Source: Produced by the thesis author

Specific Information

Location: Vesterbro – Kongens Enghave, Copenhagen

Function: The area was used for technical transport facilities such as track facilities, train and freight terminal

Land lot area: 550,000 m^2

Regeneration proposal area: 365,000 m^2

Stakeholder: DSB Ejendomsudvikling A/S, Freja Ejendomme A/S, and BaneDanmark

Requirements: preserve cultural-heritage significance buildings, preserve valuable trees and promote green environments, evironmentally sound principles

Figure 5.17 The Railway Town site area

Source: Produced by the thesis author, adapted from Google Earth

5.3.1.1 Description

The railway was originally built in the late 19th century. The new freight station was established in 1901, which we know today as *Jernbanebyen*. The surrounding area of the railways was used for a large depot. The area saw rapid development by adding new central workshops, houses, and services for the railway station. Over the years, new facilities and warehouses were built, so in 1970, the container terminal transport was constructed. The terminal finally ceased operations in 2005, and equipment and workshops were relocated in 2008. In 2009, DBS rented abandoned buildings to office communities, entrepreneurs, and creative enthusiasts. In February 2020, the area was considered for redevelopment in KP19. The developers held an architectural competition for the redevelopment of the area in which Cobe's proposal was selected (Jernbanebyen, n.d.).

Figure 5.18 The Railway Town aerial photos

Source: Jernbanebyen.dk

5.3.1.2 Mobility

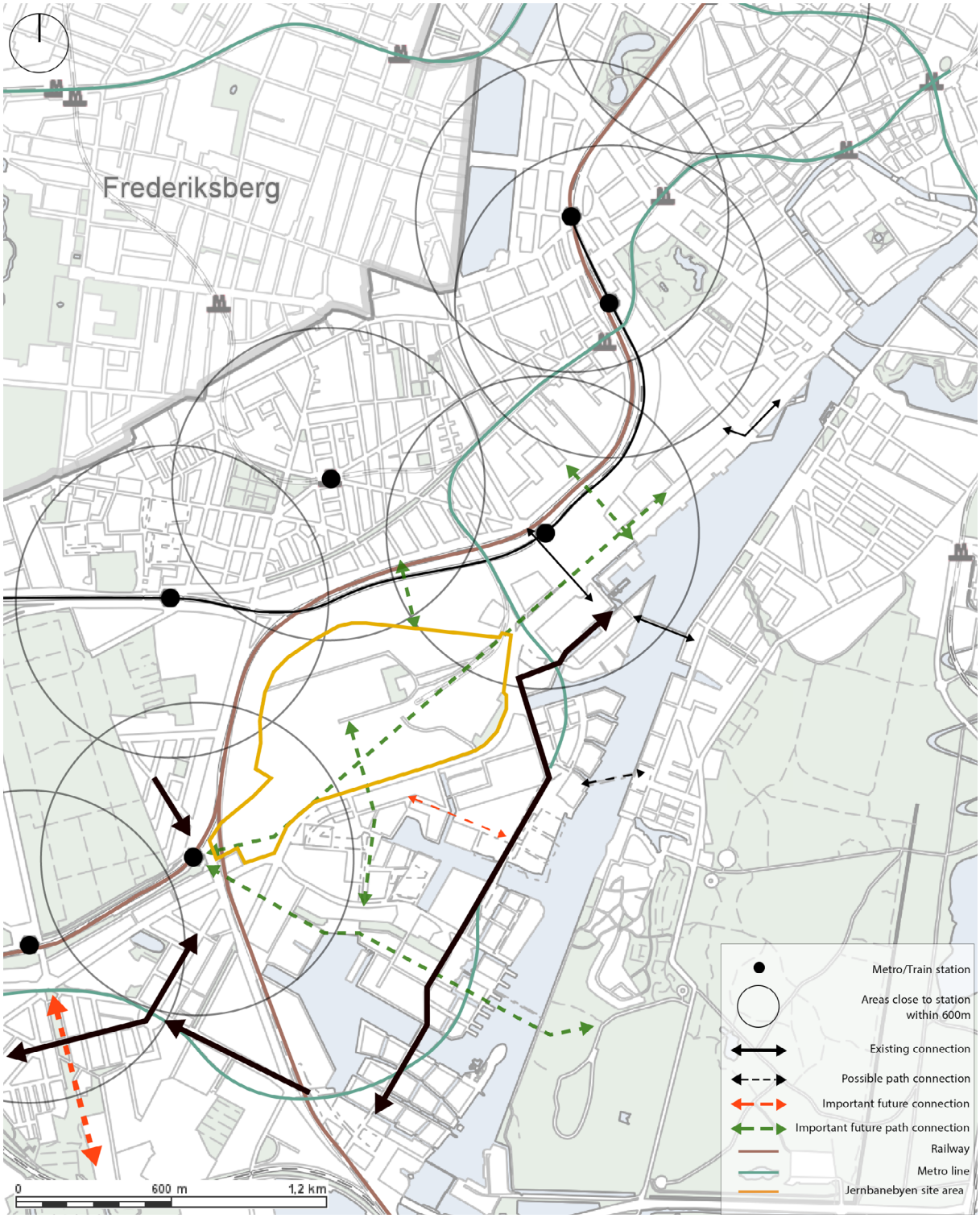


Figure 5.19 The mobility analysis of The Railway Town

Source: Produced by the thesis author on the basis of data collected from The Municipality of Copenhagen Map

The mobility analysis of the area shows that the site enjoys a pretty high level of accessibility while critical future paths are planned to cross the site. On the other hand, the site is already considered a potential large green area; thus, considering green space in the future paths should be highlighted.

5.3.1.3 Framework Areas KP19

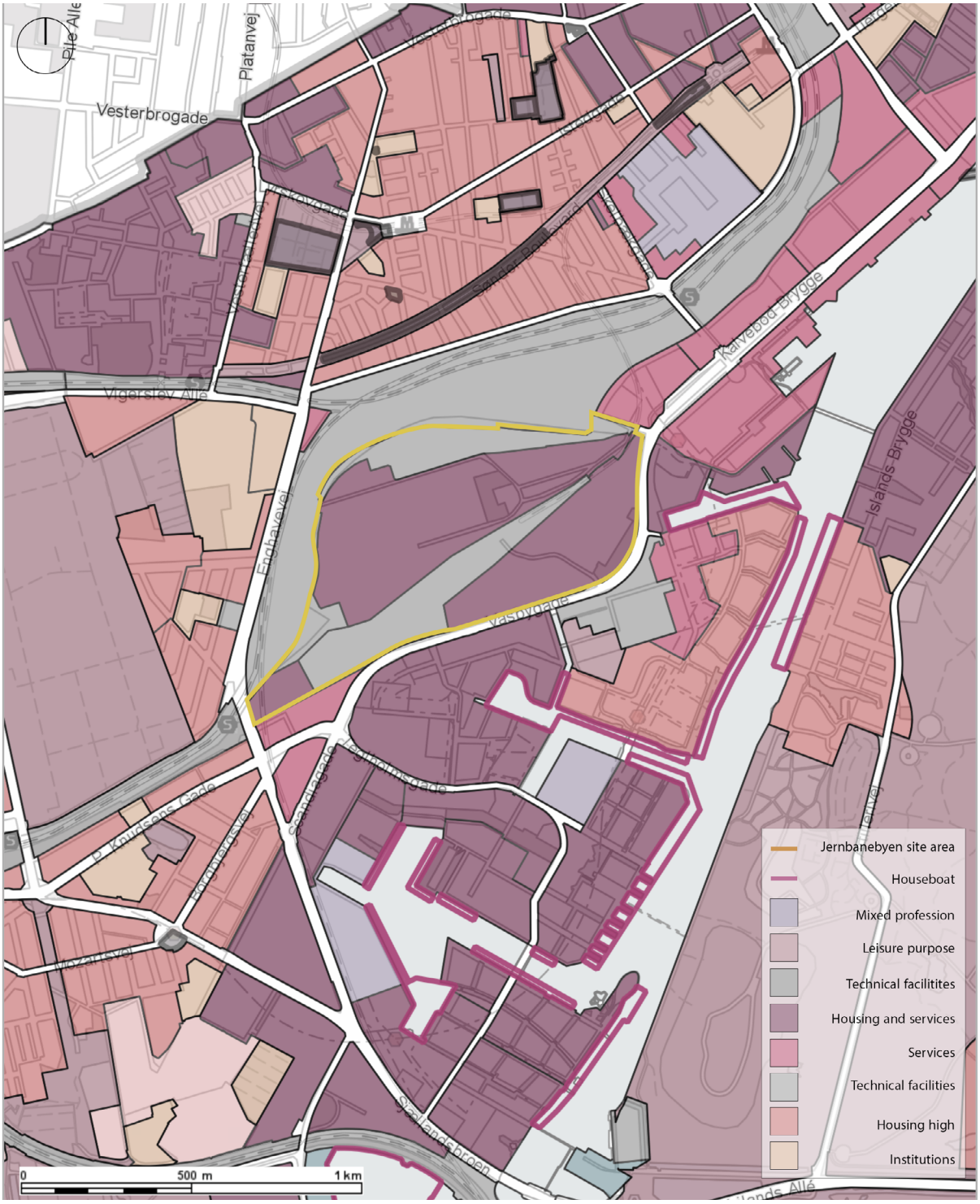


Figure 5.20 The framework areas of The Railway Town based on KP19

Source: The Municipality of Copenhagen Map

The framework area of The Railway Town shows that about 83% of the area comprises housing and services, while only 17% remains for technical facilities (industrial), which belong to the train station and its facilities. This is a demand of municipality which needs to be followed in the proposal.

5.3.1.4 Buildings Preserve Worthy

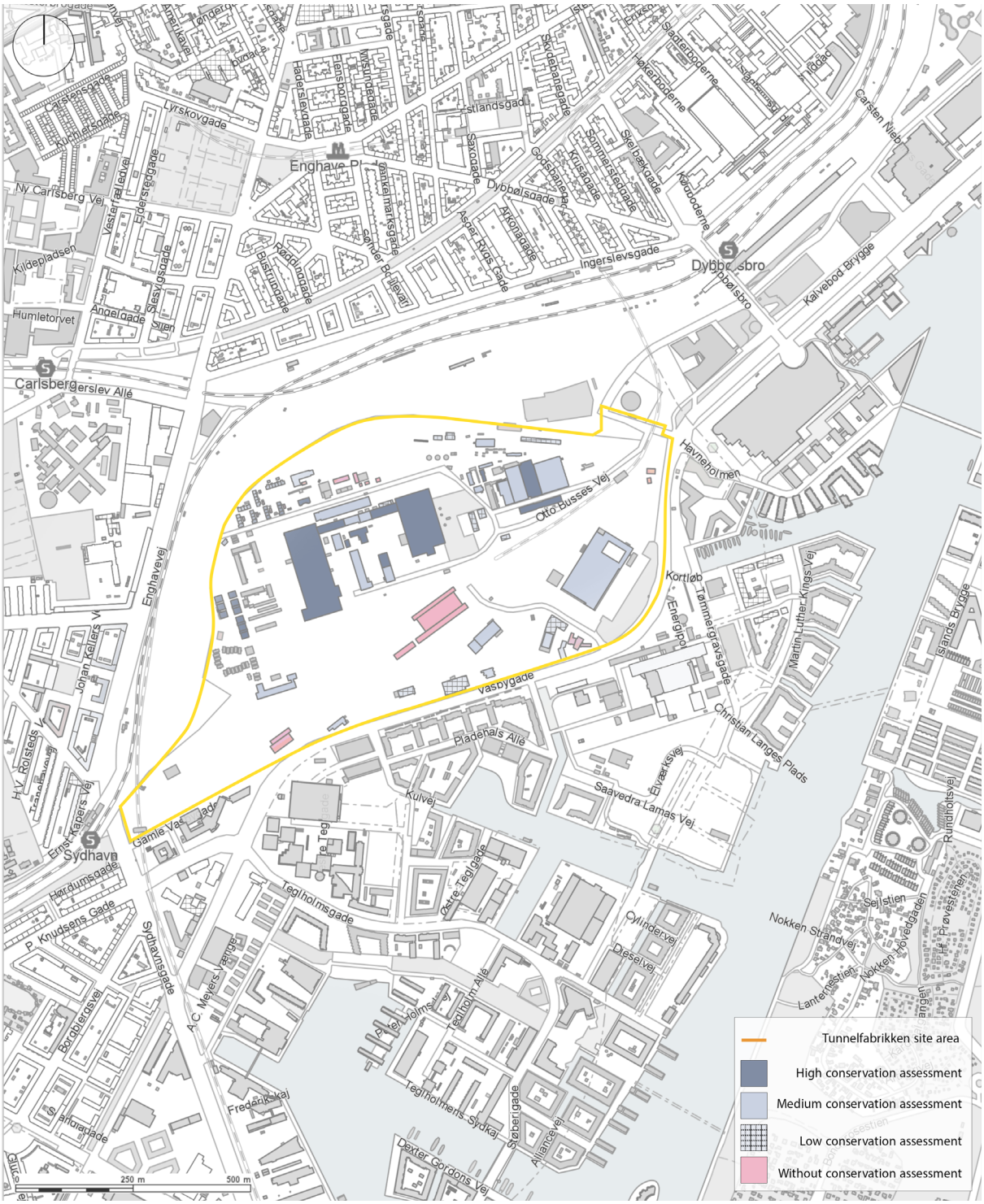


Figure 5.21 Preserve-worthy buildings of The Railway Town based on KP19

Source: The Municipality of Copenhagen Map

The assessment of conserved buildings on the site shows that most buildings are considered medium or high conservation value, that the majority of the buildings are considered as the medium or high conservation value, and may not be demolished. The proposal must respect the existing worthy-preserve buildings to promote them.

5.3.1.5 Households Income

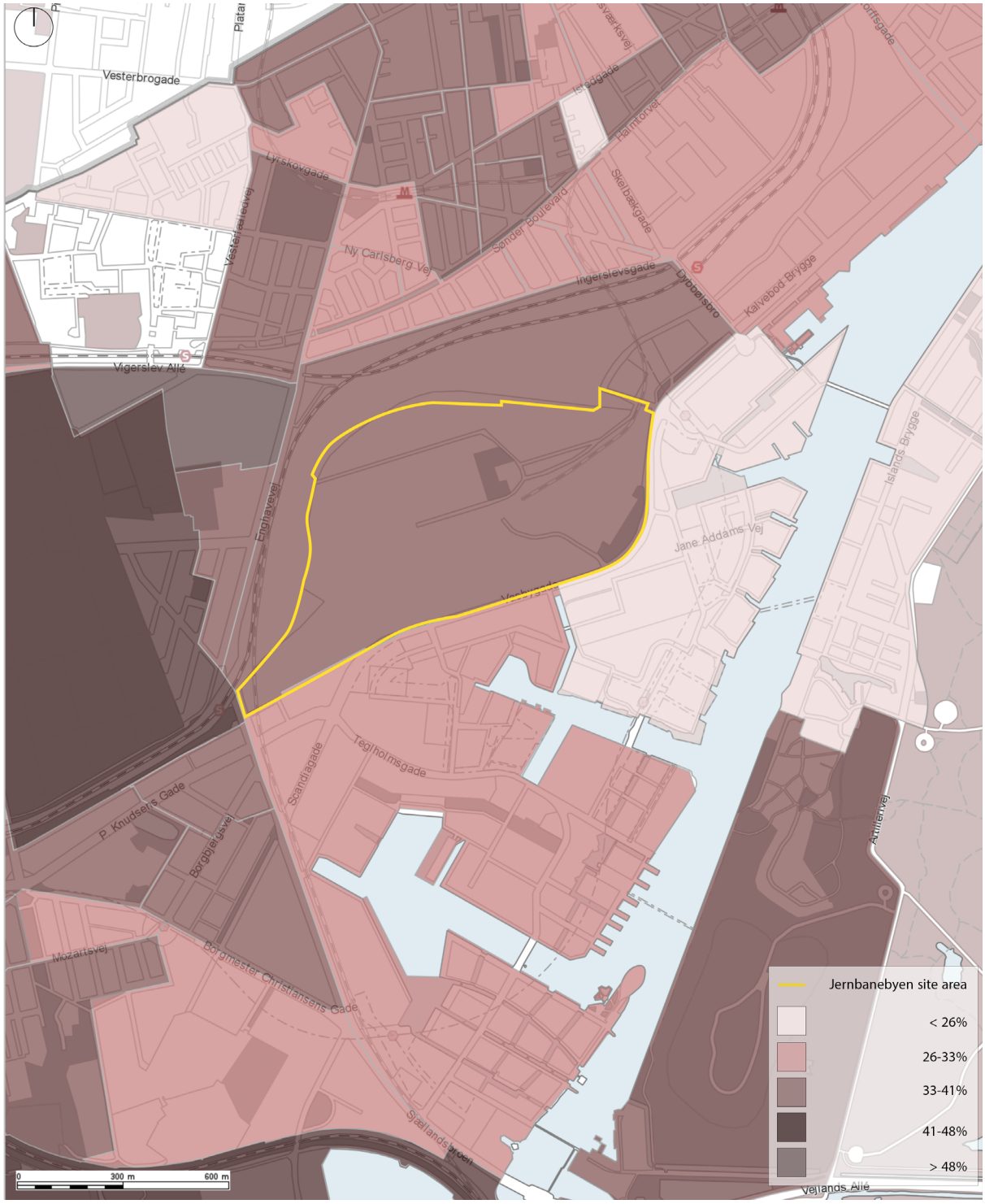


Figure 5.22 Household income rate of The Railway Town based on KP19

Source: The Municipality of Copenhagen Map

The area's household income indicates that between 33-41% of the residents are classified as low-income people, with a maximum of DKK 162,000 per year. Compared to the surrounding areas, the rate is relatively low, so the proposal should provide jobs with housing to promote this rate.

5.3.1.6 Unemployment

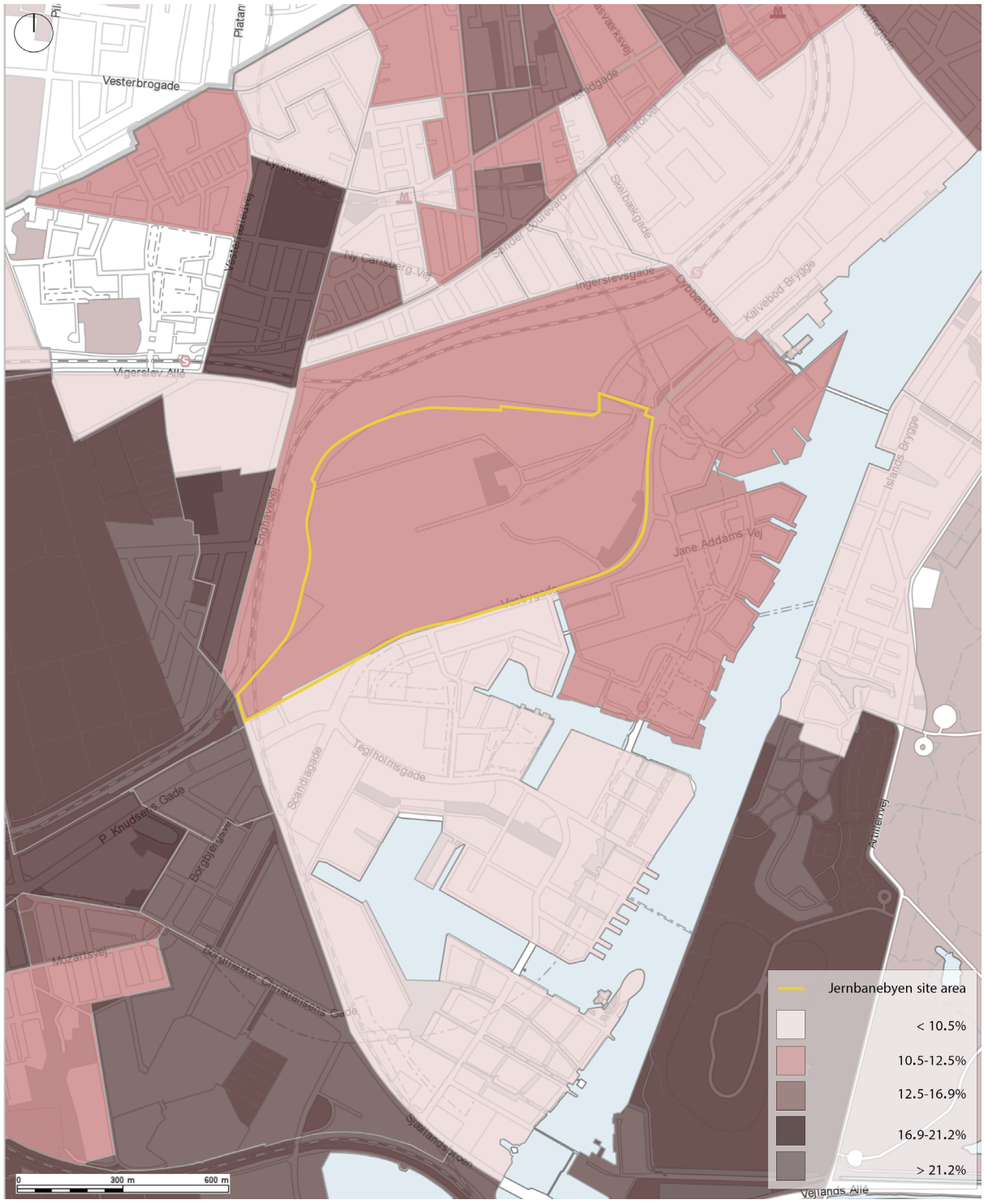


Figure 5.23 The unemployment of The Railway Town based on KP19

Source: The Municipality of Copenhagen Map

In The Railway Town, the percentage of permanently unemployed people ranges between 10% and 12%. It is considered an acceptable rate when compared to the surrounding areas.

5.3.1.7 No-Education Rate

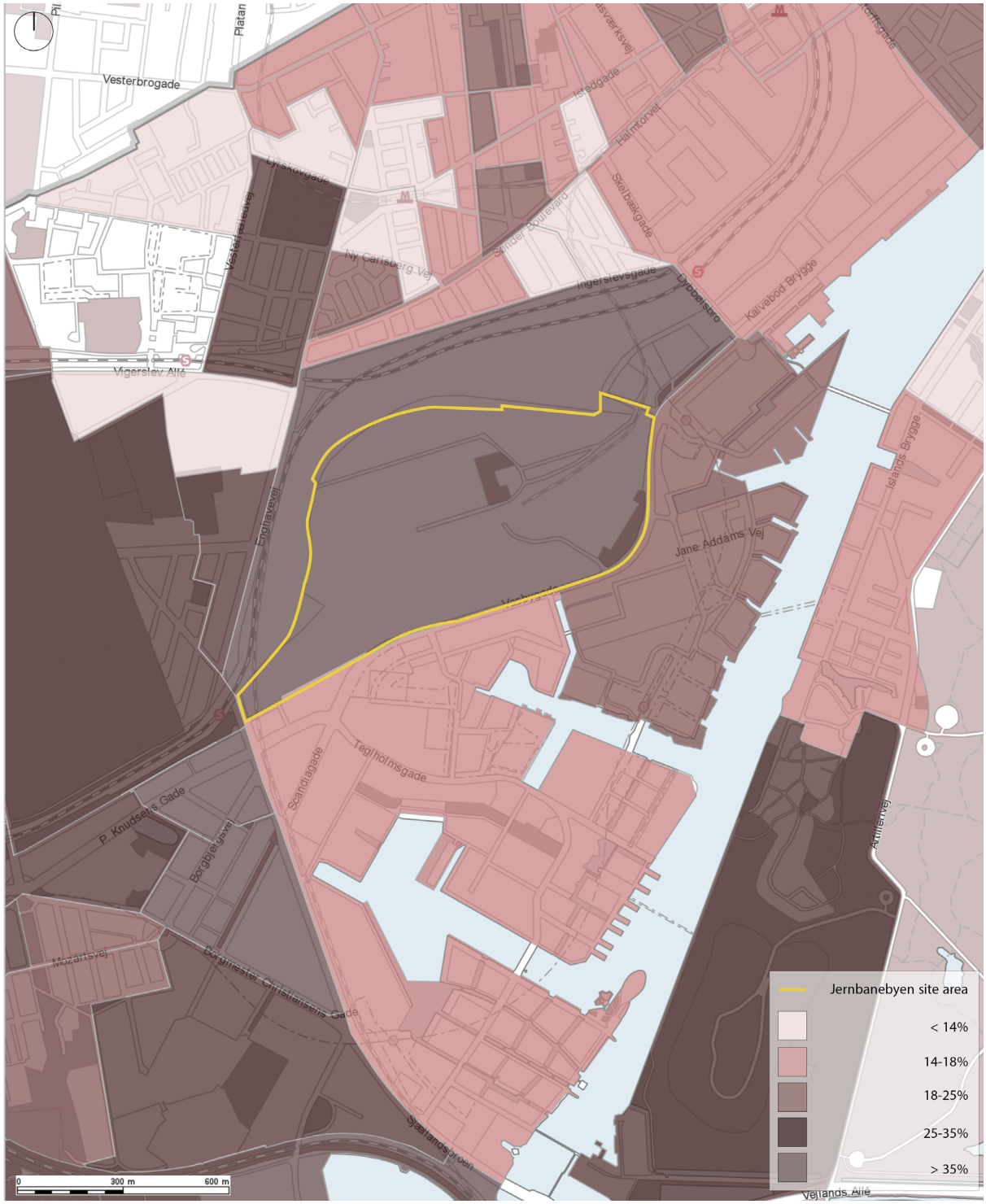


Figure 5.24 No-education rate of The Railway Town based on KP19

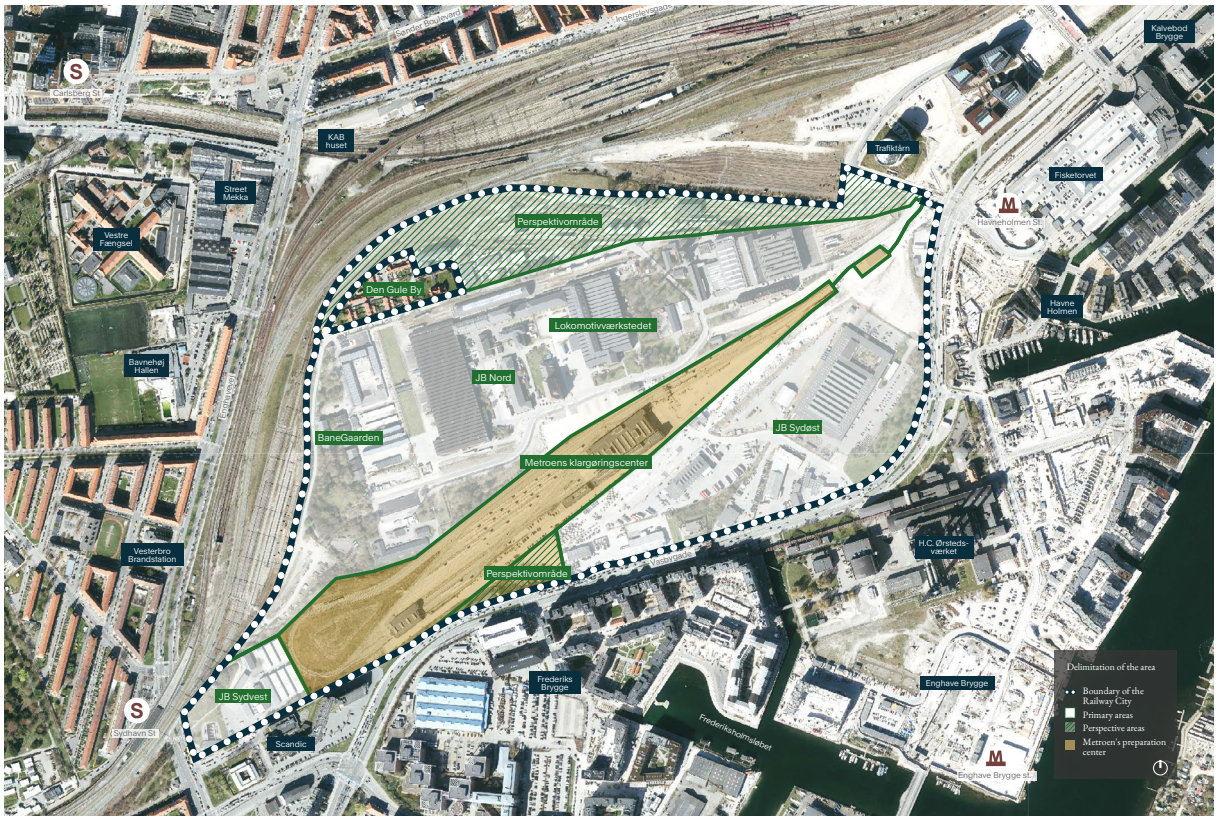
Source: The Municipality of Copenhagen Map

The education rate of the site project illustrates that more than 35 percent of the people either have primary school as the highest completed education or no education at all. By comparing all the socio-economic data of the area, it could be concluded that it is mostly inhabited by workers with low education and an average income. Another assumption could be that the area is less populated, which harms the socio-economic data.

5.3.1.8 Urban Policies and Demands

The development proposal of The Railway Town corresponding to the local plan 433 was on a competition basis held by landowners, namely Freja Ejendomme A/S and DSB Ejendomsudvikling A/S, on November 2020 between five interdisciplinary teams so that on April 2021 the proposal from Cobe architects was the winner. The developers plan to finalise comprehensive and local plans within 2022/2023 so that the construction expected to initiate in 2024. The competition was a parallel assignment, carried out as a dialogue-based process with a start-up seminar, inspections of the competition area and two workshops with the participation of the five teams, as well as the assessment committee consisting of representatives of the two landowners, the Municipality of Copenhagen, professional judges and advisers (COWI and Grandville). The proposal is at the masterplan level and is the development of a 365,000 m^2 area, exclusive of the metro company's preparation plant (CMC). The neighbourhood between the Railway City and the surrounding districts is significant for different activities inside it. Shop life, cafés, sports and association life, etc. in the neighbouring districts which are important targets for new residents in the Railway City and, conversely, new activities in the Railway City will attract visitors and users from the neighbouring districts. In general, stakeholders' ambitions categorised as the following five principles:

1. To build on the Railway City's special culture, edge and creative powers;
2. To create a green and urban district in the middle of Copenhagen;
3. To develop the Railway City in a balance between city life and active communities and



Source: jernbanebyen.dk Figure 5.25 The delimitation of The Railway Town

Note: The delimitation of the site shows that the majority of the area is considered for the primary area of development and the share of northern parts of the perspective areas later was owned to BaneDanmark and southern perspective area to CMC.

quiet everyday life;

4. To develop a district based on climate-friendly and sustainable principles;
5. To develop the Railway City together with the people of Copenhagen and together with

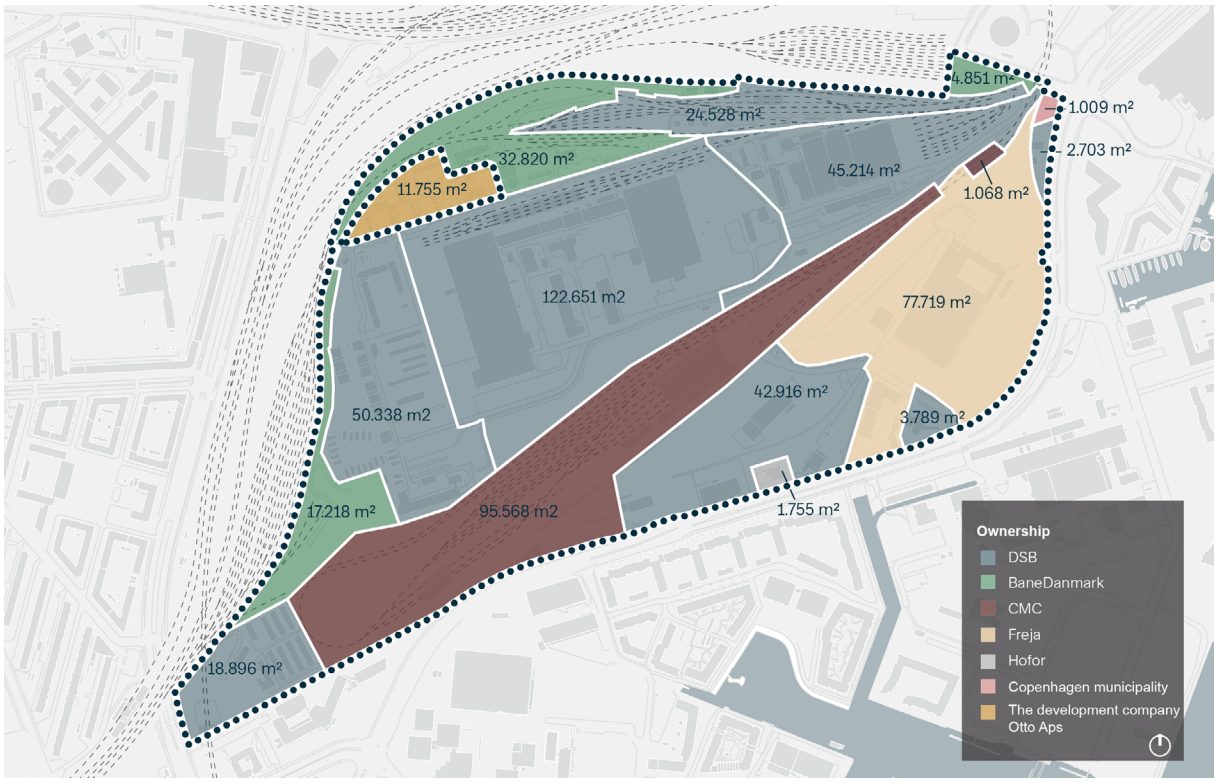


Figure 5.26 The ownership of The Railway Town

Source: Program for parallel tasks on urban development in Jernbanebyen, p. 61, by Freja Ejendomme *et al*. (2020)

Note: The area is owned by DSB and Freja Ejendomme A/S and BaneDanmark. Smaller sub-areas are owned by Metroselskabet and Copenhagen Municipality.

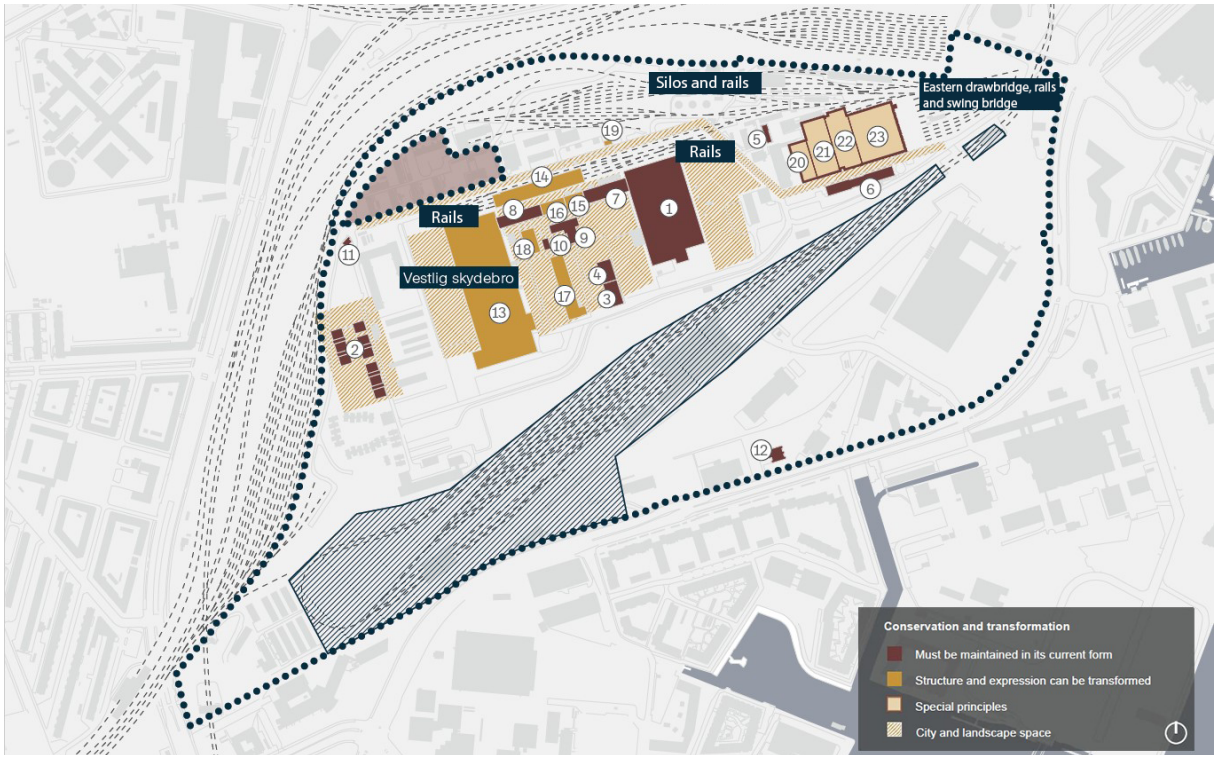


Figure 5.27 The preserve-worthy buildings list in The Railway Town according to SAVE

Source: Program for parallel tasks on urban development in Jernbanebyen, p. 23, by Freja Ejendomme *et al*. (2020)

Table 5.4 List of buildings to be conserved at The Railway Town

	Name	Origin	Area (m^2)	SAVE Value	Comment
1	The locomotive workshop	1907	10,237	3	The most identity-giving and characteristic building
2	Træladerne/BaneGaarden	1915	3,600	3	The wooden characteristic building can be offered for small shops, and businesses, etc.
3	The main warehouse	1940	3,159	5	The current function of offices and showrooms will remain
4	Jernmagasinet	1909	1,124	3	The current function of offices and showrooms will remain
5	The water tower	1903	267	2	The current function of offices expected to be transformed
6	The administration building	1908	2,374	3	The current function of offices expected to be transformed
7	The boiler shop	1907	1,052	3	Architecturally valuable building, new functions expected to be transformed
8	The electrical and saddle maker's workshop	1910	1,842	3	Well maintained building expected to be transformed for new functions
9	Boiler and engine house	1908	949	3	Workshops and boiler houses expected to be transformed for new functions
10	Warehouse	-	154	3	Iron work warehouse expected to be transformed
11	The porter's house	1909	80	3	The abandoned building expected to be transformed.
12	Technical facility at Vasbygade	-	-	4	The current function is expected to be preserved

Table 5.5 List of transformable buildings at The Railway Town

	Name	Origin	Area (m^2)	SAVE Value	Comment
13	The carriage workshop	1910	15,273	4	Culturally important building can undergo significant transformation
14	Lyntogsløftehallen	1933	2,155	4	The operating building can be transformed for new purposes
15	Gl. Refrigeration workshop	1924	714	4	The building is an extension of another building for trains service
16	Electrical workshop	1949	1,512	5	Repair service of trains
17	Blanket warehouse	1907	2,118	4	The operating building can be transformed for new purposes
18	Compressed air workshop	1933	2,374	4	The operating workshops can be transformed for new purposes
19	The track master's office	1930	51	-	The wooden structure building could be preserved and transformed
20 - 23	Workshop Inspection hall Drawbridge hall New locomotive workshop	1958 1958 1903 1982	1,306 2,379 2,259 4,476	5 5 2 5	Eastern complex

Source: Produced by the thesis author on the basis of the data collected from Program for parallel tasks on urban development in Jernbanebyen, by Freja Ejendomme *et al*. (2020)

passionate people and investors with a long-term perspective.

The landowners in collaboration with the municipality also reached an agreement in which they have defined the list of preserve-worthy buildings according to the SAVE[1] method. Such buildings may not be demolished and can be transformed into new purposes.

When speaking of the management of the Railway Town and institutional organisation for development, it is worth reminding the Ørestad development experience to take advantage of lessons. As reviewed in the study by Majoor (2015), while such large-scale projects is a necessity for UR, public and private investment should be properly managed in the development to avoid organisational tensions. Although these consequences are observed through the time, this should not be neglected that organisational changes should be managed primarily at four levels, including unifying smaller inclusive organisations, clear individual and organisational assignments, flexibility to possible alternative changes, and considering external parameters affecting the whole management process.

As it is indicated in the preserve-worthy list of buildings, the majority of edifices are recommended to transform their functions or be preserved. The SAVE value also shows that the lower grade buildings get, the older they are which means that they are less flexible to be intervened or demolished.

In addition, the landlords and municipalities in collaboration together have regulated regenerative policies of The Railway Town by which the municipality and landowners' way of thinking for the UR could be assessed. In the following there are some of the regulations summarised in subtitles. It should be noted that environmental and other observations, due to be off the thesis theme, are excluded and did not mention in this report.

Built-up area: Since there will be activity in DSB's workshops until 2025, the southern part of the Railway City will be the first stage to be developed. The proposal must also plan for a built-up percentage of 175% on each of the landowners' areas in the southern part and 100% in the northern part of the Railway City.

Urban green area: According to KP19, the area is decided to be as a beacon focusing on the green when new urban areas are developed. Therefore, green urban environment is of a high priority for the municipality and clients. A coherent green structure must be established with a public park, green urban spaces and green publicly accessible private open spaces for housing in the order of 9-12 hectares.

Car-free district: The landowners are also interested in possibilities of creating a partially car-free district. A balanced condition must be achieved between pacified areas of the Railway City for car

1 Survey of Architectural Values in the Environment. An index of preservation where buildings are graded from 1 (strictest grade) to 9

traffic, while at the same time there is good accessibility to housing, workplaces and public functions in the district. The comprehensive plan can accommodate shared space areas with a high priority for cyclists and pedestrians. Car-free zones must be designated in the Railway City, in accordance to KP19 guidelines, in the efforts to create a CO2-neutral and less car-dependent city.

Parking: The public transport and accessibility of the proposal must be to the extent that the need for car parking would be lessened. The norm on one place per 320 m^2 floor area is calculated as an average of the municipal plan's parking standards for this type of urban area. In addition, double utilisation has been calculated, which results in a reduction of the need to 80% and thus a real norm of one per person each 320 m^2 floor area.

Activities: first it was crucial for the municipality to preserve and respect historically valuable buildings in the site. Then the development's vision would be linked to green urban space, rich outdoor life, where people meet for joint activities in the yard, while promoting cultural values in the district.

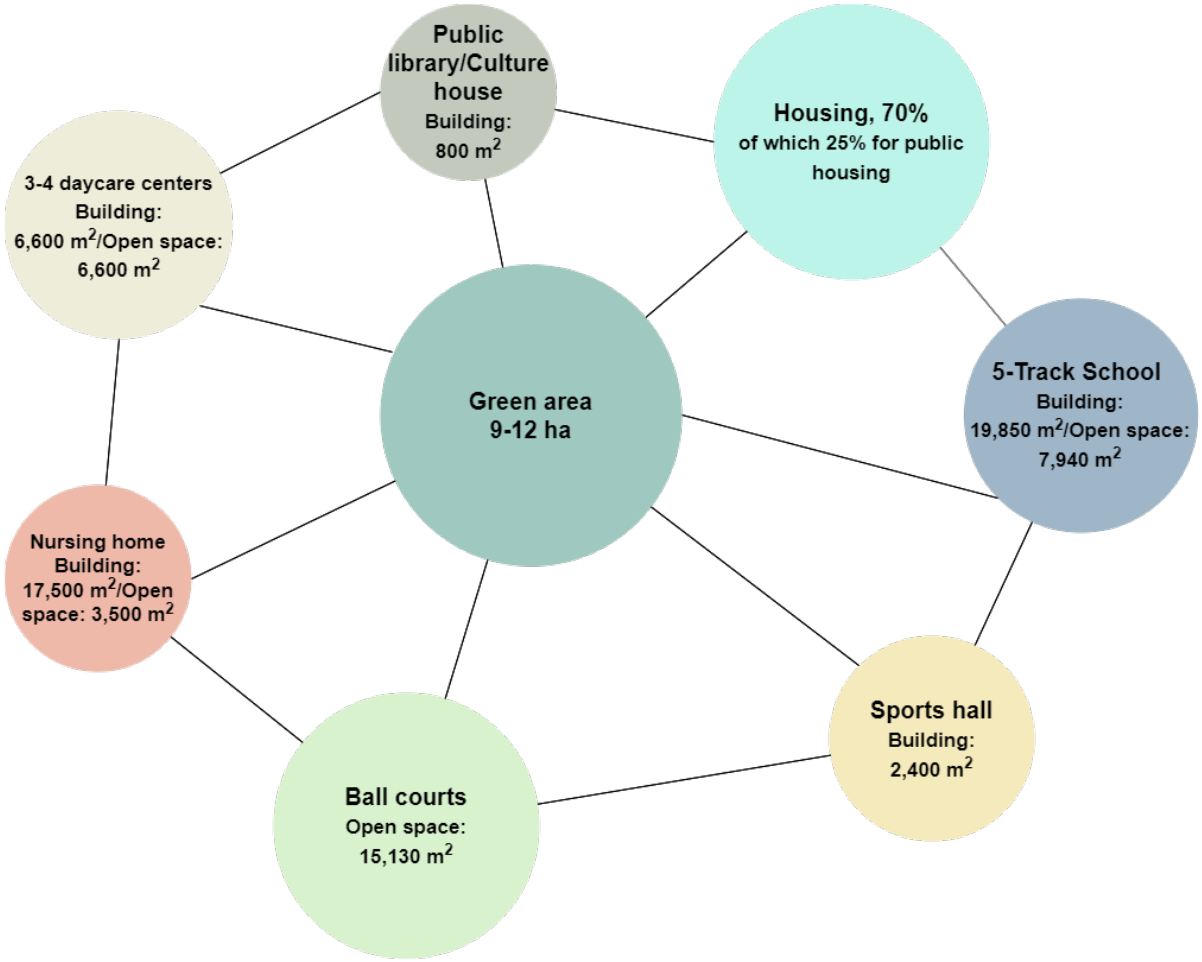


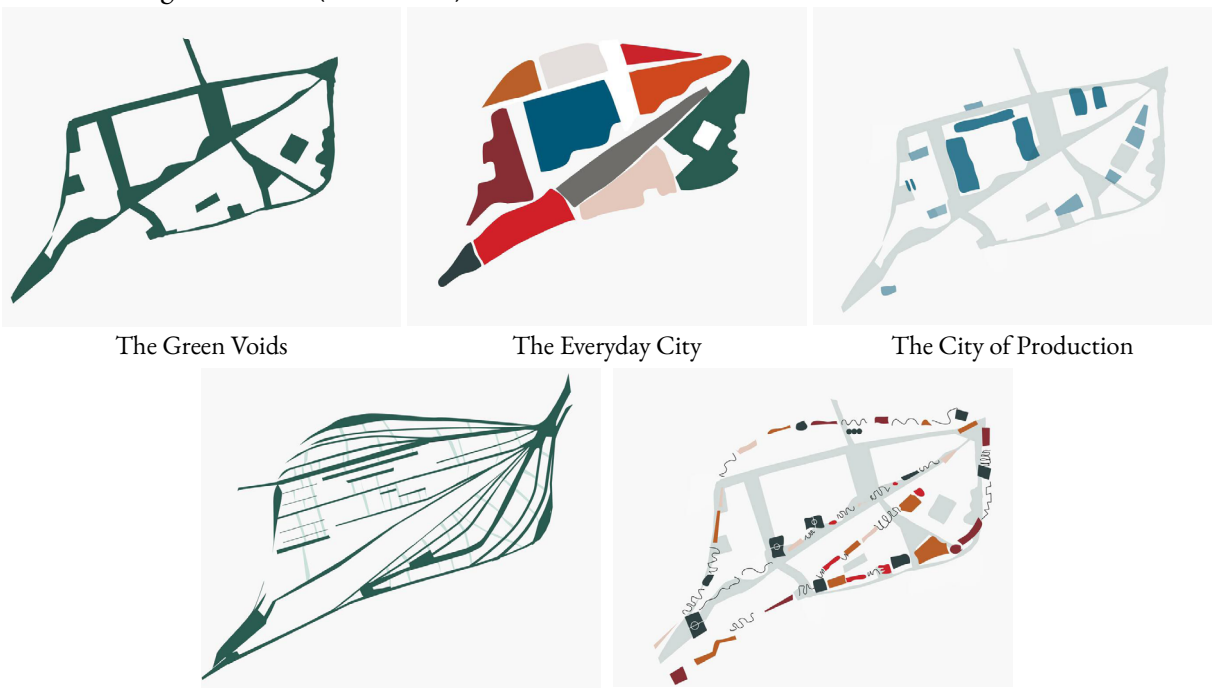
Figure 5.28 The programme of the proposal of The Railway Town

Source: Produced by the thesis author on the basis of the data collected from Program for parallel tasks on urban development in Jernbanebyen, by Freja Ejendomme *et al*. (2020)

The programme of the proposal is divided into two parts. The first one is a pre-defined by the municipality and landowners includes a 5-track school, a sports hall, library/cultural centre, 2 hectares of green area, a number of ball fields, 3-4 children's institutions, a youth environment and a nursing home. There is also a flexible opportunity for developer and architects to define other potential functions. However, landowners as the municipal planning framework needs 70% housing and 30% for the rest of the other functions, including business, public functions, retail, etc.; while also 25% of the total floor area of housing must be dedicated for public housing.

5.3.1.9 Final Urban Brownfield Regeneration Proposal

The final proposal produced by Cobe and accepted by the landowners and municipality is a producing town based on car-free structure. Products will be developed and sold out locally, while culturally valuable industrial heritage buildings will be transformed alongside urban green areas, housing, institutions, shops, and restaurants, and cultural complex, proposing a framework for a sustainable everyday life. Cobe claims that the The Railway Town development proposal offers 4,500 homes and workplaces for 8,000 people in a green district with more than 11 hectares of greenery and 8 hectares of green streets (Cobe, n.d.).



The Green Voids | The Everyday City | The City of Production

The Fabric | The Pearl Necklace

Source: Cobe

Figure 5.29 Redevelopment strategies in The Railway Town

Note: The redevelopment strategies by Cobe following the policies regulated by the landowners and the municipality.

The proposal is based on five strategies ensure the landlords and municipality requirements are met:

1. *Green voids*: A green urban network shaping the overall structure of the development
2. *The fabric*: Merging the landscape and fabric into the regeneration process.
3. *The pearl necklace*: Noise management design around the site.

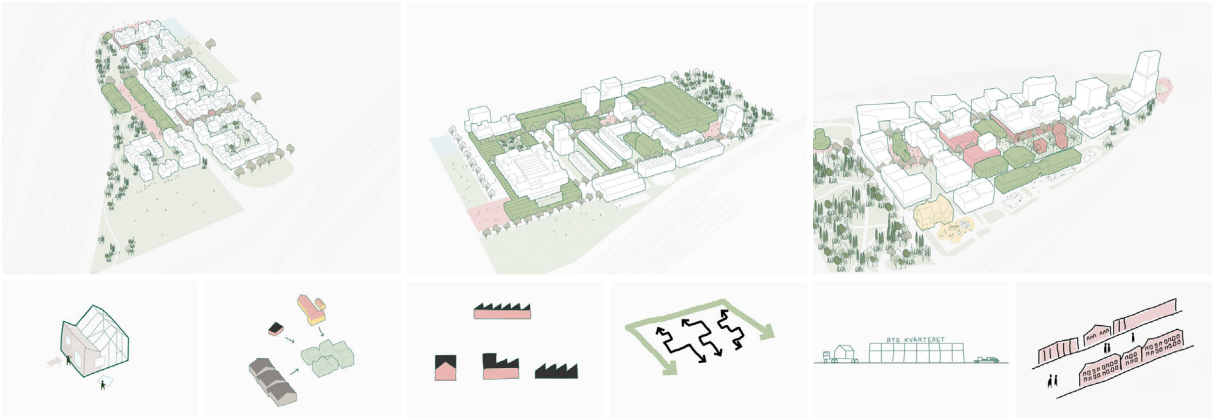
4. *The everyday city*: Subdivided urban quarters with their own characteristics and qualities
5. *The city of production*: The industrial heritage legacy is preserved and transformed (Cobe, n.d).

Urban green space was one of the crucial element for the regeneration process by Cobe. They proposed urban greenery as nature, divided into different categories, including Cultural Nature, Railway Nature, Local Nature, and Infra-Nature. In fact, translating nature in the different essence of context made it possible to achieve a highly respected environmental values, while promoting cultural values which has resulted into a unique identity of the district. On the other hand, creating different smaller neighbourhoods enabling to attract different types of residents to shape new communities. This also results in higher value of the redeveloped district for investors.

Source: Cobe

Figure 5.30 The illustration of revitalised redevelopment

Note: preserving culturally valuable elements of the district and transforming them results in a unique identity.



The Railway Station Neighbourhood | The Central Workshop Neighbourhood | The Production Neighbourhood

Figure 5.31 The effect of existing typology on the redevelopment proposal

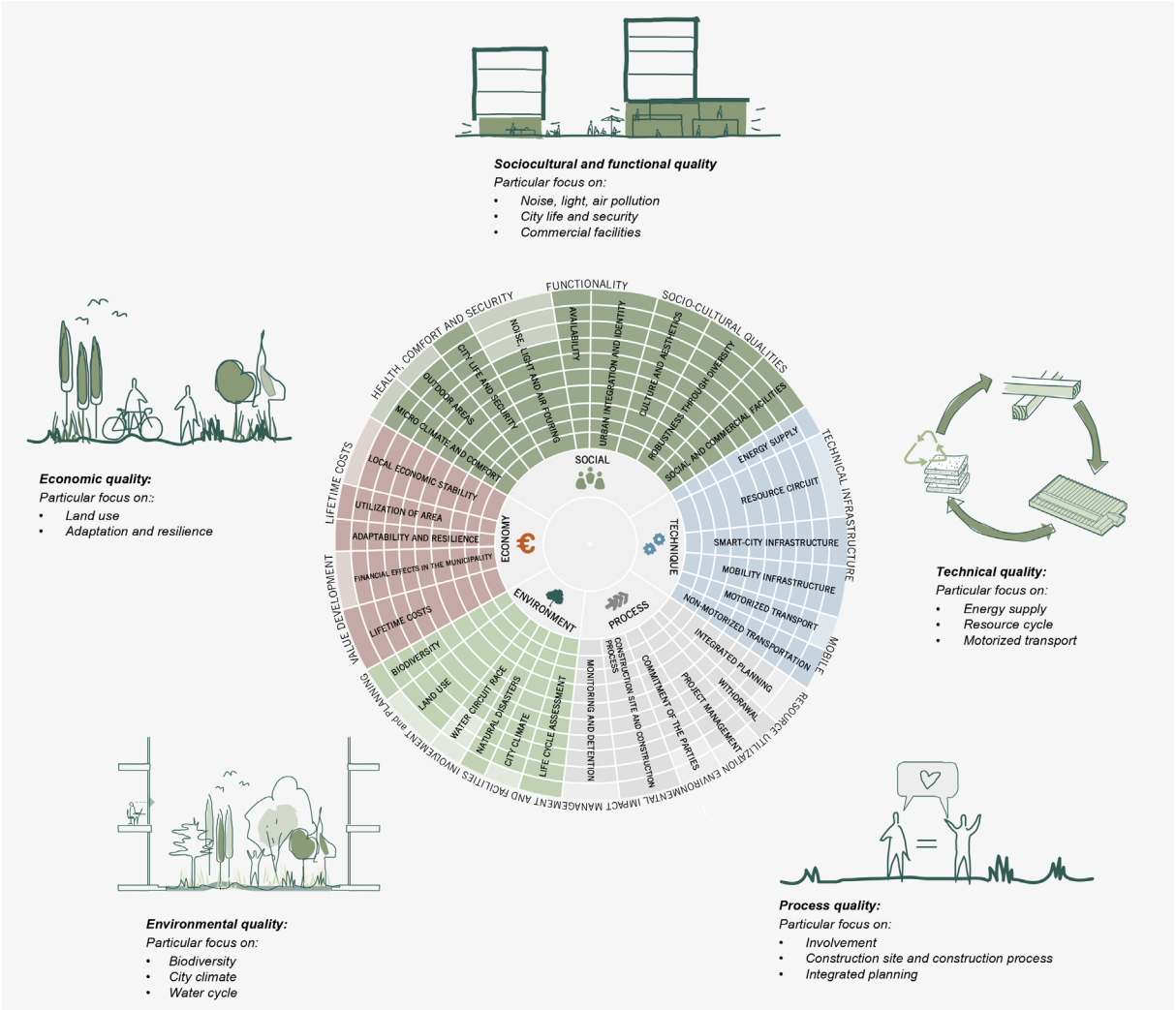
Source: Cobe

Note: Following the same typology of preserve-worthy buildings promotes cultural identity of the redevelopment.

The fact regarding the preserve-worthy buildings is that conservation is not limited to preserving physical areas, instead it is about the functional space. The illustrations of the regeneration process shows that a study of the typology in the industrial value of buildings was carried out from which the new fabric of the redevelopment emerges.

5.3.1.10 Evaluation

The title of "a sustainable district towards 2030" for the redevelopment of The Railway Town is followed by a few principles which are shown in the figure below. As mentioned earlier the project offers an economic cycle in which local economy is stabilised by the local resources utilisation and its effects on the financial adaptability and resilience. The model is flexible enough which not only considers the construction costs but also expected operating costs in different areas of the district, improving lifetime costs. This brings an economic equality which takes into account both present and future generation's needs (Cobe, 2021). The model in which workshops' needs and raw materials are recycled, produced, and utilised in the district illustrates a sustainable solution in which social, economic, and environmental values are promoted. While the framework is still at the conceptual level, this should be observed after the regeneration if the actual project will coincide with the framework.



Source: Cobe

Figure 5.32 The sustainable district in four ingredients

Note: proposing sustainable model framework in which different manners of equality in line with sustainable developments are followed.

In general, the key regenerative policies particularly affecting economic and social benefits in the regeneration introduced in the proposal could be concluded as follows:

• *Collaboration between the municipality and private sectors*: The Railway Town regeneration indicates how important the relation between the Copenhagen municipality as a public actor and DSB Ejendomsudvikling and Freja Ejendomme organisations as private actors could be to reach a robust agreement to invite well-known firms for the redevelopment under specified policies.

• *Providing a local economic resource model*: Existing workshop buildings, as worthy preservation, transformed into new production facilities feeding around creative businesses, reducing the needs for external resources of businesses.

• *Thematic smaller urban districts*: This enables the large-scale redevelopment to promote identity characteristics with its own features which, in turn, attracts more residents and investors into the area.

• *Translating "nature" into urban districts*: Increasing urban green density in the area helps achieve sustainable environmental goals.

• *Car-free structure*: Offering much more convenient possibilities for pedestrians and car-free means of transportation constitutes sustainable development footprints.

Source: Cobe Figure 5.33 The bird's-eyes view of the regenerated brownfield

Note: The element of green urban district becomes more clear at the urban level in the bird's eyes view.

5.3.2 Tunnelfabrikken (The Tunnel Factory)

Figure 5.34 The Location of The Tunnel Factory in Copenhagen

Source: Produced by the thesis author

Specific Information

Location: Østerbro, Nordhavn, Copenhagen

Function: The area was used for technical transport facilities and warehouses

Land lot area: 77,000 m^2

Regeneration floor area: 84,000 m^2

Municipality block: Local Plan 613, municipal plan supplement no. 11, Copenhagen

Stakeholder: CPH City and Port Development (By & Havn), NREP, and Unionkul Ejendomme

Requirements: private dormitory (housing), youth housing (cultural), and commercial up to 80,100 m^2. A car-free area, coherent connection for pedestrians and cyclists.

Source: Produced by the thesis author, adapted from Google Earth

Figure 5.35 The Tunnel Factory site area

5.3.2.1 Description

The giant building of 8,700 square meter, located in Nordhavn, was constructed as the warehouse for constructing the connection between Denmark and Sweden in the 1990s. Currently, it is used to store building materials (By & Havn). The hall is 261 meters long and up to 125 meters wide, and there are 24 meters to the ceiling. Thus, the old foundry hall is one of the largest factories in Denmark. Today, the hall is owned by By & Havn, which in partnership with NREP and UNIONUL will transform the hall into a huge cultural house where different activities and events such as cultural scenes, workplaces, restaurants, studio apartments, workshops, and facilities for games and sports take place (Unionkul, n.d.). The Tunnel Factory buildings and surroundings consist of 84,000 m^2 site situated in Nordhavn, Østerbro in Copenhagen. The project is part of the great redevelopment of Nordhavn.

Source: SDFE Skråfoto

Source: By og Havn

Figure 5.36 The aerial photos of The Tunnel Factory

Note: The Tunnel Factory and Airtrix Climbing & Trampoline Park with surroundings seen from south to north. Trampoline park, Crossfit as well as Padel Tennis and existing dockside businesses are located in buildings to the left of the Tunnel factory. Smaller trees are seen in the foreground and Øresund is seen in the background

5.3.2.2 Mobility

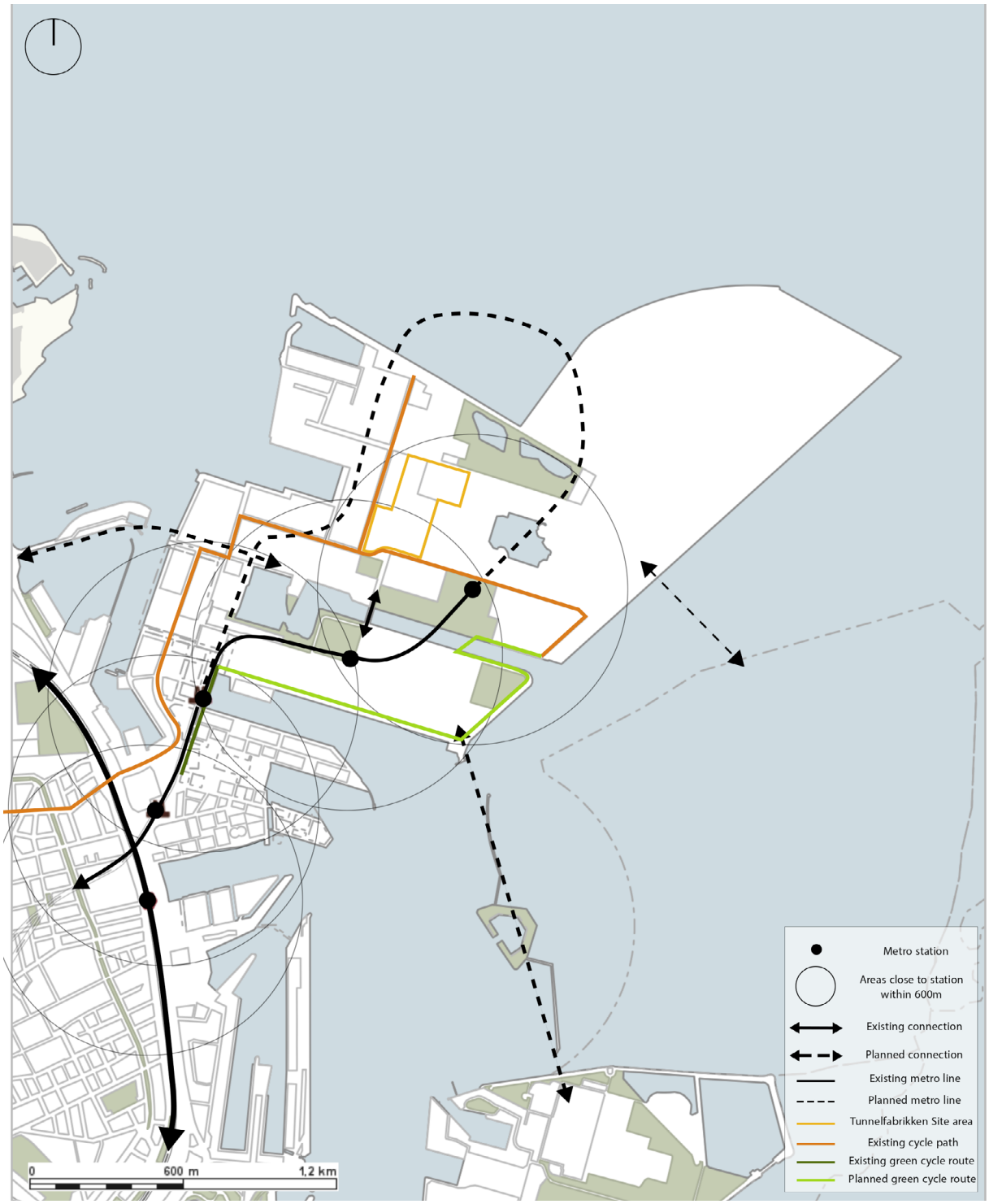


Figure 5.37 The mobility analysis of The Tunnel Factory

Source: Produced by the thesis author on the basis of data collected from The Municipality of Copenhagen Map

The Tunnel Factory, located in Nordhavn, is not considered as high-level accessibility as the Railway Town. It is a relatively new constructing area in which many routes and access lines are planned to be implemented. More importantly, accessibility to the surrounding islands is the aim of the municipality to achieve in the future.

5.3.2.3 Framework Areas KP19

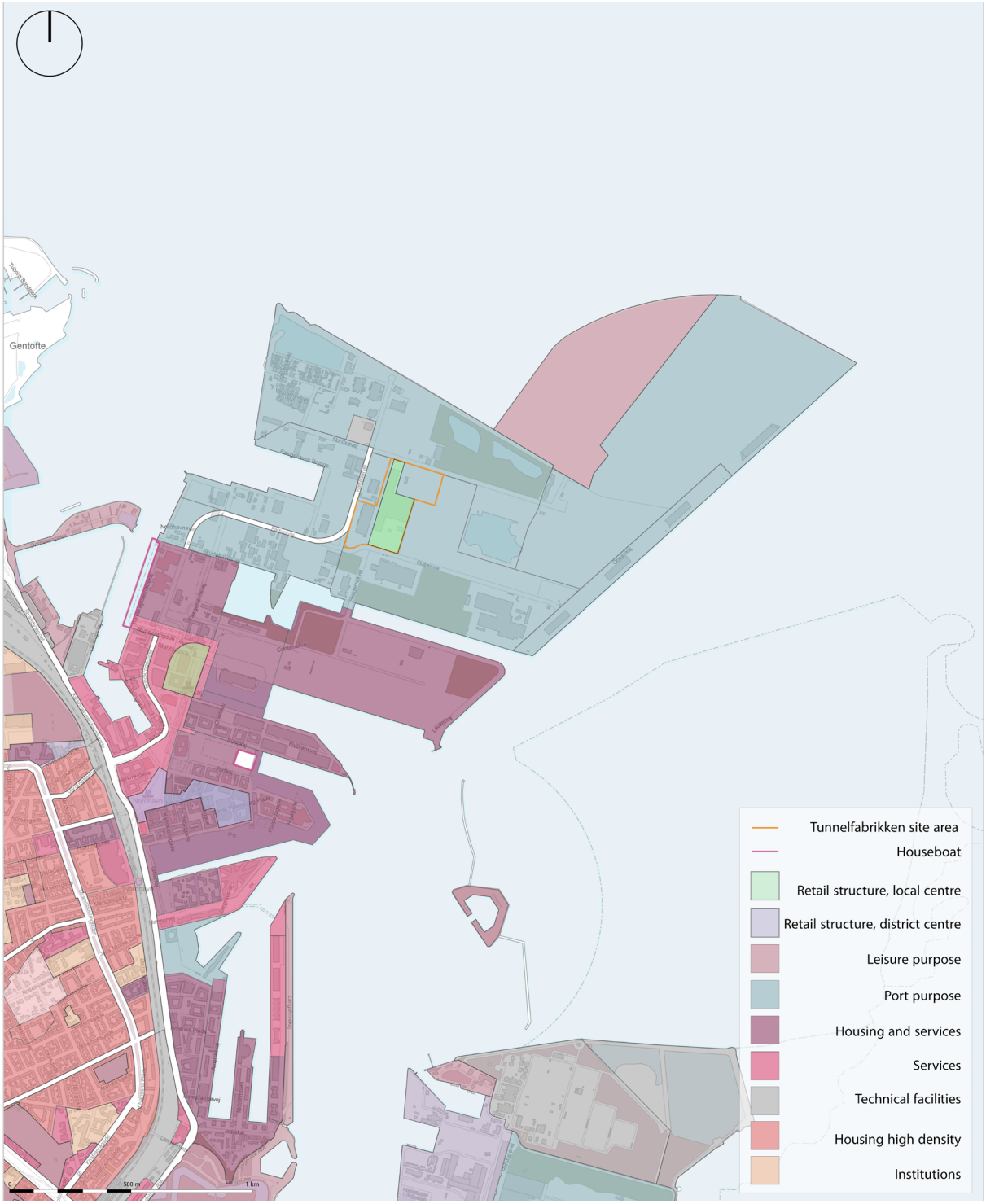


Figure 5.38 Framework areas of The Tunnel Factory based on KP19

Source: The Municipality of Copenhagen Map

The framework area of the site shows that almost all of the Nordhavn area is designated for port purposes. While in the retail structure development, The Tunnel Factory is suggested as the local centre of the district.

5.3.2.4 Preserve Worthy Buildings

Figure 5.39 Worthy-reserve buildings of The Tunnel Factory based on KP19

Source: The Municipality of Copenhagen Map

Although on the municipality's map, the conservation assessment of the area's buildings is considered without assessment, it seems that the main buildings on the site have not been taken into account yet. However, according to the observation, resources, and the municipality's ambitions, the site's main buildings constitute a high conservation value.

5.3.2.5 Urban Development Areas

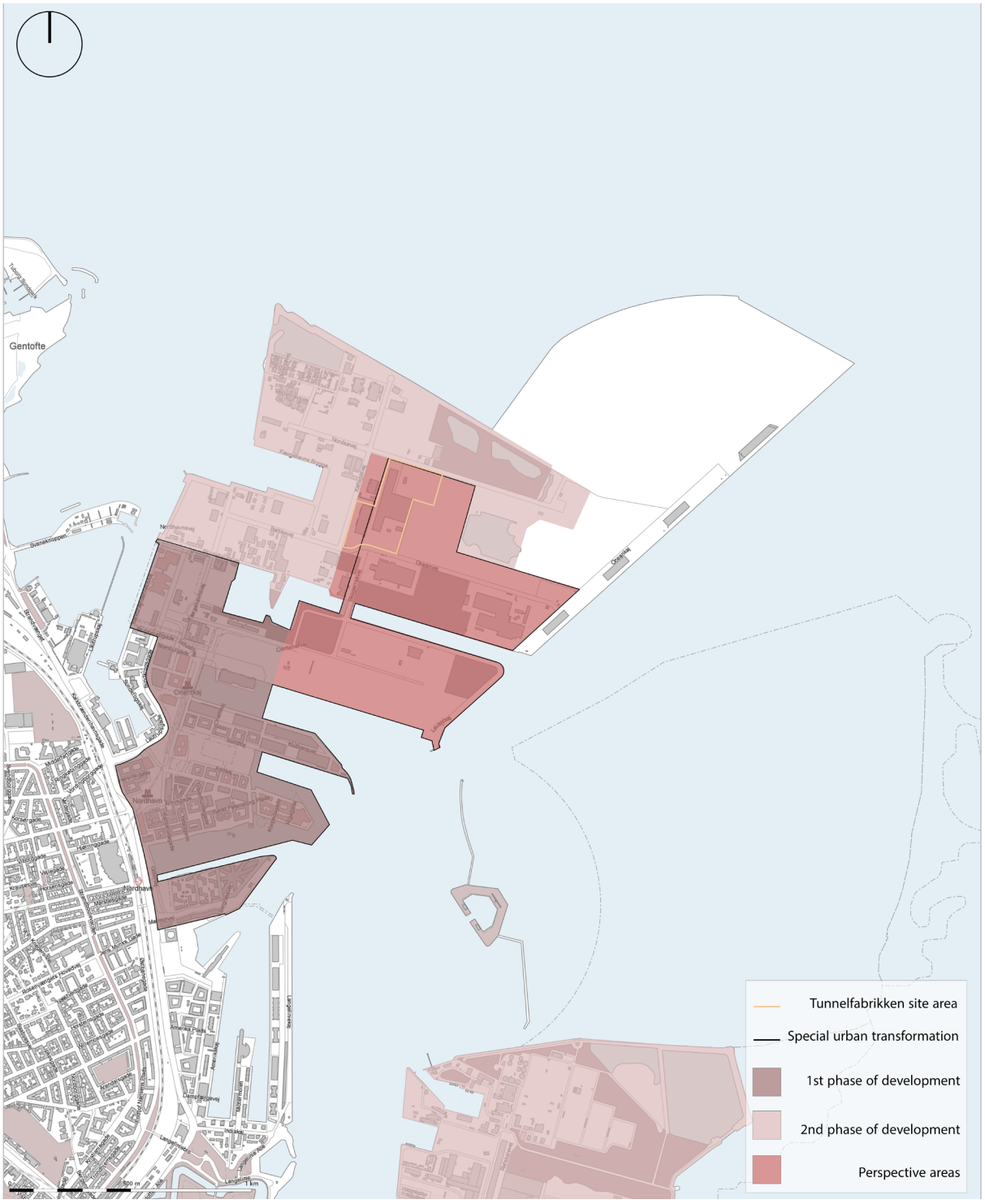


Figure 5.40 Urban development areas of The Tunnel Factory based on KP19

Source: The Municipality of Copenhagen Map

According to the UR areas in KP19, Nordhavn is a developing perspective area at least by the end of 2030. The Tunnel Factory is considered a particular urban transformation region, meaning the municipality aims to transform former industrial sites and harbours into a new urban fabric.

5.3.2.6 Proposal Overview

The development and expansion of The Tunnel Factory corresponding to the local plan 613 was agreed by the Citizens' Representation in the latest announcement of the municipality on May 5th, 2022. The redevelopment starts by cleaning up the site by moving container terminals to outer Nordhavn in mid 2023 and afterwards the construction initiates. The redevelopment will consist of the "Green Loop" extension in Nordhavn. Architecture firms of Arcgency and SLA prepared a proposal for the redevelopment of the area with 80,100 m^2 of housing (18,000 m^2 of which 4,500 m^2 is going to be assigned to a new building), business and cultural (59,100 m^2), and retail functions (3,000 m^2). The project was adapted based on the needs of By & Havn, NREP and Unionkul Ejendomme (The Citizens' Representation, 2022).

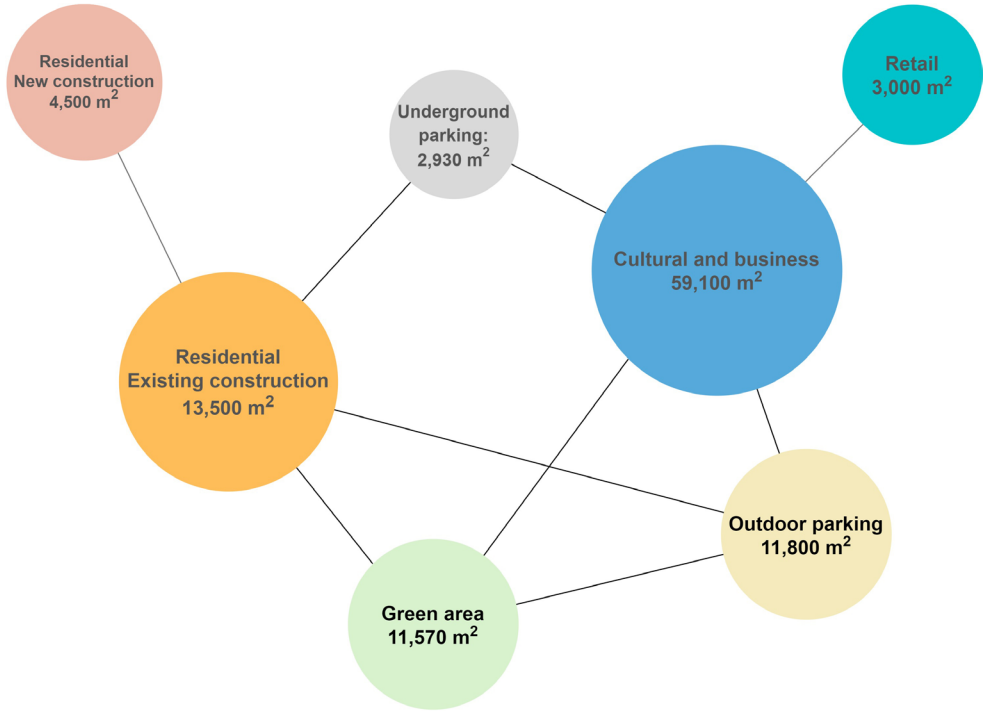


Figure 5.41 The architectural programming of the proposal

Source: Produced by the thesis author on the basis of data collected from TUNNELFABRIKKEN, LOKALPLAN 613, KOMMUNEPLANTILLÆG NR. 11 OG MILJØRAPPORT (2022)

The purpose of the local plan is to determine the planning basis for the transformation of the area and the existing tunnel factory into an area with service business, housing and culture, in continuation of the intentions in the Structure Plan for Nordhavn. The development of the Tunnel Factory is the first stage in the development of Ydre Nordhavn, and the purpose of the planning is thus to ensure that the Tunnel factory can support an active city life with good meeting places and suburban nature in the coming district (The Citizens' Representation, 2022).

In order to be able to realise the project, there is also a need for a supplement to KP19. The supplement provides the opportunity for shops as well as the possibility of a maximum height of 24 meter for new construction, including the public dormitory housing outside the Tunnel factory. In addition, the supplement enables some of the Tunnel Factory's intended facilities to be

established in new buildings outside the Tunnel Factory itself in a container academy southeast of the Tunnel Factory and in connection with the public dormitory housing, respectively (The Citizens' Representation, 2022).

Figure 5.42 The illustration of The Tunnel Factory proposal

Source: SLA and Arcgency

Note: The illustration indicating the Tunnel Factory as an example of UR in accordance with the structural planning. The buildings shown in the non-locally planned areas are preliminary examples of how urban structures and green areas can be placed in accordance with the Structural Plan for Nordhavn. Buildings A and C are proposed in existing constructions, whereas B and D represented as new buildings.

An overview of the proposal as shown in the figure below shows that existing buildings in the area are preserved and functions are transformed; meanwhile, three new buildings are to be added in the site.

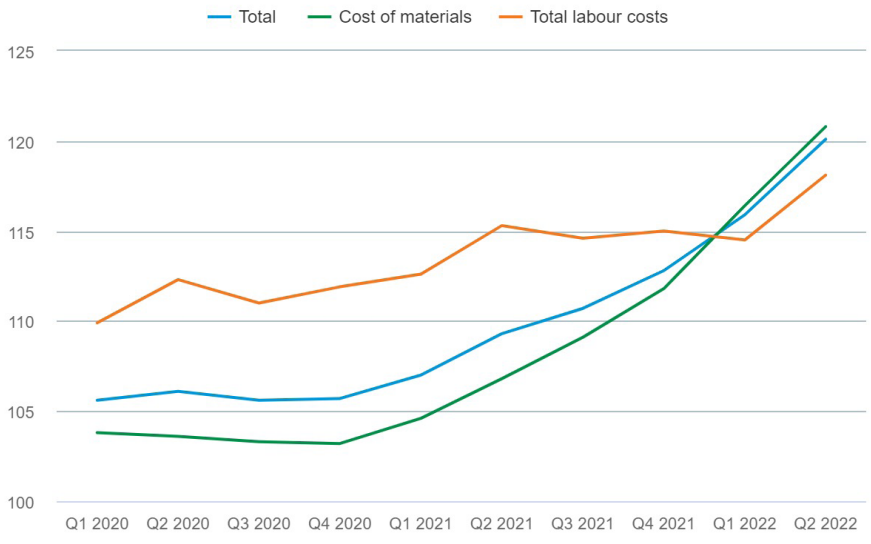
5.3.2.7 Economic Assessment
5.3.2.7.1 Economic Data

As mentioned earlier, to achieve economic valuation of the project two main resources were used. The first and foremost reliable resource was Statistics Denmark website from which some important parameters related to costs should be exported to apply for the calculation of construction costs. The other resource was a detailed construction cost of the case study Valby Maskinfabrik carried out by the students at Chopenhagen School of Design and Technology to understand the methodology and concepts of a real project in Copenhagen.

Basically, the methodology for calculating the construction cost is carried out in two steps in Denmark. Firstly, all materials and details are imported in EG Sigma software, through which it is possible to take advantage of different libraries for the calculation of construction costs. For buildings sector, chapter 8 of the Blue Book MOLIO database is used. Since using the software is complex and requires a detailed designed project, I used a typical construction cost per square meter and took advantage a real construction project whose cost already calculated.

Then after calculating general construction costs, there are different indicators to be multiplied with the construction cost to determine the definite number of costs in Denmark, such as TPI (Tender Price Index) value, regional variance, and contingency allowance. The sum and multiplication of these values define the actual construction costs. Needless to mention that these indices were adapted from a detailed construction cost project in Copenhagen (Statistics Denmark, 2022b).

Figure 5.43 Construction cost index for residential buildings (BYG42)



Source: Statistics Denmark, 2022a

Note: The index is categorised by total labour costs, cost of materials, and total. The value is defined compared to the base year (2015=100). The trend has been increasing within the last quarters.

TPI (Tender Price Index) is defined according to Index of Production in Construction (IPC). The main purpose of these statistics is to pinpoint the economic trends in the sector. The statistics are used for assessments of economic trends. The statistics is subdivided into different sectors, and in the basis of buildings it is named as "Construction cost index for residential buildings", where cost indices of materials and labours are defined every quarter. Based on Statistics Denmark, this index reflects the evolution of housing construction costs in Denmark. It is used, among other things, to regulate building contracts.

In order to apply TPI in the construction costs it is necessary to have the value of "Index cost difference". The index difference is acquired by the subtraction between the last two index costs quarters. Then the construction cost is multiplied with the index difference divided to the last quarter considered. Then the resulted value must be summed with the prior construction cost. Then the regional variance index is applied, which Copenhagen stands for 1.05. Finally, an index of the so-called "Contingency Allowance Construction" is applied to consider unforeseen or emergency expenses

A. PRELIMINARY PROJECT BUDGET USING FLOOR AREA COSTS				Date:	Oct.2022	
Price level					2022 Q2	
Project:						
				Site Area	77,000	
				Gross floor area 1.1	18,000	
				Gross floor area 1.2	59,100	
				Gross floor area 1.3	3,000	
				Total Gross Floor Area	80,100	
				Gross floor area 1.5		
				Underground Parking	11,763	
				Gross floor area 1.5		
				Demolition	5,660	
A1	**CONSTRUCTION COSTS**		Price(DKK)/m²		**DKK**	**EUR**
1.1	Residential		11,056		199,008,000	26,667,072
1.2	Cultural		10,104		597,146,400	80,017,618
1.3	Commercial		9,540		28,620,000	3,835,080
1.4	Underground Parking		7,200		84,693,600	11,348,942
1.5	Demolition		450	key figure	2,547,000	341,298
	Construction Costs V&S 2022				**909,468,000**	**121,868,712**
	Construction Costs adjusted with Tender Price Index (TPI)				**942,425,425**	**126,285,007**
	Construction Costs adjusted with TPI and Regional Variance 1.05 (Copenhagen area)				**989,546,697**	**132,599,257**
Construction Cost by TPI						
Index cost 2022 Q2 TPI2		120.1				
Index cost 2022 Q2 TPI1		115.9				
Index difference		4.2				
Index cost difference		32,957,425				
Adjusted cost by TPI		942,425,425				
Contingency Allowance Construction	20%				197,909,339	26,519,851
Total					**1,190,003,036 kr.**	**159,460,407 €**

Table 5.6 Construction costs

Source: Produced by the thesis author

Note: construction cost per m², assumed based on the similar case study BR (Valby Maskinfabrik), considering the growing costs trend.

A2.	**DESIGN FEES, SITE AND PLOT RELATED COSTS**				
2.1	5% Architectural Design of M12 incl Admin costs		49,477,335		
2.2	1% Architectural Technologist and Land Surveyor		9,895,467		
2.3	4% Engineering Design of M12 incl Admin cost		39,581,868		
2.4	11% Preliminaries (Site Ovh All.= 7% & Spec Weather Allowance = 4%) of M12		108,850,137		
2.5	4.5% Landscaping		44,529,601		
2.6	1% Plot Development		9,895,467		
2.7	3% External utilities		29,686,401		
2.8	- Land Purchase (Ex: 6500 DKK/m2 for land costs)	6500	500,500,000		
3.9	15% Contingency Design 15% (2.1, 2.2, 2.3)		14,843,200		
DESIGN FEES, SITE AND PLOT RELATED COSTS				807,259,476 kr.	108,172,770 €

PRELIM. PROJECT BUDGET EXCL VAT		**1,997,262,512 kr.**	**267,633,177 €**
PRELIM. PROJECT BUDGET INCL. VAT 25%		**2,496,578,140 kr.**	**334,541,471 €**
	M2 price Excl VAT	**24,935 kr.**	**3,341 €**
	M2 price Incl. VAT	**31,168 kr.**	**4,177 €**

Table 5.7 Other fees

Source: Produced by the thesis author

Note: Other fees usually are considered as a specific percentage of the construction cost which was already acquired. The whole design fee in Denmark is considered as 10% against the construction costs.

which is 20% of the construction cost. The sum of all values result in the total construction costs, as shown in the table below. There are also other fees must be taken into account and be summed up with the construction costs such as design, preliminaries, landscaping, plot development, external utilities, land value, and design contingency. In the end, a VAT of 25% has to be applied to the value to obtain the final amount of construction costs.

B2. DESIGN				Cost:	98,954,670 kr.	13,259,926 €
Design Fees agreed			10.00%			
Average design fee per hour			950 per hour			
Average chargeable hours per man per day			7.4 hours			
Average personnel involved in the design			30 persons			
Inaccuracy at the concept level			approx. Plus/minus 20%			
DESIGN DURATION				469	DAYS	
DESIGN DURATION WITH CONTINGENCY 15%				540		
1 year ~ 250 working days ~	**2.16**	**2 years / 1 months**	including contingency			
B3. LANDSCAPE				Cost:	44,529,601 kr.	5,966,967 €
Estimated share of labour content			300 2000			
Average Worker wages per hour			350 per hour			
Standard working hours per day			7.4 hours			
Average manning throughout construction			20 Avg. Manning			
DESIGN DURATION				129	DAYS	
DESIGN DURATION WITH CONTINGENCY 15%				148		
1 year ~ 250 working days ~	**0.59**	**0 years / 7 months**	including contingency			

C. DISTRIBUTION OF DESIGN FEES AND DESIGN TIME IN THE STAGES*				
		Days	Cost (DKK)	Cost (EUR)
Otline Proposal	25%	135	24,738,667	3,314,981
Project Proposal	30%	162	29,686,401	3,977,978
Regulative Project	15%	81	14,843,200	1,988,989
Main Project	20%	107.9	19,790,934	2,651,985
Follow up	10%	54	9,895,467	1,325,993

Table 5.9 Design and other fees and duration

Source: Produced by the thesis author

Note: The simulation of a possible distribution of design time in the project stages - based on key figures from ordinary projects - the design cost values here being agreed on construction cost.

The project construction period is calculated based on the estimation of labours and average manning throughout construction. The estimated share of labour content is like a ratio applied to the total construction cost, while the increased average manning during construction meaning the construction time-frame becomes more tightened in the optimistic scenario. These data are considered as important information for the next step of Discounted Cash Flow (DCF) analysis to distribute the amount of work within the time-line (Semesters).

B. PROJECT DURATION ESTIMATE						
B1.CONSTRUCTION				Cost:	1,190,003,036 kr.	159,460,407 €
Estimated share of labour content			400 1000			
Average Worker wages per hour			420 per hour			
Standard working hours per day			7.4 hours			
Average manning throughout constructuion			240 Avg. Manning			
Inaccuracy at the concept level			approx. Plus/minus 20%			
				Days	Semesters	
CONSTRUCTION DURATION				638	7	
CONSTRUCTION DURATION WITH CONTINGENCY 20%				766	9	
1 year ~ 250 working days ~	**3.06**	**3 years / 0 months**	including contingency			

B. PROJECT DURATION ESTIMATE						
B1.CONSTRUCTION				Cost:	1,190,003,036 kr.	159,460,407 €
Estimated share of labour content			400 1000			
Average Worker wages per hour			420 per hour			
Standard working hours per day			7.4 hours			
Average manning throughout constructuion			160 Avg. Manning			
Inaccuracy at the concept level			approx. Plus/minus 20%			
				Days	Semesters	
CONSTRUCTION DURATION				957	11	
CONSTRUCTION DURATION WITH CONTINGENCY 20%				1149	13	
1 year ~ 250 working days ~	**4.59**	**4 years / 7 months**	including contingency			

Table 5.8 Construction duration, an optimistic view (up), a pessimistic view (down)

Source: Produced by the thesis author on the basis of data collected from *denmark.workingdays.org*

Note: The project duration is substantial to distribute work and construction cost in the next step of DCF analysis. The average manning during construction is varied in both optimistic and pessimistic scenarios.

5.3.2.7.2 DCF Model, Construction and Selling

COSTS:		quantity	unit cost	Total [DKK]	%	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	
						0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Land acquisition	m^2 (gfa)	77,000	6500	500,500,000	25.5	0	500,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500,500,000
						0%	25%	75%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Architectural Design, incl Admin costs		5%	against	45,525,755	2.3																		0
Architectural Technologist and Land Surveyor		1%	construction	9,105,151	0.5																		0
Engineering Design, incl Admin cost		4%	costs	36,420,604	1.9																		0
Contingency Design		15%	against design costs	13,657,726	0.7																		0
Total Design Costs				104,709,236	5.3	0	26,177,309	78,531,927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104,709,236
Total			*81,098,038 €*	**605,209,236**	**30.8**	**0**	**526,677,309**	**78,531,927**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**605,209,236**
CONSTRUCTION COSTS.																							
						0%	0%	0%	10%	10%	10%	10%	10%	10%	10%	15%	15%	0%	0%	0%	0%	0%	100%
1.1 Residential - Existing building	m^2	13,500	10,890	147,015,000	7.5	0	0	0	14,701,500	14,701,500	14,701,500	14,701,500	14,701,500	14,701,500	14,701,500	22,052,250	22,052,250	0	0	0	0	0	147,015,000
1.2 Cultural - Existing building	m^2	5,700	9,960	56,772,000	2.9	0	0	0	5,677,200	5,677,200	5,677,200	5,677,200	5,677,200	5,677,200	5,677,200	8,515,800	8,515,800	0	0	0	0	0	56,772,000
1.3 Retail - Existing building	m^2	1,500	9,420	14,130,000	0.7	0	0	0	1,413,000	1,413,000	1,413,000	1,413,000	1,413,000	1,413,000	1,413,000	2,119,500	2,119,500	0	0	0	0	0	14,130,000
						0%	0%	0%	0%	10%	10%	10%	20%	10%	10%	15%	15%	0%	0%	0%	0%	0%	100%
1.4 Cultural - Existing building	m^2	53,400	9,960	531,864,000	27.0	0	0	0	0	53,186,400	53,186,400	53,186,400	106,372,800	53,186,400	53,186,400	79,779,600	79,779,600	0	0	0	0	0	531,864,000
						0%	0%	0%	0%	0%	15%	15%	15%	15%	20%	20%	0%	0%	0%	0%	0%	0%	100%
2.1 Residential - New building	m^2	4,500	11,350	51,075,000	2.6	0	0	0	0	0	7,661,250	7,661,250	7,661,250	7,661,250	10,215,000	10,215,000	0	0	0	0	0	0	51,075,000
2.2 Retail - New building	m^2	1,500	9,920	14,880,000	0.8	0	0	0	0	0	2,232,000	2,232,000	2,232,000	2,232,000	2,976,000	2,976,000	0	0	0	0	0	0	14,880,000
						0%	0%	0%	0%	0%	0%	20%	20%	20%	20%	20%	0%	0%	0%	0%	0%	0%	100%
Underground parking	m^2	2,930	7,200	21,096,000	1.1	0	0	0	0	0	0	4,219,200	4,219,200	4,219,200	4,219,200	4,219,200	0	0	0	0	0	0	21,096,000
																							0%
Construction Costs adjusted with Tender Price Index (TPI)				30,325,232		0	0	0	789,691	2,717,067	3,075,580	3,228,475	5,155,852	3,228,475	3,347,980	4,706,513	4,075,600	0	0	0	0	0	30,325,232
Construction Costs adjusted with TPI and Regional Variance 1.05 (Copenhagen area)		1.05	against former summed costs	**910,515,094**		0	0	0	23,710,460	81,579,925	92,344,276	96,934,977	154,804,442	96,934,977	100,523,094	141,313,056	122,369,887	0	0	0	0	0	910,515,094
Contingency Allowance Construction		20%	against costs adjusted with Reg. Var.	182,103,019	9.3	0	0	0	4,742,092	16,315,985	18,468,855	19,386,995	30,960,888	19,386,995	20,104,619	28,262,611	24,473,977	0	0	0	0	0	182,103,019
Total			*146,410,827 €*	**1,092,618,112**	**55.6**	**0**	**0**	**0**	**28,452,552**	**97,895,910**	**110,813,131**	**116,321,972**	**185,765,330**	**116,321,972**	**120,627,713**	**169,575,668**	**146,843,865**	**0**	**0**	**0**	**0**	**0**	**1,092,618,112**
Landscaping		4.5%		40,973,179	2.1	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318								40,973,179
Preliminaries (Site Ovh All.= 7% & Spec Weather Allowance = 4%)		11%	against	100,156,660	5.1	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666								100,156,660
Plot Development		1%	construction	9,105,151	0.5	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515								9,105,151
External utilities		3%	costs	27,315,453	1.4	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545								27,315,453
Overheads		2%		18,210,302	0.9	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030								18,210,302
Marketing expenses		2%	against sales	72,646,000	3.7	0	0	0	1,733,904	1,733,904	2,327,872	2,913,840	6,092,664	7,569,584	8,436,536	8,737,520	10,451,424	6,983,616	6,995,616	7,802,568	0	0	71,779,048
TOTAL COSTS EXC. VAT			*263,475,369 €*	**1,966,234,093**		**19,576,075**	**546,253,383**	**98,108,001**	**49,762,531**	**119,205,888**	**132,717,078**	**138,811,887**	**211,434,068**	**143,467,631**	**148,640,323**	**178,313,188**	**157,295,289**	**6,983,616**	**6,995,616**	**7,802,568**	**0**	**0**	**1,965,367,141**
TOTAL COSTS INC. VAT 25%		*25%*	***against total costs***	**2,457,792,617**	**100.0**	**24,470,093**	**682,816,729**	**122,635,002**	**62,203,163**	**149,007,361**	**165,896,347**	**173,514,858**	**264,292,586**	**179,334,538**	**185,800,404**	**222,891,484**	**196,619,111**	**8,729,520**	**8,744,520**	**9,753,210**	**0**	**0**	**2,456,708,927**
REVENUES:		quantity	sale price	***Total***	%	**Sem. 1**	**Sem. 2**	**Sem. 3**	**Sem. 4**	**Sem. 5**	**Sem. 6**	**Sem. 7**	**Sem. 8**	**Sem. 9**	**Sem. 10**	**Sem. 11**	**Sem. 12**	**Sem. 13**	**Sem. 14**	**Sem. 15**	**Sem. 16**	**Sem. 17**	
SALES - Down payment:	***40%***																						
						0%	0%	0%	6%	6%	8%	10%	12%	14%	14%	15%	15%	0%	0%	0%	0%	0%	100%
1.1 Residential - Existing building	m^2	13,500	52,000	280,800,000	7.7	0	0	0	16,848,000	16,848,000	22,464,000	28,080,000	33,696,000	39,312,000	39,312,000	42,120,000	42,120,000	0	0	0	0	0	280,800,000
1.2 Cultural - Existing building	m^2	5,700	43,000	98,040,000	2.7	0	0	0	5,882,400	5,882,400	7,843,200	9,804,000	11,764,800	13,725,600	13,725,600	14,706,000	14,706,000	0	0	0	0	0	98,040,000
1.3 Retail - Existing building	m^2	1,500	45,000	27,000,000	0.7	0	0	0	1,620,000	1,620,000	2,160,000	2,700,000	3,240,000	3,780,000	3,780,000	4,050,000	4,050,000	0	0	0	0	0	27,000,000
						0%	0%	0%	6%	6%	8%	10%	12%	14%	14%	15%	15%	0%	0%	0%	0%	0%	100%
1.4 Cultural - Existing building	m^2	53,400	43,000	918,480,000	25.3	0	0	0	55,108,800	55,108,800	73,478,400	91,848,000	110,217,600	128,587,200	128,587,200	137,772,000	137,772,000	0	0	0	0	0	918,480,000
						0%	0%	0%	6%	6%	8%	10%	12%	14%	14%	15%	15%	0%	0%	0%	0%	0%	100%
2.1 Residential - New building	m^2	4,500	52,000	93,600,000	2.6	0	0	0	5,616,000	5,616,000	7,488,000	9,360,000	11,232,000	13,104,000	13,104,000	14,040,000	14,040,000	0	0	0	0	0	93,600,000
2.2 Retail - New building	m^2	1,500	45,000	27,000,000	0.7	0	0	0	1,620,000	1,620,000	2,160,000	2,700,000	3,240,000	3,780,000	3,780,000	4,050,000	4,050,000	0	0	0	0	0	27,000,000
						0%	0%	0%	0%	0%	10%	15%	15%	20%	20%	20%	0%	0%	0%	0%	0%	0%	100%
Underground parking	n	80	250,000	8,000,000	0.2	0	0	0	0	0	800,000	1,200,000	1,200,000	1,600,000	1,600,000	1,600,000	0	0	0	0	0	0	8,000,000
Total			*194,691,280 €*	**1,452,920,000**	**40.0**	**0**	**0**	**0**	**86,695,200**	**86,695,200**	**116,393,600**	**145,692,000**	**174,590,400**	**203,888,800**	**203,888,800**	**218,338,000**	**216,738,000**	**0**	**0**	**0**	**0**	**0**	**1,452,920,000**
SALES - Balance:	***60%***																						
						0%	0%	0%	0%	0%	0%	0%	6%	8%	10%	10%	14%	16%	16%	18%	0%	0%	98%
1.1 Residential - Existing building	m^2	13,500	52,000	421,200,000	11.6	0	0	0	0	0	0	0	25,272,000	33,696,000	42,120,000	42,120,000	58,968,000	67,392,000	67,392,000	75,816,000	0	0	412,776,000
1.2 Cultural - Existing building	m^2	5,700	43,000	147,060,000	4.0	0	0	0	0	0	0	0	8,823,600	11,764,800	14,706,000	14,706,000	20,588,400	23,529,600	23,529,600	26,470,800	0	0	144,118,800
1.3 Retail - Existing building	m^2	1,500	45,000	40,500,000	1.1	0	0	0	0	0	0	0	2,430,000	3,240,000	4,050,000	4,050,000	5,670,000	6,480,000	6,480,000	7,290,000	0	0	39,690,000
						0%	0%	0%	0%	0%	0%	0%	6%	8%	10%	10%	14%	16%	16%	18%	0%	0%	98%
1.4 Cultural - Existing building	m^2	53,400	43,000	1,377,720,000	37.9	0	0	0	0	0	0	0	82,663,200	110,217,600	137,772,000	137,772,000	192,880,800	220,435,200	220,435,200	247,989,600	0	0	1,350,165,600
						0%	0%	0%	0%	0%	0%	0%	6%	8%	10%	10%	14%	16%	16%	18%	0%	0%	98%
2.1 Residential - New building	m^2	4,500	52,000	140,400,000	3.9	0	0	0	0	0	0	0	8,424,000	11,232,000	14,040,000	14,040,000	19,656,000	22,464,000	22,464,000	25,272,000	0	0	137,592,000
2.2 Retail - New building	m^2	1,500	45,000	40,500,000	1.1	0	0	0	0	0	0	0	2,430,000	3,240,000	4,050,000	4,050,000	5,670,000	6,480,000	6,480,000	7,290,000	0	0	39,690,000
						0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	15%	20%	20%	25%	0%	0%	0%	100%
Underground parking	n	80	250,000	12,000,000	0.3	0	0	0	0	0	0	0	0	1,200,000	1,200,000	1,800,000	2,400,000	2,400,000	3,000,000	0	0	0	12,000,000
Total			*292,036,920 €*	**2,179,380,000**	**60.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**130,042,800**	**174,590,400**	**217,938,000**	**218,538,000**	**305,833,200**	**349,180,800**	**349,780,800**	**390,128,400**	**0**	**0**	**2,136,032,400**
TOTAL REVENUES:			*486,728,200 €*	**3,632,300,000**	**100.0**	**0**	**0**	**0**	**86,695,200**	**86,695,200**	**116,393,600**	**145,692,000**	**304,633,200**	**378,479,200**	**421,826,800**	**436,876,000**	**522,571,200**	**349,180,800**	**349,780,800**	**390,128,400**	**0**	**0**	**3,588,952,400**
UNLEVERED CASH FLOW						**(24,470,093)**	**(682,816,729)**	**(122,635,002)**	**24,492,037**	**(62,312,161)**	**(49,502,747)**	**(27,822,858)**	**40,340,614**	**199,144,662**	**236,026,396**	**213,984,516**	**325,952,089**	**340,451,280**	**341,036,280**	**380,375,190**	**-**	**-**	

		year	semester
	discount rate	**10.25%**	5.00%
NPV		***41,404,396 €***	**308,988,031 kr.**
IRR (year)		8.51%	**17.75%**

LOAN CONDITIONS:		
Leverage (%)		**40.0%**
Loan amount (DKK)	***131,737,684 €***	983,117,047
Advance debt reimbursement (%)		**70.0%**
EURIRS 5 years (%)		**0.50%**
Spread (% / bps)		**2.0%**
Annual interest rate (%)		2.50%
Six months interest rate (%)		1.2%

Amortization schedule	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	
Debt beginning of the period	-	9,788,037	282,914,729	331,968,730	296,163,355	295,079,659	279,962,678	247,384,221	172,225,744	22,479,772	(179,128,614)	(89,972,020)	(11,324,376)	(7,832,568)	(4,334,760)	(433,476)	(433,476)	
Loan supply	9,788,037	273,126,692	49,054,001	24,881,265	59,602,944	66,358,539	69,405,943	105,717,034	71,733,815	74,320,162	89,156,594	78,647,644	3,491,808	3,497,808	3,901,284	-	-	982,683,571
Period sales (%)	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*6%*	*8%*	*10%*	*10%*	*14%*	*16%*	*16%*	*18%*	*0%*	*0%*	98%
Principal	-	-	-	(60,686,640)	(60,686,640)	(81,475,520)	(101,984,400)	(180,875,511)	(221,479,788)	(275,928,548)	-	-	-	-	-	-	-	-983,117,047
Debt end of the period	9,788,037	282,914,729	331,968,730	296,163,355	295,079,659	279,962,678	247,384,221	172,225,744	22,479,772	(179,128,614)	(89,972,020)	(11,324,376)	(7,832,568)	(4,334,760)	(433,476)	(433,476)	(433,476)	
Interest	**121,595**	**3,514,603**	**4,123,993**	**3,679,189**	**3,665,726**	**3,477,931**	**3,073,214**	**2,139,532**	**279,263**	**(2,225,285)**	**(1,117,708)**	**(140,681)**	**(97,303)**	**(53,850)**	**(5,385)**	**(5,385)**	**(5,385)**	**20,424,065**
LEVERED CASH FLOW	**(14,803,651)**	**(413,204,641)**	**(77,704,994)**	**(14,992,527)**	**(67,061,583)**	**(68,097,659)**	**(63,474,529)**	**(36,957,395)**	**49,119,427**	**36,643,295**	**304,258,817**	**404,740,414**	**344,040,391**	**344,587,938**	**384,281,859**	**5,385**	**5,385**	

		year	semester
	discount rate	**18.00%**	8.63%
NPV		***9,735,469 €***	**72,652,756 kr.**
IRR (year)		9.99%	**20.98%**

Cumulative Cash Flow	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17
	(14,803,651)	(428,008,292)	(505,713,286)	(520,705,813)	(587,767,396)	(655,865,055)	(719,339,584)	(756,296,979)	(707,177,552)	(670,534,256)	(366,275,439)	38,464,975	382,505,366	727,093,304	1,111,375,163	1,111,380,548	1,111,385,933

Table 5.10 DCF valuation model, construction and selling, upon an optimistic scenario

Source: Produced by the thesis author

COSTS:		quantity	unit cost	Total [DKK]	%	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	Sem. 18	Sem. 19	Sem. 20	
						0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Land acquisition	m² (gfa)	77,000	6500	500,500,000	25.5	0	500,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	500,500,000
						0%	25%	75%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Architectural Design, incl Admin costs		5%	against construction costs	45,525,755	2.3																					0
Architectural Technologist and Land Surveyor		1%		9,105,151	0.5																					0
Engineering Design, incl Admin cost		4%		36,420,604	1.9																					0
Contingency Design		15%	against design costs	13,657,726	0.7																					0
Total Design Costs				104,709,236	5.3	0	26,177,309	78,531,927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104,709,236
Total			81,098,038 €	**605,209,236**	**30.8**	0	526,677,309	78,531,927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**605,209,236**
CONSTRUCTION COSTS:																										
						0%	0%	0%	5%	5%	5%	5%	5%	5%	5%	10%	10%	10%	10%	10%	15%	0%	0%	0%	0%	100%
1.1 Residential - Existing building	m²	13,500	10,890	147,015,000	7.5	0	0	0	7,350,750	7,350,750	7,350,750	7,350,750	7,350,750	7,350,750	7,350,750	14,701,500	14,701,500	14,701,500	14,701,500	14,701,500	22,052,250	0	0	0	0	147,015,000
1.2 Cultural - Existing building	m²	5,700	9,960	56,772,000	2.9	0	0	0	2,838,600	2,838,600	2,838,600	2,838,600	2,838,600	2,838,600	2,838,600	5,677,200	5,677,200	5,677,200	5,677,200	5,677,200	8,515,800	0	0	0	0	56,772,000
1.3 Retail - Existing building	m²	1,500	9,420	14,130,000	0.7	0	0	0	706,500	706,500	706,500	706,500	706,500	706,500	706,500	1,413,000	1,413,000	1,413,000	1,413,000	1,413,000	2,119,500	0	0	0	0	14,130,000
						0%	0%	0%	0%	5%	5%	5%	5%	5%	5%	10%	10%	10%	10%	15%	15%	0%	0%	0%	0%	100%
1.4 Cultural - Existing building	m²	53,400	9,960	531,864,000	27.1	0	0	0	0	26,593,200	26,593,200	26,593,200	26,593,200	26,593,200	26,593,200	53,186,400	53,186,400	53,186,400	53,186,400	79,779,600	79,779,600	0	0	0	0	531,864,000
						0%	0%	0%	0%	0%	4%	3%	5%	5%	10%	10%	10%	10%	13%	15%	15%	0%	0%	0%	0%	100%
2.1 Residential - New building	m²	4,500	11,350	51,075,000	2.6	0	0	0	0	0	2,043,000	1,532,250	2,553,750	2,553,750	5,107,500	5,107,500	5,107,500	5,107,500	6,639,750	7,661,250	7,661,250	0	0	0	0	51,075,000
2.2 Retail - New building	m²	1,500	9,920	14,880,000	0.8	0	0	0	0	0	595,200	446,400	744,000	744,000	1,488,000	1,488,000	1,488,000	1,488,000	1,934,400	2,232,000	2,232,000	0	0	0	0	14,880,000
						0%	0%	0%	0%	0%	0%	5%	5%	10%	10%	10%	10%	10%	20%	20%	0%	0%	0%	0%	0%	100%
Underground parking	m²	2,930	7,200	21,096,000	1.1	0	0	0	0	0	0	1,054,800	1,054,800	2,109,600	2,109,600	2,109,600	2,109,600	2,109,600	4,219,200	4,219,200	0	0	0	0	0	21,096,000
																										0%
Construction Costs adjusted with Tender Price Index (TPI)				30,325,232		0	0	0	394,845	1,358,533	1,454,137	1,468,460	1,516,262	1,554,486	1,673,990	3,032,523	3,032,523	3,032,523	3,180,674	4,192,164	4,434,113	0	0	0	0	30,325,232
Construction Costs adjusted with TPI and Regional Variance 1.05 (Copenhagen area)		1.05	against former summed costs	**910,515,094**		0	0	0	11,855,230	40,789,962	43,660,456	44,090,508	45,525,755	46,673,430	50,261,547	91,051,509	91,051,509	91,051,509	95,499,730	125,869,709	133,134,238	0	0	0	0	910,515,094
Contingency Allowance Construction		20%	against costs adjusted with Reg. Var.	182,103,019	9.3	0	0	0	2,371,046	8,157,992	8,732,091	8,818,102	9,105,151	9,334,686	10,052,309	18,210,302	18,210,302	18,210,302	19,099,946	25,173,942	26,626,848	0	0	0	0	182,103,019
Total			146,410,827 €	**1,092,618,112**	**55.6**	0	0	0	14,226,276	48,947,955	52,392,547	52,908,609	54,630,906	56,008,116	60,313,856	109,261,811	109,261,811	109,261,811	114,599,676	151,043,651	159,761,086				0	**1,092,618,112**
Landscaping		4.5%		40,973,179	2.1	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318	4,097,318											40,973,179
Preliminaries (Site Ovh All.= 7% & Spec Weather Allowance = 4%)		11%	against construction costs	100,156,660	5.1	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666	10,015,666											100,156,660
Plot Development		1%		9,105,151	0.5	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515	910,515											9,105,151
External utilities		3%		27,315,453	1.4	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545	2,731,545											27,315,453
Overheads		2%		18,210,302	0.9	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030	1,821,030											18,210,302
Marketing expenses		2%	against sales	70,075,000	3.6	0	0	0	1,254,150	1,684,200	1,684,200	1,690,200	4,616,550	4,644,550	6,038,050	5,614,000	6,617,450	6,591,450	7,148,850	7,134,850	5,602,000	2,926,350	3,901,800	2,926,350	0	70,075,000
TOTAL COSTS EXC. VAT			263,130,855 €	**1,963,663,093**		19,576,075	546,253,383	98,108,001	35,056,501	70,208,229	73,652,822	74,174,884	78,823,530	80,228,740	85,927,981	114,875,811	115,879,261	115,853,261	121,748,526	158,178,501	165,363,086	2,926,350	3,901,800	2,926,350	0	**1,963,663,093**
TOTAL COSTS INC. VAT 25%		25%	***against total costs***	**2,454,578,867**	**100.0**	24,470,093	682,816,729	122,635,002	43,820,626	87,760,287	92,066,027	92,718,605	98,529,413	100,285,925	107,409,976	143,594,764	144,849,077	144,816,577	152,185,657	197,723,126	206,703,858	3,657,938	4,877,250	3,657,938	0	**2,454,578,867**
REVENUES:		quantity	sale price	***Total***	%	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	Sem. 18	Sem. 19	Sem. 20	
SALES - Down payment: 30%																										
						0%	0%	0%	6%	8%	8%	8%	8%	8%	10%	8%	8%	8%	6%	6%	8%	0%	0%	0%	0%	100%
1.1 Residential - Existing building	m²	13,500	49,000	198,450,000	5.7	0	0	0	11,907,000	15,876,000	15,876,000	15,876,000	15,876,000	15,876,000	19,845,000	15,876,000	15,876,000	15,876,000	11,907,000	11,907,000	15,876,000	0	0	0	0	198,450,000
1.2 Cultural - Existing building	m²	5,700	41,000	70,110,000	2.0	0	0	0	4,206,600	5,608,800	5,608,800	5,608,800	5,608,800	5,608,800	7,011,000	5,608,800	5,608,800	5,608,800	4,206,600	4,206,600	5,608,800	0	0	0	0	70,110,000
1.3 Retail - Existing building	m²	1,500	40,000	18,000,000	0.5	0	0	0	1,080,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,800,000	1,440,000	1,440,000	1,440,000	1,080,000	1,080,000	1,440,000	0	0	0	0	18,000,000
						0%	0%	0%	6%	8%	8%	8%	8%	8%	10%	8%	8%	8%	6%	6%	8%	0%	0%	0%	0%	100%
1.4 Cultural - Existing building	m²	53,400	42,000	672,840,000	19.2	0	0	0	40,370,400	53,827,200	53,827,200	53,827,200	53,827,200	53,827,200	67,284,000	53,827,200	53,827,200	53,827,200	40,370,400	40,370,400	53,827,200	0	0	0	0	672,840,000
						0%	0%	0%	6%	8%	8%	8%	8%	8%	10%	8%	8%	8%	6%	6%	8%	0%	0%	0%	0%	100%
2.1 Residential - New building	m²	4,500	49,000	66,150,000	1.9	0	0	0	3,969,000	5,292,000	5,292,000	5,292,000	5,292,000	5,292,000	6,615,000	5,292,000	5,292,000	5,292,000	3,969,000	3,969,000	5,292,000	0	0	0	0	66,150,000
2.2 Retail - New building	m²	1,500	43,500	19,575,000	0.6	0	0	0	1,174,500	1,566,000	1,566,000	1,566,000	1,566,000	1,566,000	1,957,500	1,566,000	1,566,000	1,566,000	1,174,500	1,174,500	1,566,000	0	0	0	0	19,575,000
						0%	0%	0%	0%	10%	10%	15%	15%	15%	15%	10%	10%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Underground parking	n	80	250,000	6,000,000	0.2	0	0	0	0	600,000	600,000	900,000	900,000	900,000	900,000	600,000	600,000	0	0	0	0	0	0	0	0	6,000,000
Total			140,850,750 €	**1,051,125,000**	**30.0**	0	0	0	62,707,500	84,210,000	84,210,000	84,510,000	84,510,000	84,510,000	105,412,500	84,210,000	84,210,000	83,610,000	62,707,500	62,707,500	83,610,000	0	0	0	0	**1,051,125,000**
SALES - Balance: 70%																										
						0%	0%	0%	0%	0%	0%	0%	6%	6%	8%	8%	10%	10%	12%	12%	8%	6%	8%	6%	0%	100%
1.1 Residential - Existing building	m²	13,500	49,000	463,050,000	13.2	0	0	0	0	0	0	0	27,783,000	27,783,000	37,044,000	37,044,000	46,305,000	46,305,000	55,566,000	55,566,000	37,044,000	27,783,000	37,044,000	27,783,000	0	463,050,000
1.2 Cultural - Existing building	m²	5,700	41,000	163,590,000	4.7	0	0	0	0	0	0	0	9,815,400	9,815,400	13,087,200	13,087,200	16,359,000	16,359,000	19,630,800	19,630,800	13,087,200	9,815,400	13,087,200	9,815,400	0	163,590,000
1.3 Retail - Existing building	m²	1,500	40,000	42,000,000	1.2	0	0	0	0	0	0	0	2,520,000	2,520,000	3,360,000	3,360,000	4,200,000	4,200,000	5,040,000	5,040,000	3,360,000	2,520,000	3,360,000	2,520,000	0	42,000,000
						0%	0%	0%	0%	0%	0%	0%	6%	6%	8%	8%	10%	10%	12%	12%	8%	6%	8%	6%	0%	100%
1.4 Cultural - Existing building	m²	53,400	42,000	1,569,960,000	44.8	0	0	0	0	0	0	0	94,197,600	94,197,600	125,596,800	125,596,800	156,996,000	156,996,000	188,395,200	188,395,200	125,596,800	94,197,600	125,596,800	94,197,600	0	1,569,960,000
						0%	0%	0%	0%	0%	0%	0%	6%	6%	8%	8%	10%	10%	12%	12%	8%	6%	8%	6%	0%	100%
2.1 Residential - New building	m²	4,500	49,000	154,350,000	4.4	0	0	0	0	0	0	0	9,261,000	9,261,000	12,348,000	12,348,000	15,435,000	15,435,000	18,522,000	18,522,000	12,348,000	9,261,000	12,348,000	9,261,000	0	154,350,000
2.2 Retail - New building	m²	1,500	43,500	45,675,000	1.3	0	0	0	0	0	0	0	2,740,500	2,740,500	3,654,000	3,654,000	4,567,500	4,567,500	5,481,000	5,481,000	3,654,000	2,740,500	3,654,000	2,740,500	0	45,675,000
						0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	20%	15%	15%	10%	10%	0%	0%	0%	0%	100%
Underground parking	n	80	250,000	14,000,000	0.4	0	0	0	0	0	0	0	0	1,400,000	1,400,000	1,400,000	2,800,000	2,100,000	2,100,000	1,400,000	1,400,000	0	0	0	0	14,000,000
Total			328,651,750 €	**2,452,625,000**	**70.0**	0	0	0	0	0	0	0	146,317,500	147,717,500	196,490,000	196,490,000	246,662,500	245,962,500	294,735,000	294,035,000	196,490,000	146,317,500	195,090,000	146,317,500	0	**2,452,625,000**
TOTAL REVENUES:			469,502,500 €	**3,503,750,000**	**100.0**	0	0	0	62,707,500	84,210,000	84,210,000	84,510,000	230,827,500	232,227,500	301,902,500	280,700,000	330,872,500	329,572,500	357,442,500	356,742,500	280,100,000	146,317,500	195,090,000	146,317,500	0	**3,503,750,000**
UNLEVERED CASH FLOW						(24,470,093)	(682,816,729)	(122,635,002)	18,886,874	(3,550,287)	(7,856,027)	(8,208,605)	132,298,087	131,941,575	194,492,524	137,105,236	186,023,423	184,755,923	205,256,843	159,019,374	73,396,142	142,659,563	190,212,750	142,659,563	-	

	year	semester
discount rate	**10.25%**	5.00%
NPV	***32,123,290 €***	**239,726,043 kr.**
IRR (year)	7.78%	**16.17%**
LOAN CONDITIONS:		
Leverage (%)		**50.0%**
Loan amount (DKK)	***164,456,784 €***	1,227,289,433
Advance debt reimbursement (%)		**70.0%**
EURIRS 5 years (%)		**0.50%**
Spread (% / bps)		**2.0%**
Annual interest rate (%)		2.50%
Six months interest rate (%)		1.2%

Amortization schedule	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	Sem. 18	Sem. 19	Sem. 20	
Debt beginning of the period	-	12,235,047	353,643,411	414,960,912	392,975,975	377,909,118	364,995,132	352,197,434	269,088,109	186,156,483	(501,033,092)	(429,235,710)	(356,811,172)	(284,402,883)	(208,310,055)	(109,448,491)	(6,096,562)	(4,267,594)	(1,828,969)	(6,096,562)	
Loan supply	12,235,047	341,408,365	61,317,501	21,910,313	43,880,143	46,033,014	46,359,302	49,264,706	50,142,963	53,704,988	71,797,382	72,424,538	72,408,288	76,092,829	98,861,563	103,351,929	1,828,969	2,438,625	1,828,969	-	1,227,289,433
Period sales (%)	0%	0%	0%	0%	0%	0%	0%	6%	6%	8%	8%	10%	10%	12%	12%	8%	6%	8%	6%	0%	100%
Principal	-	-	-	(43,895,250)	(58,947,000)	(58,947,000)	(59,157,000)	(132,374,031)	(133,074,589)	(740,894,563)	-	-	-	-	-	-	-	-	-	-	-1,227,289,433
Debt end of the period	12,235,047	353,643,411	414,960,912	392,975,975	377,909,118	364,995,132	352,197,434	269,088,109	186,156,483	(501,033,092)	(429,235,710)	(356,811,172)	(284,402,883)	(208,310,055)	(109,448,491)	(6,096,562)	(4,267,594)	(1,828,969)	0	(6,096,562)	
Interest	151,994	4,393,254	5,154,992	4,881,876	4,694,703	4,534,275	4,375,291	3,342,838	2,312,592	(6,224,252)	(5,332,325)	(4,432,607)	(3,533,091)	(2,587,802)	(1,359,661)	(75,737)	(53,016)	(22,721)	0	(75,737)	**10,144,868**
LEVERED CASH FLOW	(12,387,041)	(345,801,619)	(66,472,492)	(7,979,939)	(23,311,847)	(25,304,289)	(25,381,594)	45,845,925	46,697,357	(486,472,799)	214,234,943	262,880,569	260,697,302	283,937,473	259,240,598	176,823,808	144,541,547	192,674,096	144,488,531	75,737	

	year	semester
discount rate	**18.00%**	8.63%
NPV	***2,481,917 €***	**18,521,766 kr.**
IRR (year)	9.00%	**18.81%**

Cumulative Cash Flow	Sem. 1	Sem. 2	Sem. 3	Sem. 4	Sem. 5	Sem. 6	Sem. 7	Sem. 8	Sem. 9	Sem. 10	Sem. 11	Sem. 12	Sem. 13	Sem. 14	Sem. 15	Sem. 16	Sem. 17	Sem. 18	Sem. 19	Sem. 20
	(12,387,041)	(358,188,660)	(424,661,152)	(432,641,091)	(455,952,938)	(481,257,226)	(506,638,820)	(460,792,895)	(414,095,539)	(900,568,337)	(686,333,394)	(423,452,826)	(162,755,523)	121,181,950	380,422,547	557,246,355	701,787,902	894,461,998	1,038,950,529	1,039,026,266

Table 5.11 DCF valuation model, construction and selling, upon a pessimistic scenario

Source: Produced by the thesis author

The introduction of costs, values, indices, and methodology pave the way to contextualise a DCF valuation model in Denmark for the next step. The DCF model is customised based on the project facts, construction costs, indices, and properties values in Danish real estate. While the construction costs calculation was gathered from a similar case study "Valby Maskinfabrik" project carried out by students at Copenhagen School of Design and Technology, as mentioned earlier, the sale price of properties extracted from an average properties value of similar case studies "Carlsberg City District" and "Paper Island" on their websites at *carlsbergbyen.dk* and *papiroeen-boliger.dk* based on optimistic and pessimistic views. The model suggests optimist and pessimist economic scenarios for the development of Tunnel Factory brownfield in an acceptable Net Present Value (NPV) and Internal Rate of Return (IRR) values in both levered and unlevered cash flows. Although many variables affect the final result, the main difference between two scenarios are introduced based on timing manner of construction costs and revenues, as well as the estimated properties values. The calculation of DCF model of optimistic and pessimistic scenarios for regenerating The Tunnel Factory is indicated in the tables.

5.3.2.8 Assessment

The DFC model was used with optimistic and pessimistic approaches in which a few variables were taken into account to experiment results. The results as cumulative cash flow were interesting.

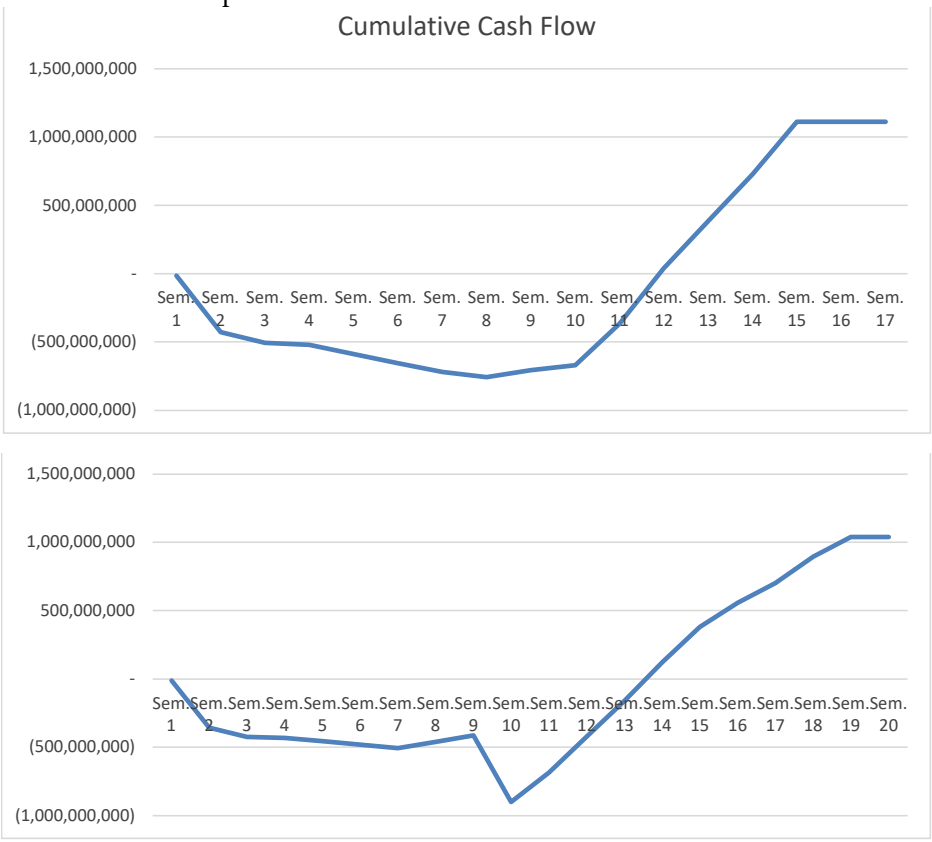


Figure 5.44 Cumulative cash flow, optimistic (up) and pessimistic approach (down)

Source: Produced by the thesis author

Note: comparison between cumulative cash flow in two scenarios show that the payback period is less in optimistic approach. The longer payback period in pessimistic view is resulted from longer construction time and more distributed costs to compensate worse scenarios.

Although in both conditions the results were achieved in an attempt to gain positive NPV value, whether in levered or unlevered cash flows, and higher IRR to meet the economic profitability of the project, the most considerable difference is varied within the NPV values of levered cash flow.

Basically, the main variables changed in two scenarios, including timing distribution, sale price, and the share of down payment. In the optimistic approach there was higher down payment, and the distribution between share of sale throughout semesters were more generously dedicated than the pessimistic scenario. Furthermore, the sale price of properties are considered slightly more than pessimistic approach. Whereas in contrast, in the pessimistic view, all above-mentioned variables were dedicated less than optimistic view, the NPV result was negative for levered cash flow which did not meet profitability requirement. Therefore, in order to mitigate the burden of costs on every semester, I distributed and divided the work within more semesters which, in turn, resulted in more duration of construction, and therefore delayed in selling properties. Likewise, I had to increase the amount of leverage to 50% to compensate deficits.

Another study carried out at the level of the DCF sensitivity results. The DCF sensitivity charts, basically, explains about possible variations in different parameters and compare results. In this analysis the variation amount considered 5% in three factors of cost of building lot, construction cost of existing residential building, and sale price of residential building. While the results in both

Cost of building lot			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	20.04%		
-15%	740 €	5525	24.07%	3.09%	14.73%
-10%	784 €	5850	23.00%	2.02%	9.63%
-5%	827 €	6175	21.97%	0.99%	4.72%
0%	871 €	6500	20.98%	0.00%	0.00%
5%	915 €	6825	20.03%	-0.95%	-4.53%
10%	958 €	7150	19.11%	-1.87%	-8.91%
15%	1,002 €	7475	18.23%	-2.75%	-13.11%

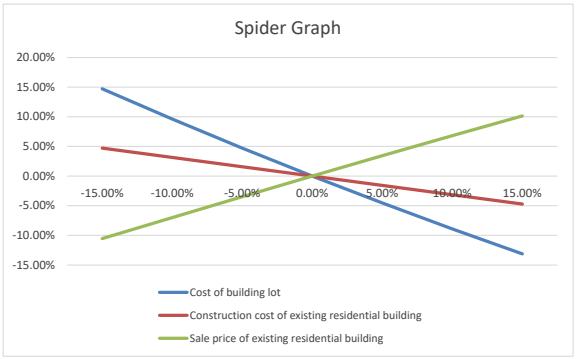
Cost of building lot			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	18.48%		
-15%	740 €	5525	21.85%	3.04%	16.16%
-10%	784 €	5850	20.79%	1.98%	10.53%
-5%	827 €	6175	19.78%	0.97%	5.16%
0%	871 €	6500	18.81%	0.00%	0.00%
*5%	915 €	6825	17.89%	-0.92%	-4.89%
*10%	958 €	7150	17.00%	-1.81%	-9.62%
*15%	1,002 €	7475	16.14%	-2.67%	-14.19%

Construction cost of existing residential building			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	20.04%		
-15%	1,240 €	9257	21.97%	0.99%	4.72%
-10%	1,313 €	9801	21.64%	0.66%	3.15%
-5%	1,386 €	10346	21.31%	0.33%	1.57%
0%	1,459 €	10890	20.98%	0.00%	0.00%
5%	1,532 €	11435	20.65%	-0.33%	-1.57%
10%	1,605 €	11979	20.32%	-0.66%	-3.15%
15%	1,678 €	12524	19.99%	-0.99%	-4.72%

Construction cost of existing residential building			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	18.48%		
-15%	1,240 €	9257	19.75%	0.94%	5.00%
-10%	1,313 €	9801	19.44%	0.63%	3.35%
-5%	1,386 €	10346	19.12%	0.31%	1.65%
0%	1,459 €	10890	18.81%	0.00%	0.00%
5%	1,532 €	11435	18.50%	-0.31%	-1.65%
10%	1,605 €	11979	18.19%	-0.62%	-3.30%
*15%	1,678 €	12524	17.88%	-0.93%	-4.94%

Sale price of residential building			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	20.04%		
-15%	5,923 €	44200	18.77%	-2.21%	-10.53%
-10%	6,271 €	46800	19.51%	-1.47%	-7.01%
-5%	6,620 €	49400	20.25%	-0.73%	-3.48%
0%	6,968 €	52000	20.98%	0.00%	0.00%
5%	7,316 €	54600	21.70%	0.72%	3.43%
10%	7,665 €	57200	22.41%	1.43%	6.82%
15%	8,013 €	59800	23.11%	2.13%	10.15%

Sale price of residential building			IRR	IRR variation	% IRR variation
Variation %	EUR	DKK	18.48%		
*-15%	5,581 €	41650	16.75%	-2.06%	-10.95%
*-10%	5,909 €	44100	17.45%	-1.36%	-7.23%
-5%	6,238 €	46550	18.13%	-0.68%	-3.62%
0%	6,566 €	49000	18.81%	0.00%	0.00%
5%	6,894 €	51450	19.48%	0.67%	3.56%
10%	7,223 €	53900	20.15%	1.34%	7.12%
15%	7,551 €	56350	20.80%	1.99%	10.58%



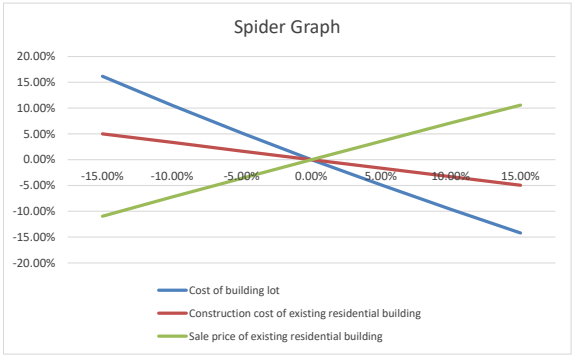


Figure 5.45 DCF sensitivity chart, optimistic (left) and pessimistic approach (right)

Source: Produced by the thesis author

Note: Although variations result in almost the same in charts, the NPV value of levered cash flow becomes negative in variations marked with a star in pessimistic approach. However, under no condition NPV becomes negative in the optimistic variation. In general, in both scenarios land price is the most sensitive factor for obtaining higher NPVs.

approaches were quite similar, the most influential parameter to change results was land price, possibly because it is purchased at once at the beginning. The least influential factor is construction costs which might be due to the long enough distribution of costs.

In general, the key parameters of the profitable investment that have been affected in two scenarios are explained as the following:

• *Construction duration*: The distribution of construction costs to more semester can unload the amount of debt in for a specific periods when revenues have not been regenerated, albeit post-construction sales are delayed.

• *Sale price*: The sale price of properties depending on various factors, including marketing success, surrounding development, facilities, accessibilities, inflation, etc., although the price has been increasing since 2011 in a reference to the construction cost index for residential buildings (BYG42).

• *The share of down-payment*: It is obvious the more percentage of down-payment is defined, the more helpful it is to balance the cash flow. Less share of down-payment might also increase the debts and potentially dangerous for the investment and external funds may even be required.

• *Construction costs*: This is a decisive factor for managing costs and more precise costs can be obtained when the project is detailed in materials, structure, technology, etc.

• *Leverage amount*: The leverage amount could support the cash flow become more balanced, while the paid-off debt also increases because of the interest rate. However, an increased leverage amount in pessimistic approach can help achieve a profitable investment.

It should be noted that although there are other parameters could have fluctuated results in both scenarios, they are fixed as a regular method of construction costs and values within a determined cost framework.

CHAPTER 6 CONCLUSION

6.1 Primary Questions

Brownfield has been considered a critical issue in the realm of urban planning. Industrial brownfield sites, as one of the most common types of brownfields, are the legacy of industrial prosperity in the past that could not be merged with the new conditions of urban needs, technology, and environmental concerns and caused abandoned or unused sites (Lakatos, 2015). It is argued that de-industrialisation is one of the main reasons for the appearance of industrial brownfields. Denmark has not been an exception in this trend. Several large brownfields appeared since the 1980s when Denmark was dealing with adverse social and economic problems, particularly in large cities like Copenhagen. Brownfields could be found in waterfronts and urban or peri-urban areas. However, there are different types of brownfields, such as industrial, waterfront, vacant houses, infrastructural brownfields, etc. Brownfields often used to be seen on waterfronts in the 1980s in Copenhagen. However, with the help of Danish urban policymakers at the national and local scale, many brownfields have been regenerated and act as driving forces for boosting economic and social values in urban growth. Studying Danish stories helped me extract essential lessons from Danish experiences to address one of the primary strategies for dead with brownfields.

In order to know strategies to address brownfield matter, it is necessary to understand the origin and the notion of brownfields to deal with this urban phenomenon properly is also for the first step. The origin of brownfields could be different in general. However, as mentioned earlier, industrial brownfields often come from the industrial prosperity period when factories and industrial sites were active. As de-industrialisation signs appeared, they became abandoned and shaped brownfields. Even though there is no common definition of brownfields at the EU level, it differs among European countries (Grimski & Ferber, 2001; Cobârzan, 2007). While the definition of brownfields in Denmark is the "land affected by contamination" by the Danish Environmental Protection Agency (Olive *et al*., 2005), it seems that paying attention to only contaminated sites may limit the topic to more technical solutions for managing brownfields. Thus, all abandoned sites were considered "brownfields" to avoid being off the thesis theme. According to one of the eldest authentic research groups in brownfields, CLARINET (2002), brownfields:

1. have been affected by former use of the site and surrounding area;
2. have been abandoned or insufficiently used;
3. have pollution problems;
4. primarily found in developed urban areas;
5. require intervention for benefits.

However, the most recent papers have carried out more studies on the brownfields notion, among which the research group of EPFL have defined requirements in a thematic basis for naming brownfields, including dimension, type, and vacancy. In contrast, other scholars have different methods for classifying brownfields. Ferber and Grimski (2001) categorised brownfields based on their location. Last but not least, it is worth mentioning in attempts to categorise brownfields, SCTM (2011) sorted out brownfields according to economic valuation. This category could be the most interesting way of classification when counting the economic benefits of brownfield regeneration (BR). Therefore, methods are different; they could be applied to understand brownfields. Below there is a summary of different methods of classifying brownfields.

Table 6.1 Methods to determine brownfields

Thematic		Location		Economically	
Larger than half of a hectare	Dimension	Caused by de-industrialisation since 1980s	In traditional industrial sites	High value sites	No need of state funding
Depending on the activity performed	Type	Caused by urbanisation	In urban areas	Lower value sites	Require public attention
Has been vacant for at least one year	Vacancy	Caused by economic crisis	In rural areas	Negative land value in rural areas	Require state finance

Source: Produced by the thesis author

In this vein, it is vital to mention that brownfields can bring about adverse effects in different socio-economic and environmental aspects, such as economic breakdown, investors' refusal, unemployment rate, tax income decline, and greenfields consumption (CLARINET, 2002). Such problems could be imprinted at the site scale and the surrounding and neighbourhood scale and facilitate urban sprawl. Thus, it is of high importance to tackle this issue.

Despite these problems, if re-managed well, brownfields could be potentially positive for urban growth in light of sustainable development. In the realm of urbanisation, having access to available land and resources is critical. At the same time, land-use sustainability has gained much popularity among developed countries following sustainable development. In this regard, brownfields can play a significant role in paving the way for land-use management and preventing the capture of greenfields (Kurtovic *et al*., 2014). In other words, regenerated brownfields can be turned from trash into treasure. Redeveloped brownfields can result in high benefits in social and economic values. Such benefits as increased property values and employment opportunities are merely points in regenerating brownfields (Baskaya, 2010). This made European countries understand the value of brownfields. A method to evaluate brownfields was developed by Thomas (2002), where criteria at the level of government and county authority level were introduced. A survey on EU brownfields revealed that the value of brownfield sites increased by 32.6% between 2006 and 2011, which led to the European Regional Development Fund's allocation of 336 billion euros for regenerating brownfields (ERDF) of the EU in the period 2014 to 2020.

The story of regenerating brownfields in the EU already began in the 1980s by redeveloping steel

mills and textile companies in some parts of France and Germany. While the BR trend was boosted by the early 21st century between European countries, Danish policymakers have already followed the trend since the early 1990s. The most significant project at that time in the capital region of Denmark appeared by redeveloping Ørestad region, which was the leftover from a former military base, and transforming it into a large-scale and long-term redevelopment project, which later on led to the regeneration of other waterfront brownfields such as Frøsilo.

6.2 Danish Regenerative Urban Practices

The city of Copenhagen has seen dramatic experiences in social and economic effects. The socio-economic prosperity as the result of industrialisation peaked in the mid-1970s once about 1.75 million people lived in the capital region. However, the fortune did not last for a long time. A great decline in Denmark's economy, population, employment rate, and industry started at the beginning of the de-industrialisation period in the 1980s. Industrial sites were closed, activities in the city centre mostly stopped, urban sprawl grew, and Copenhagen entered harsh conditions. So Danish policymakers had to urgently regulate significant changes in economic and social structure and urban policies in the early 1990s as the result of new reforms (Kidokoro *et al*., 2008). A new scheme needed to be implemented to address spatial and economic challenges which Copenhagen had been dealing with since the late 1970s.

The regulated policies helped Denmark later reach an organisational urban planning system for regulating land use and urban development (UR) from the local to the regional and national levels. The new reforms in urban practices started with the Regional Plan 1989, when the decision was to stop urban expansion mainly by developing retail, public and private services and revitalising housing - followed by the Vesterbro programme - to improve the employment situation. Another worth-noting result of this action was attempting to prepare opportunities for reusing abandoned sites in reaction to newly changed economic and industrial basis. New urban planning development projects were suggested, among which the expansion of railway tunnels and metro were the most substantial projects (Andersen & Jørgensen, 1995). That was an important decision since urban redevelopment projects started in the next phase in the early 1990s, which was followed by initiating the bridge connection between Malmo (Sweden) and Copenhagen to promote the Øresund region, backed by the EU, as well as Ørestad development the redevelopment the urban area along the railway from the city centre to the airport to make the city more developed and attractive for investors. The Ørestad development is the prime large-scale UR carried out by the Ørestad Development Cooperation (ODC), conceived as a requirement for UR and socio-economic promotion in Copenhagen (Majoor, 2015). The cooperation was jointly owned by Copenhagen Municipality and the Danish Ministry of Finance, and the municipality was responsible for providing urban planning for the area (Sørensen & Torfing, 2019). The proposed urban structure helped manage the traffic system in Copenhagen and prevent urban sprawl and more areas for different recreational, retail, education, and commercial activities (The Danish Nature Agency, 2015).

Even though the Finger Plan, which was primarily implemented in 1947, should be noticed

over the UR of Copenhagen. The Finger Plan introduced a structural framework for city growth through which suburbanisation is managed more appropriately. Finger structures also provide more accessibility between suburbs, rural areas, and the city. The Finger Plan mainly helped Copenhagen develop within a specific structure, which is updated in the 2019 version and KP19.

Overall, new urban policies implemented in the 1990s, at first, showed the attitude of local politicians and the relationship between politicians and urban policymakers for addressing socio-economic issues was appreciated as a responsibility of a "national interest". The role of ODC as the first organisation for such a large development project was inevitable. The collaboration between the Danish and Swedish governments to promote common benefits under the programme of INTERREG in Øresund and the Baltic sea should not be ignored. The construction projects for developing transport and accessibility, namely the railway link between Copenhagen and Malmo, were crucial for UR. Designating Copenhagen as the Cultural Capital of Europe in 1996 boosted the Danish capital city, waterfronts, and urban infrastructure to be seen more than in the past which resulted in a flow of investors and economic growth in the city. In this way, some district development programmes were promoted and supported, such as the Vesterbro scheme for revitalising old buildings and encouraging private investments in the housing sector. These were considered key decisions for turning Copenhagen into a regenerative city (Anderson & Jørgensen, 1995; Katz & Noring, 2017).

However, critics of the ODC operation are multitude. Private investments could not take up in the development, and public funds were utilised for regeneration. Andersen (2003) estimated that the state funded about 850 million EUR over the development of the district. The issue even becomes more critical once the amount of governmental loans is calculated between 1 and 2 billion EUR and the debt last for a decade. The author argues that over-optimistic calculation was the main justification for that, and a seemingly pessimistic approach was not or less considered for the calculation. Even though external factors should not be neglected, as Majoor (2015), who studied the Ørestad development drawbacks at two levels of pre-crisis and post-crisis, claims that other the global economic crisis in 2007 contributed to this tragedy when the house prices in Copenhagen dropped by 40%, this also affected building programmes and the sale plan of properties.

Nevertheless, as mentioned earlier, ODC was a substantial experience, albeit unpleasant, to facilitate UR steps in Copenhagen. In this vein, other factors have played crucial roles in the UR of Copenhagen since the 1990s. ODC and the connection bridge between Copenhagen and Malmo were decisions supported by "national interests", which attracted investors' attention to the region and Copenhagen. The role of waterfront regeneration in the UR of Copenhagen should not be ignored. Waterfronts were owned between The Danish State, the municipality of Copenhagen, harbour authorities, and several private landlords. Regeneration of waterfronts resulted in an increase in the value of the real estate in such areas; Katz & Noring (2017) state that stakeholders of Copenhagen port generated 15 million USD in profits for the development, which shows the beneficial investment in BR. These were the primary steps for regenerating urban areas and brownfields for the next step. The letter UR phase was regenerated abandoned harbour brownfields such as Frøsilo and, more recently, Nordhavn. Organisation-wise, considering the ODC and the Port Development Corporation,

which was in charge of harbours and waterfront regeneration made, the government merged them to shoulder the other major redevelopment projects. Then CPH City & Port Development (CPD) was formed.

The strategies of CPD, which is a reformed model of ODC, are appreciated. The model, fundamentally, is based on selling land to fund infrastructure to avoid using public finances in development. The government tended to sell land in the Nordhavn district by generating 450 million USD, which was more than predicted in 2007. Then the earnings were reinvested in the development in Nordhavn, about 15 billion USD, of which 5.8 billion USD were dedicated to the metro construction (Bruns-Berentelg *et al*., 2022). The appraisal of CPD strategies is carried out at five layers by Katz & Noring L. (2017): (1) Transparent public ownership, (2) Integration of public assets and entities, (3) Collaborative relation between the local municipalities and state (4) Avoid political intervention, (5) Having a long-term perspective and supervision.

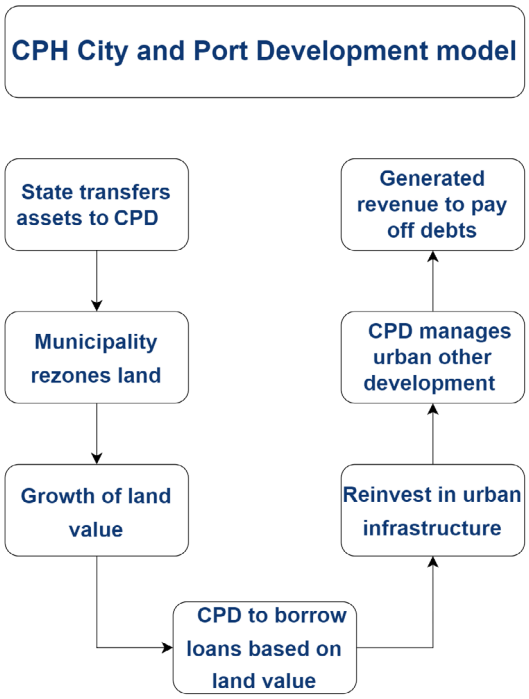


Figure 6.1 The financial solution of The CPH City and Port Development model

Source: Produced by the thesis author on the basis of the data collected from Bruns-Berentelg *et al*., 2022

Note: The economic cycle model proposed by CPD intended to avoid public funds for mass urban development projects. This strategy was successfully applied in the development of Nordhavn.

Today, Denmark's urban planning system and land use are based at three levels: the national government, five regional governments, and 98 local municipalities; where the government establishes the national planning report and municipalities need to manage municipal plans at a smaller scale local plans. UR at these three levels needs these organisations' approval. Studying the Danish urban planning system shows a mutual collaborative approach between different public entities, which has resulted in the proper management of land use and, in turn, UR and BR.

Researching urban BR practices in developing the current brownfield Jernbanebyen (The

Railway Town) in Copenhagen as a regenerated proposal in primary phases reflects quite a few facts. (1) A collaborative relationship between the municipality and private sectors has made a solid agreement to reach efficient and effective policies for regeneration. (2) Creating a local economic resource model for regeneration; the economic cycle will result in a growth-generating self-dependent economic condition by which the need for external resources is reduced. (3) Thematic smaller urban neighbourhoods enable the district to promote its characteristic identity by revitalising preserve-worthy buildings and elements. (4) Implementing a "nature" structure and car-free accessibilities in the regeneration process, dense urban greenery and offering more opportunities to take advantage of environmentally friendly solutions for routines is homogeneous with sustainable environmental goals.

6.4 Regenerative Economic Assessment

The economic assessment of regeneration brownfields is conducted within two steps. At first, it was essential to understand the cost of brownfield projects according to their typology and transformed activities. Comparing BR project costs revealed that residential purposes are a popular activity into which brownfields are mostly transformed. Offices and commercial activities are other popular functions for regenerating brownfields in Copenhagen and Denmark. Since the resources for checking the total costs of regeneration projects were limited, their only construction cost was considered in the compilation. The comparison also showed that The Timberyard project in Aarhus was the most expensive one among the rest of the projects, whereas in contrast, Ørestad constitutes the least cheap one. The Carlsberg district is the densest, and Vestas Wind Systems, as the least dense project, is not the highest and the lowest expensive project. In the following, there are further points we can conclude from:

1. The density does not necessarily affect the highest and lowest cost of regeneration projects; other parameters could be more influential.
2. The cost of regeneration trend throughout time has been increasing; this shows that the impact of time on the growth of costs is proven.
3. The price of projects in Copenhagen differs according to the locations, density, and accessibility.
4. Ørestad project, as the largest and the least expensive project, might also be considered the most cost-benefit project for developers, in terms of construction costs, while The Timberyard, as the most expensive one and provides smaller areas, may not be considered the most cost-effective project.

In the next step, the thesis aims to go through the economic valuation of the current brownfield project in Copenhagen, namely Tunnelfabrikken (The Tunnel Factory). The site area was chosen according to the municipality's perspective for the redevelopment of the area in the long-term UR of Copenhagen indicated in KP19. In this vein, two primary resources were used; first, Statistics Denmark is the most reliable source to learn about prices, trends, and indices in Denmark. In addition, the construction cost of the BR case study "Valby Maskinfabrik", carried out by the students at Copenhagen School of Design and Technology, was considered as the reference for finding out the

methodology of construction cost calculation in Copenhagen. According to Statistics Denmark, the index of total construction cost in Denmark, which is used for achieving the Tender Price Index (TPI) in calculating the costs, has considerably increased compared to the first quarter of 2020. That also may be why the price of the most recent projects, such as The Timberyard, has grown, as earlier explained in the comparison of case studies.

Understanding the methodology of construction costs helped me formulate a DCF model of construction and selling in Denmark. The DCF model contextualised based on Danish construction costs indices and sale prices can pave the way for evaluating the regeneration of brownfields for investors in terms of profitability, carried out in two optimistic and pessimistic scenarios.

While in the two economic valuation scenarios of The Railway Town, profitability requirements, positive IRR and NPV values, are met, the most worthy-re-mentioning factors can affect two scenarios vary, as follows; (i) Construction duration, the distribution of construction costs, and instalments could lessen the debts in the period when sales or down-payment sales have yet to start. (ii) Sale price could be expected to increase because of inflation and growing construction cost indices. (iii) Leverage amount, although a higher leverage amount supports construction costs and causes an increase in the paid-off amount, it helps to acquire a profitable investment in the pessimistic approach.

6.5 Critical Notes and Reflection

BR is a key solution to tackle social, economic, and even environmental problems on an urban scale. In this way, as an example of successfully regenerated brownfields, Copenhagen proves that practices and experiences in urban regeneration come from successful management and policies. The economic valuation of BR could be profitable based on the DCF model, whether in a pessimistic or optimistic approach.

At this point, it is necessary to remember two facts. First, Denmark enjoys a robust organisational system for urban planning in which there is a relationship between the national planning act and municipalities where also the public can participate in the development of local plans. This means that the land-use planning system has a mutual language between the government and the people, resulting in the attraction of private sectors as the successful collaboration between public and private sectors has created The City and Port Development organisation, which has redeveloped a variety of significant projects in Copenhagen. On the other hand, the brownfield definition in Denmark is limited to contaminated lands. It is crucial to increase awareness of brownfield's potential benefits. The BR is defined in UR indirectly, as seen in the Municipal Plan 2019 (KP19). Reviewing the literature in the field of BR benefits is yet to be comprehensive as other European countries such as Germany. Thus, proposing such methods as the Thomas model (2002), though updated, for evaluating brownfield values in the Danish context could be effective in raising the understanding of derelict sites in the realm of economic benefits and structuring the concept in the framework of brownfields.

Furthermore, it should be admitted that the limitation of the thesis aims prevented the thesis from looking more deeply at other aspects. For instance, the thesis did not aim to provide information on if Danish BR strategies can be implemented in other European or Scandinavian contexts. The thesis also offers an analysis comparison by putting Danish strategies aside the world scale and comparing them with other practices, such as brownfield policies in the US or China, to understand similarities and differences and provide customised frameworks for each. Carrying out detailed studies on Danish sustainable architectural solutions for BR and experimenting it real projects may be other goals in this field in the future.

Another underlying opportunity for further research in this field and economic interests would be experimenting with other types of DCF valuation models, such as investment and management, and understanding how it works in the Danish context, as Interviews with Danish developers or architects of BR could also be done to understand BR benefits from officials' point of view. The research could also offer possibilities for economic evaluation assessment of BR by studying an in-depth Life Cycle Cost (LCC) analysis of brownfield projects.

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