
AR REVOLUTION

AR SCAPE

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# AR-scape : Pioneering Inclusive and Resilient 'PHYGITAL' Public Spaces in the Augmented Reality Era

The advent of the internet and digital technology has transformed public spaces, impacting human interactions and diluting their original purpose. However, augmented reality (AR) technology, exemplified by Pokémon Go, presents a unique opportunity to revitalize urban public spaces in the digital era. AR technology offers virtual flexibility, empowering public spaces to become multifunctional environments and redistributing the value of urban areas.

To accommodate this transformative potential, inclusive and enduring architectural structures are needed as resilient containers for AR development. This project focuses on designing robust, inclusive public buildings that seamlessly integrate into the urban fabric undergoing AR development. These structures adapt to the evolving needs and activities facilitated by AR, fostering social interaction and a sense of belonging within the community.

The integration of AR technology necessitates a holistic approach to urban design, extending beyond individual buildings to the broader urban context. By leveraging the transformative power of AR, this project envisions digitally enhanced and physically resilient urban environments that accommodate diverse activities and cultivate community. It explores new paradigms for urban design where public buildings serve as adaptable containers for AR experiences, fostering social cohesion and redefining the relationship between people, architecture, and the environment.

Through the integration of AR technology and thoughtful architectural design, this project showcases the potential for vibrant, inclusive, and sustainable urban public spaces in the digital age. By embracing flexibility, durability, and inclusivity, it establishes a foundation for AR-neutral buildings that respond to the evolving needs and aspirations of urban communities, creating a more engaging and harmonious urban environment.

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# Table of Contents

# Introduction

Introduction
Introduction
Introduction

## 1.1 Context
## 1.2 Motivation
## 1.3 Introduction to AR


**Fig.1.1** Hyper-Reality
Hyper-Reality presents a provocative and kaleidoscopic new vision of the future, where physical and virtual realities have merged, and the city is saturated in media.

https://www.youtube.com/watch?v=YJg02ivYzSs

# 1.1 Context

## 1.1.1 digital transition

Digital Transition

Decline of public spaces

New spatial form needed

With the advent of the internet era, the digital transition of society has led to a greater reliance on devices, weakening physical interaction. It has led to an increasing decline in the original episodic activity and mediating function of public spaces. Traditional gathering spots, such as parks, town squares, and community centers, once vital for social interaction and community cohesion, have been overshadowed by virtual social networks and online engagement. The allure of convenience, personalized experiences, and instant connectivity offered by digital platforms has resulted in a decreased demand for physical public spaces. This decline poses a profound challenge as it undermines the opportunities for face-to-face interactions, community bonding, and the overall well-being of individuals within urban environments.

More people rely on smartphones to fulfill their daily responsibilities, and this trend is reported to be intensifying through the effects of COVID-19. A new survey finds that responses to COVID-19 have speeded the adoption of digital technologies by several years and that many of these changes could be here for the long haul. During the pandemic, consumers have moved dramatically toward online channels.

The COVID 19 pandemic also forced many companies to adopt new business models based on digital solutions. The in-person collaboration came to a sudden halt. Businesses that survived discovered new, efficient digital workflows. Which made digital platform better established.

Digital transformation simultaneously requires new urban form to adapt and enables digital system to develop. By changing the way city working, the urban space can keep up with an evolving market and consumer expectations while addressing challenges specific to urban issues.

*Source: Euromonitor Voice of the Industry: COVID-19 surveys*


**Fig.1.2** Rapid Urbanization And Population Growth

https://parametric-architecture.com/rapid-urbanization-and-population-growth-earths-population-reaches-8-billion/

**Fig. 1.3** High Density Development of Saskatoon

https://saskedge.ca/suburban-growth-vs-urban-densification/

# 1.1 Context
## 1.1.2 Urbanization

Urbanization
gentrification of
public space

HOUSING PROBLEM
dencification
multi-use spaces

Today city residents are experiencing a new way of life which is unprecedented ever since the urbanization concept appearance. The rapid development of cities has also placed new demands on urban spaces and urban systems. The process of urbanization, coupled with economic growth and demographic changes, has triggered the gentrification of public spaces and amplified issues of exclusiveness. As cities expand and evolve, neighborhoods that were once diverse and inclusive become subject to revitalization efforts and rising property values. This often attracts affluent residents, investors, and businesses, resulting in the displacement of lower-income communities and altering the dynamics of public spaces. Gentrification can lead to the transformation of once accessible and vibrant public areas into exclusive enclaves catering primarily to the interests and preferences of the privileged few. The consequences are diminished diversity, reduced accessibility, and a loss of the social fabric that once characterized these spaces. As a result, marginalized populations are often left with limited access to the very public spaces that are essential for social interaction, recreation, and community engagement.[1]

And at the same time, the population expansion of the city did not stop and housing became an important issue to be addressed. There is a shortage of 390,000 homes in the Netherlands. That amounts to about 5 percent of the total number of homes, according to the Atlas for municipalities 2022. On average, there are 105 candidates for every 100 available homes in the Netherlands.

In this context, the exploration of designing more inclusive and accessible urban spaces emerges as a significant goal. Recognizing the challenges posed by the decline of public spaces and the gentrification process, there is a need to delve deeper into the concept of creating liveable urban environments. Subsequent chapters of this work will delve into the author's motivation and provide an insightful understanding of what constitutes a liveable urban space. Through a comprehensive examination of relevant factors and considerations, the aim is to present innovative approaches and strategies that foster inclusivity, accessibility, and diversity within urban contexts. By addressing these critical issues, it is hoped that this exploration will contribute to the broader discourse on urban design and pave the way for the development of sustainable and socially enriching urban spaces.

[1] Lindner, Christoph, Sandoval, Gerard . 2021. Aesthetics of Gentrification-Seductive Spaces and Exclusive Communities in the Neoliberal City. Amsterdam University Press: 296. doi:10.5117/9789048551170.


**Fig. 1.4** Pokémon Go
*Turning Data Collection into a Game*

https://www.nextgov.com/emerging-tech/2020/06/pokemon-go-wants-make-3d-scans-whole-world-planet-scale-augmented-reality-experiences-good/166232/

# 1.2 Motivation

## 1.2.1 Augmented Reality

TECHNOLOGIES
5G WIFI AR VR XR

Urban planners and designers have spent the last 50 years trying to activate unused public spaces, create walkable cities and encourage sociability through urban design. Pokémon Go has succeeded, almost overnight, to entice people of all demographics into the streets of cities around the world. In fact, many previously underutilized public spaces have suddenly become hot spots for all demographics, playing Pokémon Go and other similar augmented reality games.[1]

It also made me realise that these games could activate public spaces, increase community interactions and facilitate exploration of urban spaces. These have been made possible by the emergence of new technologies, so could Augmented reality solve more urban problems if applied to urban public spaces in another way? The emergence of new technologies has become an opportunity for us.

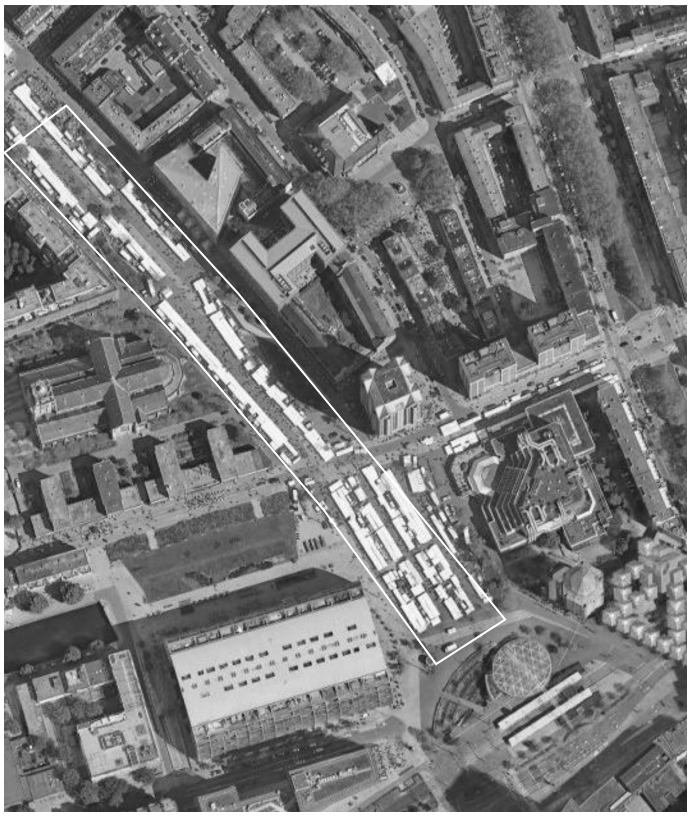
[1] Ruth Potts, Lisa Jacka & Lachlan Hartley Yee (2017) Can we 'Catch 'em All'? An exploration of the nexus between augmented reality games, urban planning and urban design, Journal of Urban Design, 22:6, 866-880, DOI: 10.1080/13574809.2017.1369873

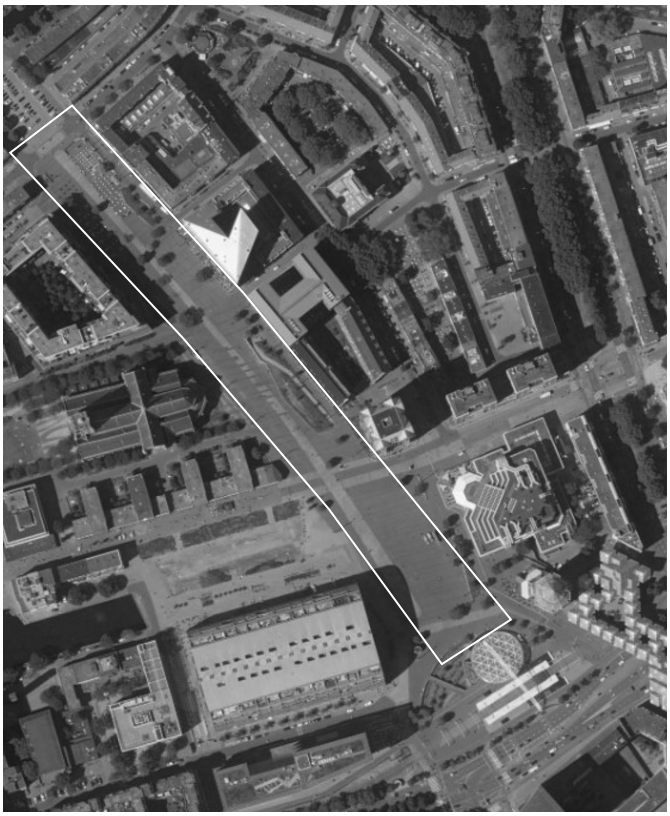
# 1.2 Motivation

## 1.2.2 Project Location

The location I have chosen as a project site holds significant potential due to its role as an important part of Rotterdam's city center. Every time I pass by, I am captivated by the striking contrasts it offers. This space serves as a transit area on a regular basis, but it undergoes a remarkable transformation twice a week when it becomes a bustling open market. These market days infuse the atmosphere with vibrancy and liveliness, attracting a multitude of visitors who come to enjoy the diverse offerings of fresh flowers, fruits, vegetables, and groceries. It becomes a vibrant hub of activity where people engage in shopping, socializing, and exploration. However, the dynamic nature of this space seems to be limited to these specific market days. Throughout the remaining five days of the week, the ambiance undergoes a noticeable shift, becoming relatively cold and lacking human presence.

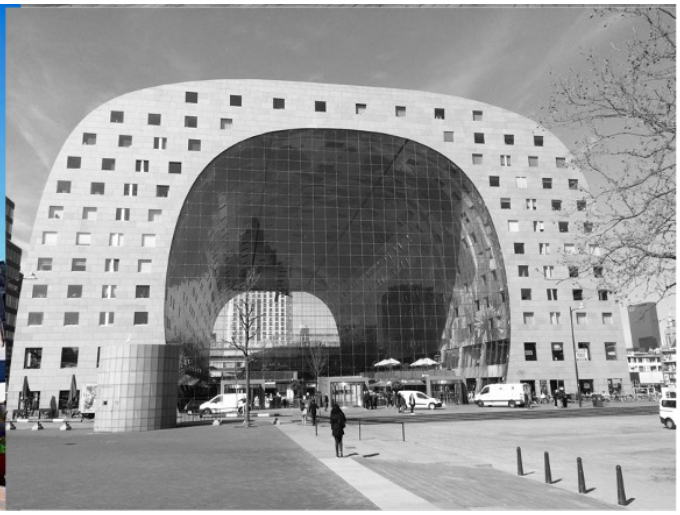
On these weekdays, the space primarily serves as a thoroughfare, with people simply passing through without pausing or engaging in any substantial activities. This stark contrast between the vibrant market days and the relatively inactive weekdays highlights the need to revitalize the space and explore strategies that promote consistent usage and public engagement throughout the entire week. By undertaking this project, we aim to transform this location into a vibrant and inviting space that not only serves as a transit area but also fosters a sense of community, encourages social interactions, and provides opportunities for diverse activities. The goal is to create a space that remains lively, inviting, and engaging for both residents and visitors alike, enhancing the overall appeal and vitality of Rotterdam's city center.

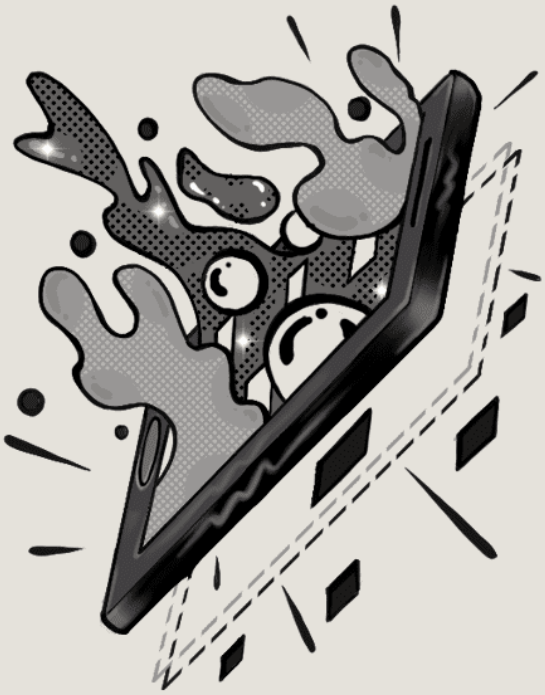





GAAN MET
DIE BANAAN!


GAAN MET
DIE BANAAN!
START





# Augmented Reality

*[ȯg-ˈmen-təd rē-ˈa-lə-tē]*

A type of technology that allows digital images and information to be displayed onto the physical environment.

Investopedia

Defination of AR

By ADAM HAYES Oct 29, 2022

# 1.3 AR Introduction

Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli and delivered via technology. It is a growing trend among companies involved in mobile computing and business applications in particular.

The AR study focuses on exploring the influence of Augmented Reality (AR) on urban space and society by examining existing application scenarios. The investigation centers on four primary areas: Travel & Tourism, Commercial & Retail, Culture and Heritage, and Public Art. By comprehensively examining these domains, the aim is to gain a deeper understanding of how AR can shape and transform urban environments and societal interactions.

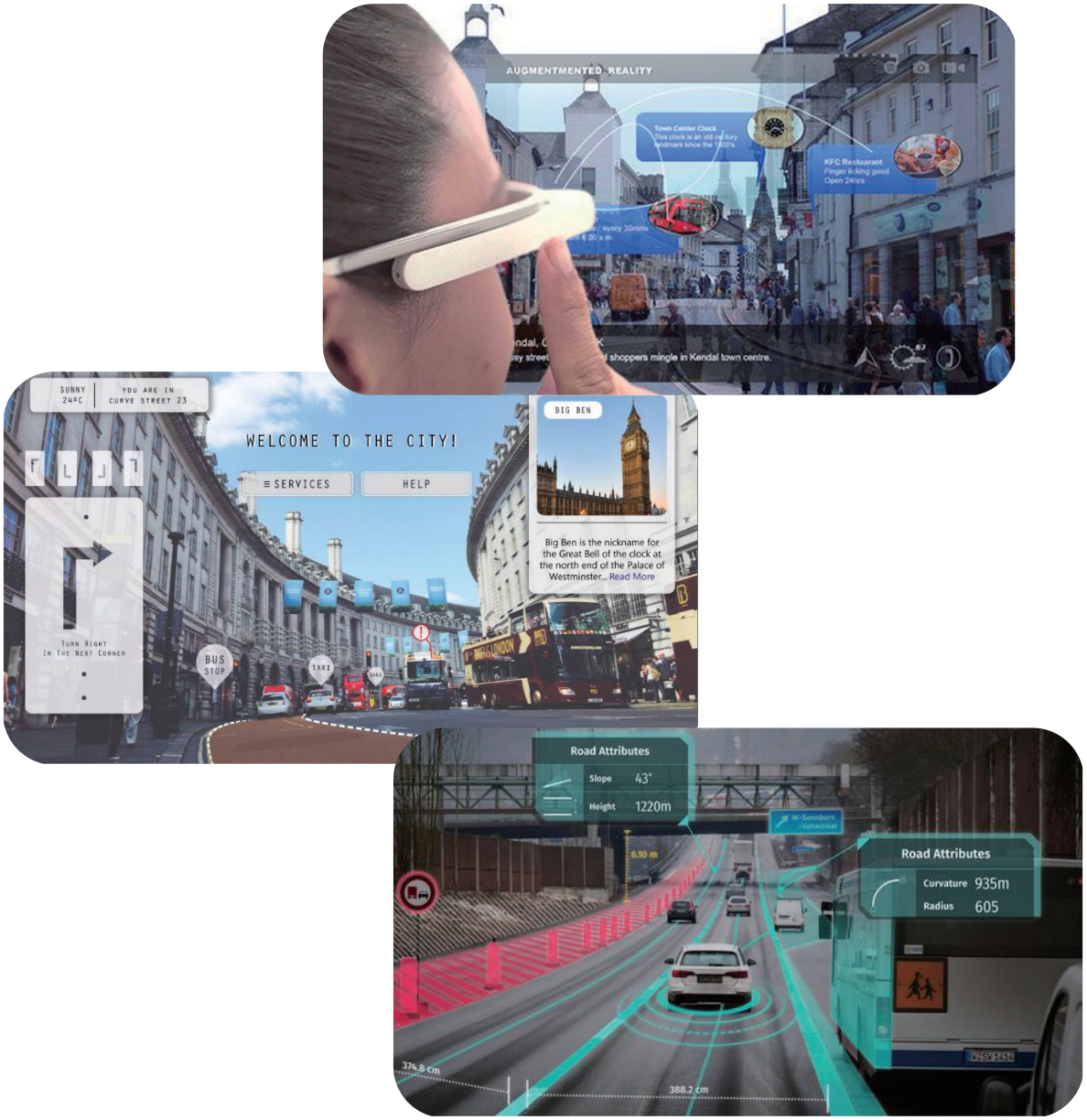



**Fig. 1.5** Navigation of AR
*Google have already started implementing this over Google Maps AR (available on pixel 3A) which allows users to see directional overlays for better navigation around cities.*

https://www.darfdesign.com/blog/7-ways-augmented-reality-will-revolutionise-our-cities

## 1.3.1 Travel & Tourism

spatial implications

The utilization of AR technology in navigation and tourism has significant implications for the structure of cities, with potential transformative effects. AR navigation offers the possibility of enhanced urban mobility, enabling individuals to navigate cities more efficiently and potentially reducing congestion in specific areas. This spatial optimization could lead to a more streamlined and sustainable urban environment. Furthermore, AR tourism has the capacity to reshape cities by fostering the development of new attractions and amenities. This could result in the emergence of novel spatial configurations and the reconfiguration of existing urban spaces to accommodate augmented experiences.

In terms of inclusive, accessible, and adaptable city design, AR technology presents promising avenues for improvement. By employing AR overlays, valuable information about accessibility features in public spaces, such as wheelchair ramps and accessible restrooms, can be readily provided. Real-time information about accessible transportation options and routes can also be delivered through AR, facilitating seamless mobility for individuals with disabilities. These advancements hold the potential to create more inclusive and barrier-free urban environments, promoting equitable access and enhancing the overall spatial experience.

Looking ahead, the future potential of AR technology in shaping cities is substantial. For instance, AR could enable personalized and interactive urban experiences, allowing individuals to engage with their surroundings in novel ways. It has the potential to facilitate data-driven urban planning, providing valuable insights into user behavior and preferences. As the technology evolves, the spatial implications of AR in urban contexts are likely to expand, offering opportunities for more immersive, adaptive, and intelligent urban environments.

In summary, the integration of AR technology in navigation, tourism, and inclusive city design holds profound spatial implications. As cities embrace AR applications, they have the potential to become more optimized, accessible, and adaptable. Moreover, the ongoing advancement of AR technology presents exciting prospects for the future development of cities, paving the way for transformative spatial experiences and data-informed urban planning.

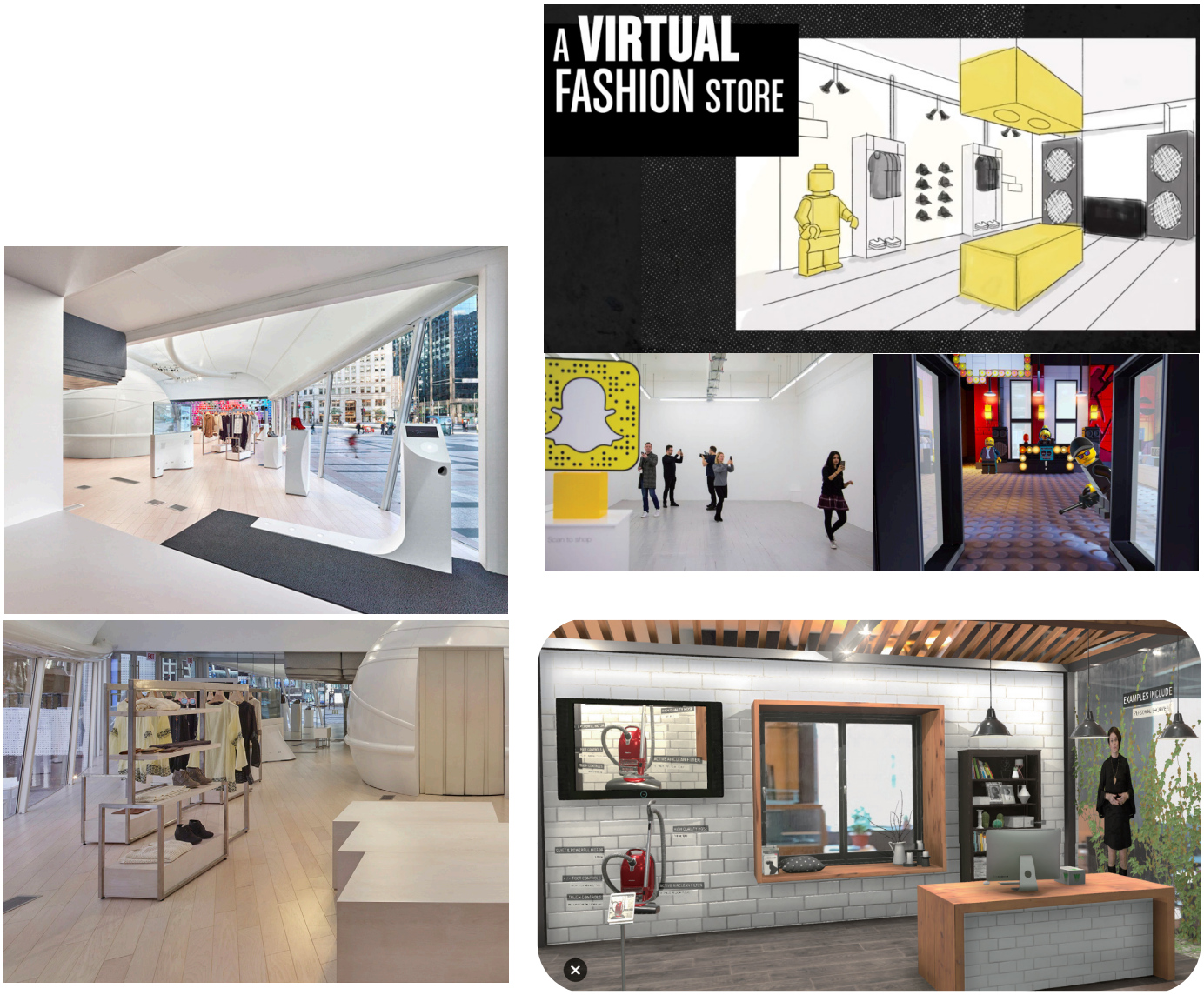



**Fig. 1.6** Augmented Reality in Retail
*How Retailers are Using AR for Better Shopping Experiences*

https://www.nextechar.com/blog/augmented-reality-and-the-future-of-retail
https://www.shopify.com/retail/how-retailers-are-using-ar-technology-to-build-buzz-and-brand-awareness

## 1.3.2 Commercial & Retail

In the future, Augmented Reality (AR) will revolutionize the retail landscape, bringing about significant spatial implications. AR has the potential to scale down the size of retailing areas due to the introduction of digital displays and virtual product showcases. With AR technology, physical store space can be optimized by reducing the need for extensive physical inventory on shelves. Instead, virtual representations of products can be digitally showcased, allowing customers to interact with a wide range of items in a compact physical space.

Additionally, the integration of AR in retailing has spatial implications for store layouts and design. Retailers can allocate more space for immersive AR experiences, creating interactive zones where customers can virtually try on clothes, visualize home furnishings, or test out products. By leveraging AR, retailers can provide an engaging and interactive environment that enhances the overall shopping experience while efficiently utilizing physical space.

Besides, physical stores will still have importance in offering an omnichannel experience to customers, but they will serve more as a media to acquire customers, while online platforms will transform into real stores where transactions happen.

In summary, AR technology in retailing presents various spatial implications. It enables retailers to scale down physical retailing areas by leveraging digital displays and virtual product showcases. Additionally, AR allows for the optimization of store layouts by creating immersive zones for interactive experiences. Furthermore, the virtual nature of AR expands spatial boundaries, enabling customers to shop from anywhere. As AR continues to evolve, its spatial implications in the retail sector are poised to reshape the industry by combining the best of physical and virtual shopping experiences.

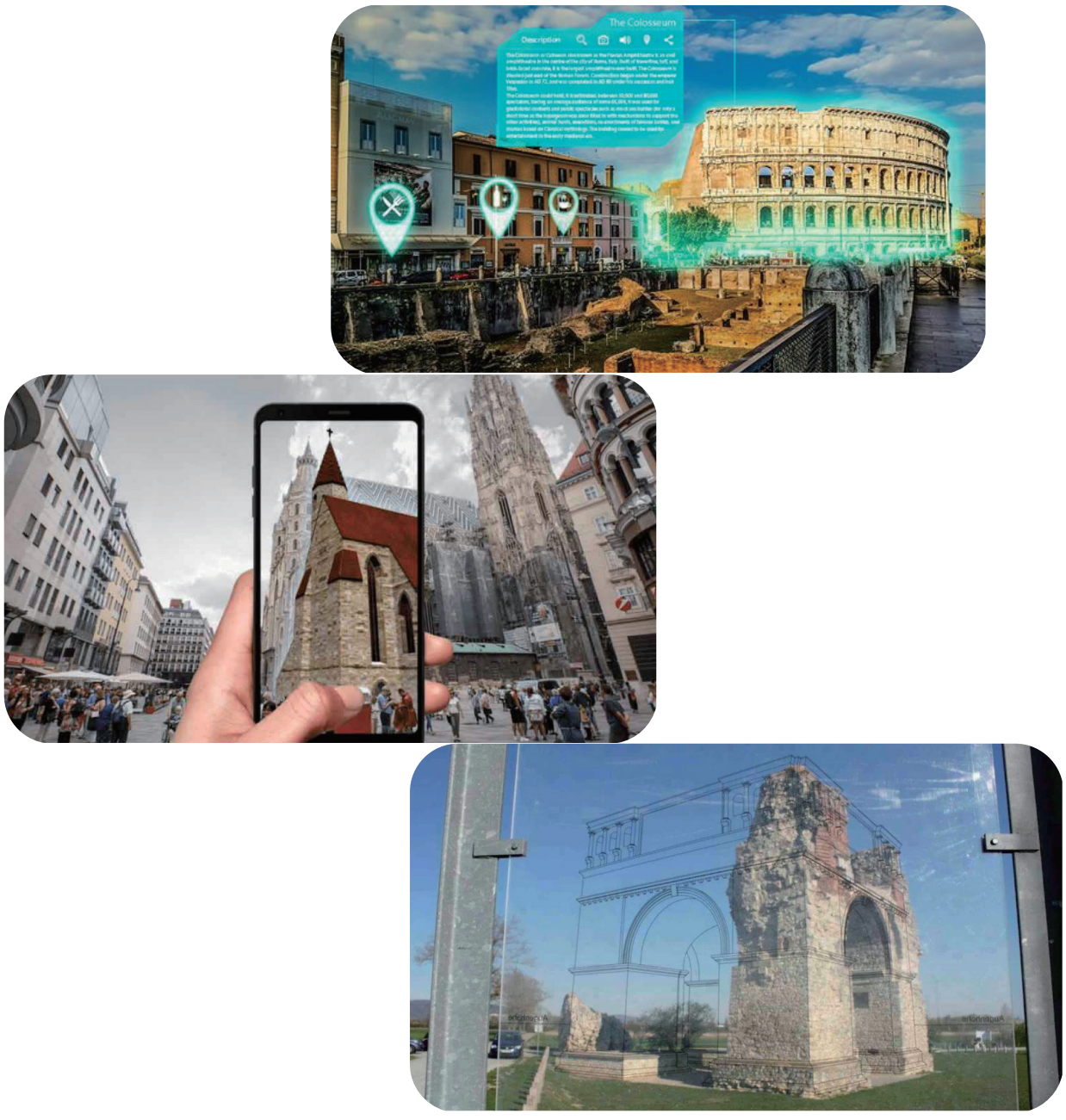



**Fig. 1.7** VR in Tourism & Heritage Preservation
*Virtual and Augmented Reality development Studio in Austria | VARS | AR*

https://www.vars.at/
https://twitter.com/JamesCorbett/status/698086622420668417

### 1.3.3 Culture & Heritage

The use of augmented reality (AR) technology brings about transformative spatial implications in the revitalization of cultural and heritage sites. By superimposing digital overlays onto existing architecture, AR creates a unique spatial experience that enhances visitors' understanding and appreciation of these sites. The integration of AR within museums and tourist attractions allows for the seamless blending of physical and digital elements, resulting in a spatially immersive environment.

Moreover, AR contributes to the spatial revitalization of cultural sites by transforming the way spaces are perceived and utilized. By digitally augmenting the physical environment, AR can breathe new life into historic structures, turning them into interactive spaces for storytelling and engagement. This spatial transformation revitalizes cultural sites and attracts a broader range of visitors, promoting their continued relevance and sustainability.

AR technology also plays a crucial role in the preservation and promotion of cultural heritage by making it accessible and relevant in contemporary spatial contexts. By overlaying digital content onto physical spaces, AR provides a dynamic and interactive means of conveying historical narratives and cultural significance. This spatially immersive approach to storytelling enables heritage organizations to engage audiences in novel ways, fostering a deeper understanding and appreciation of cultural heritage.

In summary, the utilization of AR technology in culture and history brings about transformative spatial implications. By superimposing digital overlays onto physical environments, AR enhances the spatial experience, deepens connections to cultural heritage, and revitalizes historic spaces. Through the seamless integration of physical and digital elements, AR contributes to the preservation, promotion, and spatial transformation of cultural sites, ensuring their continued relevance and accessibility for future generations.

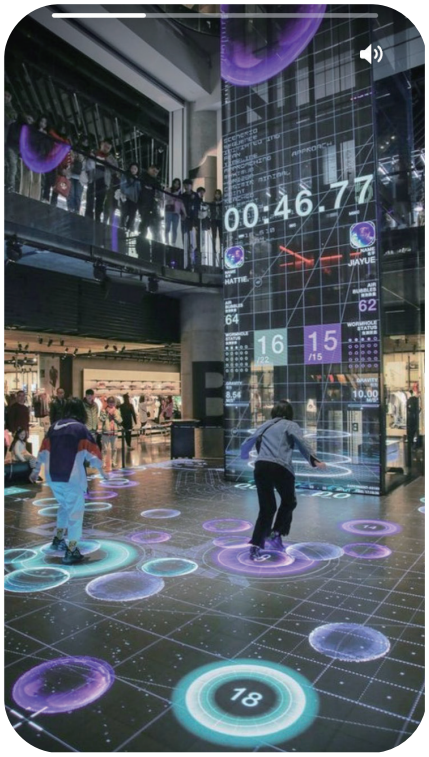





**Fig. 1.8** AR in public art
*Enhancement of the public interactions*

https://www.dandad.org/awards/professional/2021/234990/eva-cremers/?epik=dj0yJnU9SnpVdVB6QmdYbXdHU2d1WU4td09ZZ05I-aTJRUGY4dGsmcD0wJm49YmlsV0VQN1BaamNRT0pyRDdVWlY3USZ0PUF-BQUFBR1I0bmJj
https://www.behance.net/gallery/78110255/Nike-Air-Max-Campaign-720-Just-Go-Bigger

### 1.3.4 public art

Augmented reality has opened up new possibilities for public art, allowing artists to freely express themselves without the constraints of local authority permissions. An example of this is the AR project by Apple and the New Museum, featuring works by renowned contemporary artists. These AR experiences are accessible to the public for free and take participants on immersive art walks in cities worldwide. Through the use of iOS devices, participants can explore the creations of artists like Nick Cave, Nathalie Djurberg and Hans Berg, Cao Fei, John Giorno, Carsten Höller, and Pipilotti Rist. The art installations are integrated into public spaces, such as Trafalgar Square, Yerba Buena Gardens, and Grand Army Plaza, providing a unique and interactive artistic encounter.

The statement from Andrea Curtis, VMF Executive Director, emphasizes the commitment to reimagining the integration of art and people in public spaces while ensuring safety. Over the past two years, the significance of public art and public space in enhancing community well-being, both individually and collectively, has been recognized. It has also been acknowledged that public art and space have a positive economic impact. The success of the VMF Winter Arts festival has inspired the organization to create an even more ambitious event. This suggests that the use of augmented reality (AR) art in public spaces can have a profound influence by bringing joy, inspiration, and a new level of engagement to downtown areas and beyond. AR art has the potential to transform the way people interact with public spaces, fostering creativity, cultural appreciation, and community connection.

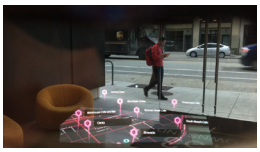
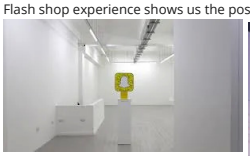
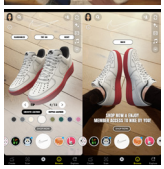
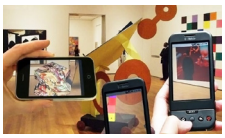
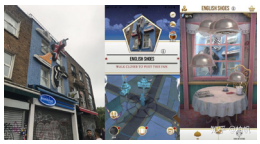
| | | | |
|---|---|---|---|
| Travel & Tourism |     | Navigation<br>Way-finding | Inclusive accessible |
| Commercial & Retail | Flash shop experience shows us the possibilities of digital retail      | physical shop(storage) will be replaced<br>**Flash/popup shops instead** | Multi-functional Intensive |
| Public |       | Art exhibition<br>Attractions<br>Interactive experience | Diverse Interactive |
| Culture & Heritage |  history telling  | History/Story telling | Attractive Accessible |

**Fig. 1.9** Potential impact on urban space

illustrated by author

## 1.3.5 AR conclusions

As a conclusion, the integration of Augmented Reality (AR) technology in various aspects such as navigation and tourism, inclusive city design, retailing, and culture and heritage sites brings about significant spatial implications and holds promising potential for future development.

AR technology has the capacity to transform the structure of cities by optimizing urban mobility and reducing congestion through AR navigation. It also has the potential to reshape cities by fostering the development of new attractions and amenities in the context of AR tourism, leading to the reconfiguration of urban spaces.

In terms of inclusive city design, AR overlays provide valuable information about accessibility features and real-time information on accessible transportation, promoting inclusive and barrier-free environments.

Furthermore, AR technology in retailing has spatial implications as it allows for the scaling down of physical retailing areas through virtual product showcases, while creating immersive zones that enhance the shopping experience and optimize store layouts.

In the realm of culture and heritage, AR technology offers transformative spatial experiences by superimposing digital overlays onto existing architecture. It revitalizes cultural sites, making them more engaging and accessible to visitors. AR contributes to the preservation and promotion of cultural heritage by conveying historical narratives and fostering a deeper understanding of cultural significance in contemporary spatial contexts.

Looking forward, the future potential of AR technology in shaping cities is substantial. AR has the capability to enable personalized and interactive urban experiences, facilitate data-driven urban planning, and create more immersive, adaptive, and intelligent urban environments.

Overall, the integration of AR technology in these areas presents profound spatial implications that have the potential to optimize cities, enhance inclusivity, reshape retailing, and transform cultural and heritage experiences. With ongoing advancements, AR technology has the capacity to revolutionize spatial interactions and contribute to the continued development and improvement of urban environments.

*Zheng, N. (2019). New Possible Applications of Augmented Reality in Urban Design.IOP Conference Series: Earth and Environmental Science, 267(5), 052007. DOI: 10.1088/1755-1315/267/5/052007.*

Fig. 1.10


FASTER
2020™

**Fig. 1.11 Light festival GLOW EINDHOVEN 2019**
https://www.reizen-en-reistips.nl/fotoverslag-glow-eindhoven-2019/

AR is everywhere with us,

in another form.

# Problem Field
Problem Field
Problem Field
Problem Field

illustrated by author

## Introduction

This chapter addresses the problem field arising from the digital transition and urbanization, focusing on their relevance to urban design. We explore how Augmented Reality (AR) can contribute to solving urban issues like densification and inclusive public space design. AR offers new perspectives on urban patterns and the integration of virtual and physical spaces. Additionally, we consider the ethical implications, particularly regarding public space gentrification. By examining these issues, this chapter aims to uncover the potential of AR in shaping inclusive and accessible urban environments.

# 2.1 Problem Analysis

## 2.1.1 Problematization


**Fig. 2-1** Low-headed people
*People in Japan are looking at their phones*

https://www.cna.com.tw/news/firstnews/201909120273.aspx

In contemporary urban environments, the problems posed by the decline of public space and social segregation are significant, stemming from the context of digital transition and urbanization. The emergence of the internet and technological advancements like 5G and Wi-Fi have fundamentally altered people's lifestyles, resulting in a transformation of the traditional functions and dynamics of public spaces.

The development of virtual socializing platforms and the increasing reliance on digital interactions have weakened the connections among individuals in traditional public spaces. People now engage more with others through online platforms, resulting in decreased social interaction and a diminished sense of community in physical public spaces. This digital transition has contributed to the decline of public spaces, as they are no longer the primary venues for socializing and communal activities.

Simultaneously, urbanization has led to social segregation and spatial inequalities within cities. The housing crisis, unaffordable cities, and racial tensions have exacerbated these issues. Scholars have identified various forms of gentrification, including eco-gentrification, techno-gentrification, super-gentrification, and planetary-gentrification, which involve the displacement of vulnerable communities due to development patterns and the promotion of idealized city concepts.

These trends have significant implications for the inclusivity, diversity, and equitable access to public spaces. The decline of traditional public spaces and the social segregation resulting from urbanization contribute to spatial inequalities and the marginalization of certain groups within cities. Addressing these challenges requires the efforts of urban planners, policymakers, and designers to reimagine and revitalize public spaces, foster social cohesion, and ensure equal access to urban resources for all members of the community.

In summary, the decline of public space caused by the digital transition and the social segregation resulting from urbanization pose dual challenges in contemporary urban environments. The digital transition has shifted social interactions to virtual platforms, diminishing the importance of physical public spaces. Simultaneously, urbanization has exacerbated social segregation and spatial inequalities, leading to the displacement of vulnerable communities. Addressing these challenges requires a comprehensive approach that revitalizes public spaces, promotes social cohesion, and ensures equal access to urban resources for all.


**Fig. 2-2** Hudson Yards, NYC
An example of "place" being installed, rather than growing organically
*Photo by Joe Shlabotnik, Flickr Commons*

https://www.pps.org/article/gentrification

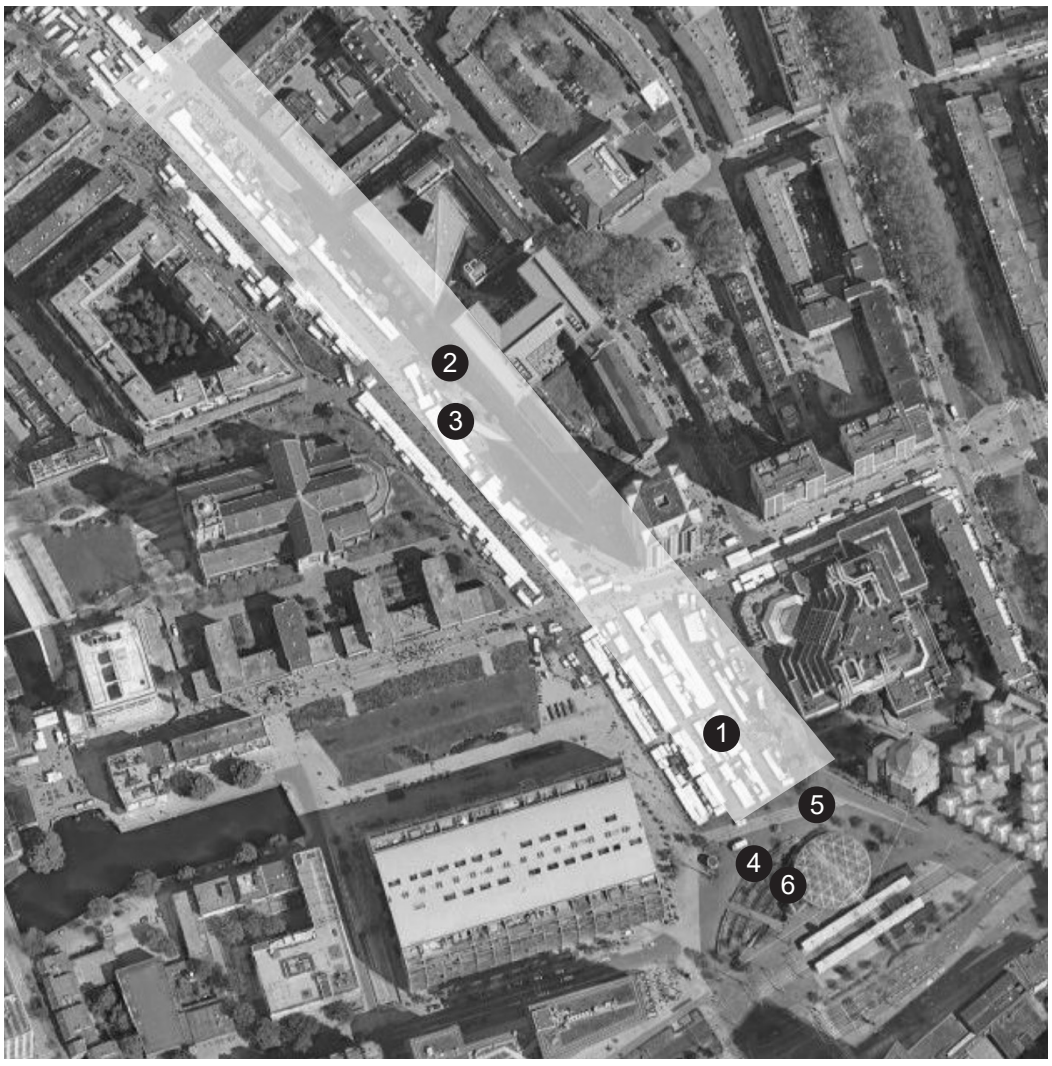
PUBLIC EXLUSIVENESS

[1] Badger, E., (2012) How Smart Phones Are Turning Our Public Places Into Private Ones. The Atlantic City, 16 May. Available at: http://www.theatlanticcities.com/technology/2012/05/how-smart-phones-areturning-our-public-places-private-ones/2017/ (Last accessed 9 November 2013)

# 2.1 Problem Analysis

## 2.1.2 Problem on site

The vast open space located in front of the Blaak station is a notable feature in the neighborhood, offering a rare opportunity for a sizable public gathering area. However, despite its potential, it is interesting to observe that people tend to gravitate towards the benches surrounding the station square, rather than occupying the central expanse directly in front of the station. Detailed site research has revealed that individuals are less inclined to linger in the immediate vicinity of the station, instead choosing to gather at the periphery of the square. This phenomenon suggests a preference for the boundary areas, which offer a sense of enclosure and possibly a more comfortable and inviting atmosphere for social interaction. Consequently, the white open space, while designated as public, assumes more of a transient character, primarily serving as a thoroughfare for passing pedestrian traffic rather than a space for prolonged public engagement.




[1] Jan Gehl. Cities For People[M]. Washington: Island Press, 2010: 153-155; 162.

1

2


3

4


5

6


**Fig. 2-3 Lanes for low-headed people**
https://www.kocpc.com.tw/archives/201643


手机CELLPHONES
低头族
专用通道


**Fig. 2-4** A "gentrification sale" in Williamsburg, Brooklyn
After tenants were evicted from their apartment so the building could be turned into condo units.
*Photo, Flickr Commons*

https://www.pps.org/article/gentrification

# Considering the p
# tunities that digit
# banization bring,
# clusive and access
# and spatial forms
# adapting to peop
# and aiding physic
# goal. AR and its v
# help solve many u
# additional layer o

**problems and oppor-
al transition and ur-
designing more in-
sible urban patterns
for the future by
le's future lifestyles
al spaces is the final
virtual content can
urban issues as an
f urban information.**

## 2.2 Problem Statement

Firstly, with the advent of the internet era, the digital transition of society has led to a greater reliance on devices, weakening physical interaction and reducing the need for physical space. It has led to an increasing decline in the original episodic activity and mediating function of public spaces.
However, the AR game Pokémon Go has succeeded, almost overnight, in enticing people into the streets of cities around the world, which make many previously underutilized public spaces suddenly become hot spots.
Many studies have shown that virtual spaces are becoming increasingly functional and gradually replacing some physical spaces. However, virtual worlds cannot replace people's senses and experiences, such as restaurants and other experiential services. Traditional businesses that rely solely on physical spaces will face a transformation. Therefore, physical space, as a place to accommodate activities, needs to work in synergy with virtual space to achieve some balance, and AR technology can integrate virtual information into the physical world, acting as an information supplement and a catalyst for vitality.

Secondly, accelerated urbanization and intensification have led to a high concentration of resources in the physical world. It has made both public resources and public space exclusive, which will increase social segregation as well as conflict. Despite this, the housing shortage is still in urgent requirement of a solution. High-density or multifunctional spaces might be the solution, but at the same time, the spatial justice of the city needs to be considered. Virtual spaces brought about by AR are adaptable and not limited by physical space, freeing up part of the urban function and providing more available space.

# 2.3 Relevance

Scientific Relevance

Firstly, it provides a new perspective from the technology that how could AR involve and benefit the urban design process, especially focusing on solving urban issues like where to densify or how to design public space inclusively. It is showing the future possibilities of urban patterns and helping form a data-adapted urban system. People could find the space they need to use based on data flow, enabling more intensive urban spatial development, which can address the densification of the city and reserve more space for other functions.

Design of the Urban Fabric

Secondly, facing the digital transition of society, working with augmented reality could help us rethink the relationship between physical space and virtual space. The focus of urban design is usually on physical space, the design of relay spatial forms that can accommodate both virtual and physical spaces need to meet the possibilities of multifunctional development and the different needs of people for public and private spaces. As a new technology, there is little existing research on the spatial impact of augmented reality on urban design, and the possibility of changing urban patterns and spatial forms is of interest to future urban research or urban design.

## Societal Relevance

This project is showing the future possibilities of urban patterns and helping form a data-adapted urban system.
People find the space they need to use based on data flow, enabling more intensive urban spatial development, which can address the densification of the city and reserve more space for other functions.

Applying this technology to a less sexy task—seamlessly integrating data into everyday experiences—could provide much more concrete value to cities. This will show how people's lives will be changed and what will happen as a result of the interaction between people's behaviour and space. The designing part of the project will be an experiment to evaluate the results to determine if the implication of the task on the city is beneficial. And the whole process itself is also valuable to the future urban design and research.

**Fig. 2-5** GENTRIFICATION AND PLACEMAKING

*Juliet Kahne, New York*

https://thecityateyelevel.com/stories/gentrification-and-place-making-an-interview-with-juliet-kahne/

# 2.4 Ethical considerations

**The gentrification of public space**

Whenever public space is discussed, whether users can share spaces equally is an important issue. With the development of urbanization, city centres are built better, and relatively affluent people are attracted to live in city centres and enjoy abundant material resources, while those who live far from centres are greatly disadvantaged from infrastructure to public space.

Therefore, one of the major advantages of digital AR public space is that it can create public space in any place, allowing people to have equal access to information and resources.

# Methodology
# Methodology
# Methodology
# Methodology

# Using Augmented Reality as a solution to address spatial and social segregation, how can we design virtual and physical spaces for collaborative working while ensuring that urban spaces are inclusive, accessible and dynamic?

## Introduction

This chapter presents the methodology employed to investigate the use of Augmented Reality (AR) as a solution to address spatial and social segregation in urban environments. The research structure is outlined, providing an overview of the subsequent sections. The central research question focuses on designing virtual and physical spaces for collaborative working while ensuring inclusivity, accessibility, and dynamism. A methodological framework is established, encompassing research methods, data collection, analysis, and interpretation. Hypotheses are formulated to guide empirical investigation. A case study approach is utilized to gain practical insights, and a conceptual framework is developed to provide theoretical underpinnings. This methodology chapter ensures a systematic and comprehensive approach to studying AR's potential in addressing urban segregation and designing inclusive, accessible, and dynamic spaces.

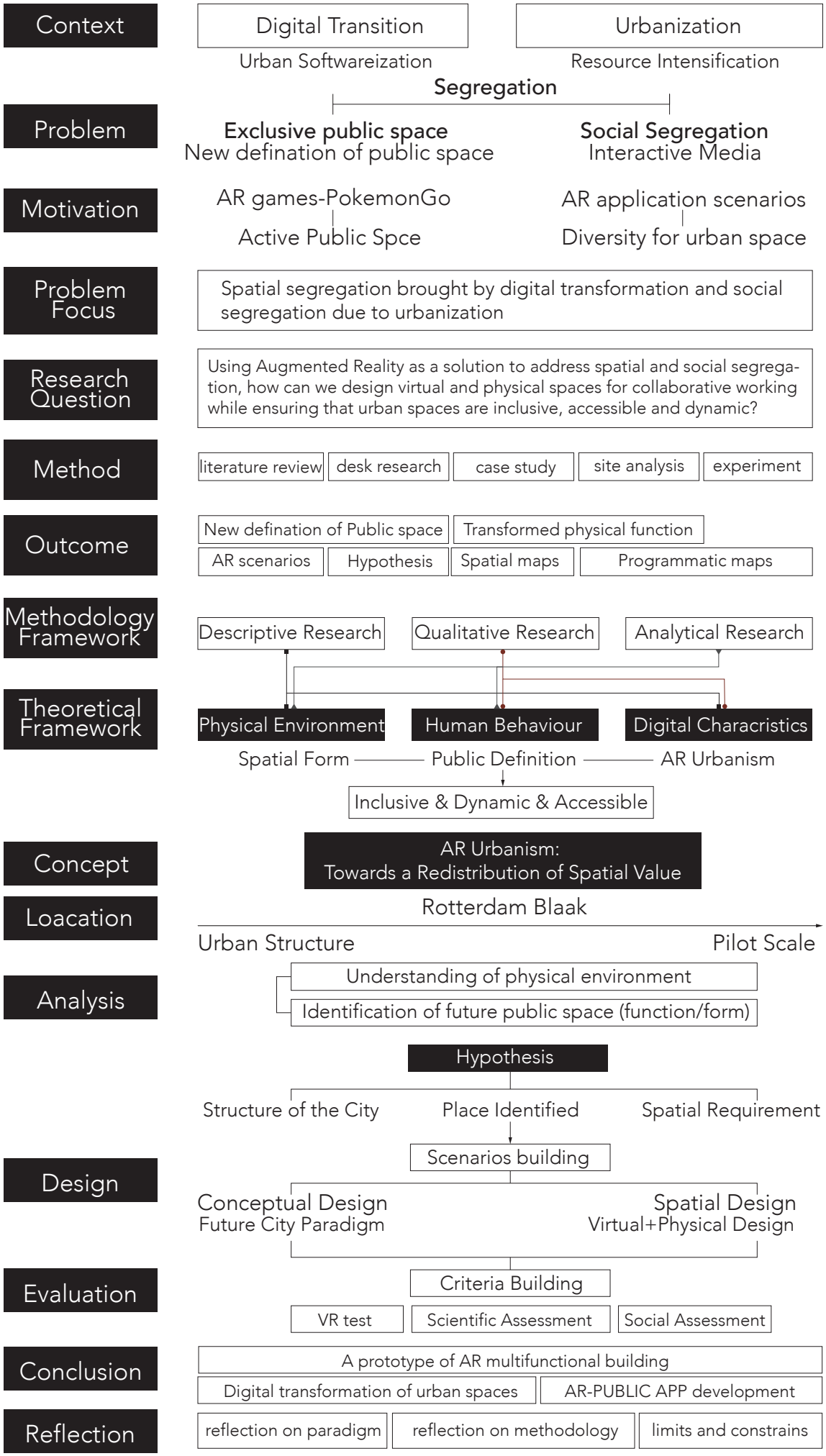



**Fig. 3-1** Research Structure
illustrated by author

# 3.1 Research Structure

Methodology

The methodology chapter outlines the way in which the research is to be taken and identifies the methods included in the process, which can be understood also as a research structure. Each section and unit will have its specific method, and respond to specific research questions.

The general structure of the thesis is shown. It starts with understanding the general context by taking a deeper look into the role of digital transition and urbanization. Through this process, it helps to define the urban problems, which need more space and new spatial form in the future.

In order to understand the potential and features of future AR space, and improve the cognitive image of public space, the interrelation is studied through a series of data gathering and analysis. The main methods used are categorized into three types, the descriptive research, the qualitative research and the analytical research. The proposed methodological framework is also divided in scales to understand the existing network and elements and to have future projection on development.

The outcomes are expected to have both research ones and design ones, and it will be conveyed through scales. On the macro scale, the city structure will be provided in alternative for extreme scenarios where AR play a role to fill in the gap of space and people; in micro scale, within the identified block, design of building blocks and public spaces are proposed to transform the segregated space to a space that encourages social interactions satisfying the densification problem. The design will be reflect back in scales to understand its impact on local placemaking and its contribution to the overall quality of life.

The pilot is studied with evaluation and reflection in the process, which is going to be the first attempt to promote the paradigm approach in other areas and form a more regional implications.

# 3.2 Research Question

MAIN RESEARCH QUESTION

Using Augmented Reality as a solution to address spatial and social segregation, how can we design virtual and physical spaces for collaborative working while ensuring that urban spaces are **inclusive, accessible and dynamic**?

SUB QUESTIONS

## Foundamental

F1 What are the main characteristics of AR?

F2 What are the **spatial&social segregations** that AR technology can help to solve?

F3 Why and how can virtual spaces enhance physical spaces?
(how AR benefit)

F4 What kind of space / activities the future public space need?

## Spatial order

S1 What is the current urban condition in Rotterdam blaak and how is it working relating to inclusiveness and accessibility?

S2 What is the spatial distribution of current types of housing and what are the characteristics of these bulldings?

S3 What are the spatial distribution of current types of social activities (public space&shopping,etc) and what are the characteristics of these locations?

## Concept

C1 How does digital transformation contribute to spatial segregation in urban environments, and how can AR be utilized to mitigate these divisions?

C2 What are the social factors driving urban segregation, and how can AR applications foster inclusive public spaces and social interaction?

## Intervention

I1 What kinds of physical spaces can be aided/changed by AR, and where is the distribution?

I2 What kinds of virtual spaces can be combined by AR?

I3 What design principles and features should be incorporated into a public building addressing urban issues, while also facilitating adaptability for AR technology and promoting flexibility and diversity?

I4 To what extent can AR technologies address the exclusivity and social segregation observed in public spaces, and what are the potential implications for urban planning and design?

## Evaluation

E1 How to evaluate the result?

E2 How will the development of pilot design affect urban structure in transition to future city?

| METHOD | EXPECTED OUTCOME |
| --- | --- |
| Literature Review/AR application case study | AR application scenarios and features |
| Literature Review/Desk research(site?) | urban issues/AR potentials<br>(Relation between technology & urban development) |
| Literature/Reference Review | Hypothesis/Pattern languages |
| Literature Review/Desk research/Interview | Scenarios |
| Spatial Mapping based on data drawn from online datasouce in order to identify level of intergration and spatial type. | a map of city structure and relating functions in proximity; a map of accessibility of mobility and infrastructure; a map of density and accessibility of public functions; a map of aggregation of resources |
| Spatial Mapping and Typological analysis | a map of different housing type; a table of building typology; |
| Use Behavioral Mapping to locate the activities and use Empirical Observation and Photographing to identify changes. | a table of public space typology; a map of human behaviour (activities) in public space |
| Based on the criteria in different scales drawn from Literature Review and Case Study, Questionnaires and Interviews are made to verify the A&I relevance and weights. | AR Scenarios<br>criteria radar graphic of I&A |
| Map the 'drosscape 'based on analytical mappings<br>Identify specific areas or public spaces where AR can enhance the user experience. | analytical mappings |
| Integrating virtual elements into the user's real-world environment. Scenarios are built based on the hypothesis. | virtual and physical types making for AR building |
| Design principles for AR-adaptable public buildings: Flexible layouts, AR-friendly infrastructure, interactive spaces, clear signage<br>Based on the known pilot sites, spatial conditions will be studied to have Case Comparision for design | design components<br>design principles |
| Evaluate inclusivity, social interactions, spatial dynamics, urban implications. Design a building prototype adapting AR that could be applied to other places. | prototype design<br>application scenarios |
| Criteria setting and workshop for VR experiment. | Observations and feedback from experiment |
| Workshop | Conclusions of AR-public |

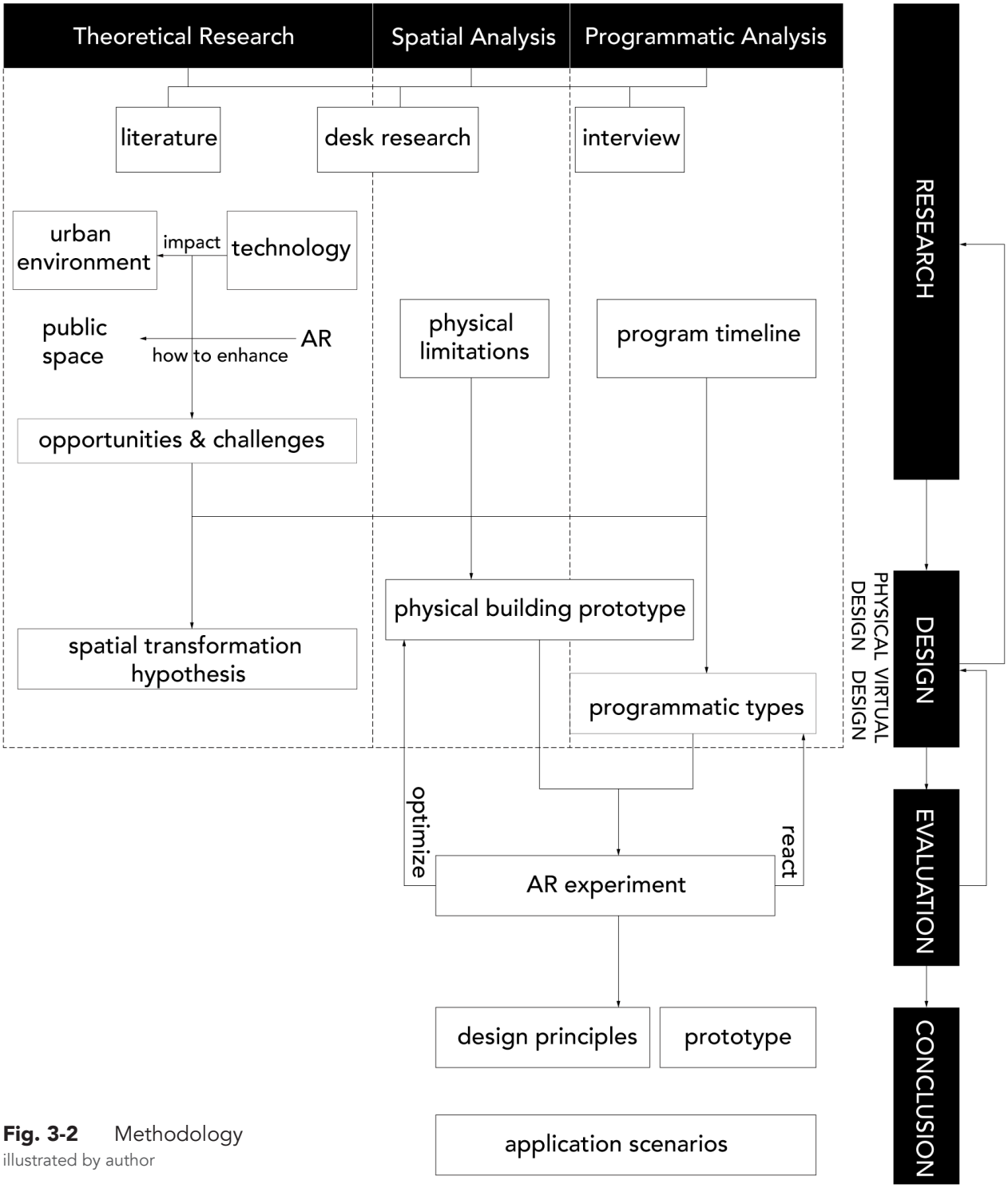



**Fig. 3-2** Methodology
illustrated by author

# 3.3 Methodological Framework

Research by design

**Research**

• Theoretical framework: literature, desk research and interviews

The relation between urban development and technology (help formulate hypotheses for future city models basing on AR revolution)

The public space defination (help understand and redefine public)

• Exploration of technical development of AR

AR applications case study provides future potential to solve urban issues. And the features of AR are studied to suggest approaches in which AR might help to improve the inclusiveness and accessibility of public space.

• Spatial analysis

to understand the condition and relevant elements

• Programmatic analysis

to understanding the physical space and looking for opportunities.

**Design**

• Conceptual design

Practice AR scenarios in urban systems from a conceptual perspective

• Spatial design for Blaak location (Binnenrotteplein), combining physical and digital models

Using Rotterdam Blaak as a pilot to test whether and how could AR solve the urban issues and benefit the urban environment.

• Virtual design for programs

Based on the study of AR application scenarios and the analysis of activities on the blaak site, design of virtual activities that can be used within the physical model.

**Evaluation**

• AR experiment

Design an experiment to test the feasibility of the activity and the behaviour of human interaction with the building. Evaluate and optimise the design content by analysing the results of the experiment.

Evaluation criteria are set with reference to urban research, digital models of the pilot designs are used to evaluate the results.

**Conclusion**

• Spatial prototype based on physical and digital environments

Research and design are carried out simultaneously and iterative way.

• Application scenarios

# Hypothesis

Activities and Mobility

THE SHOPPING SPACE DEVELOPEMNT

THE PUBLIC SP

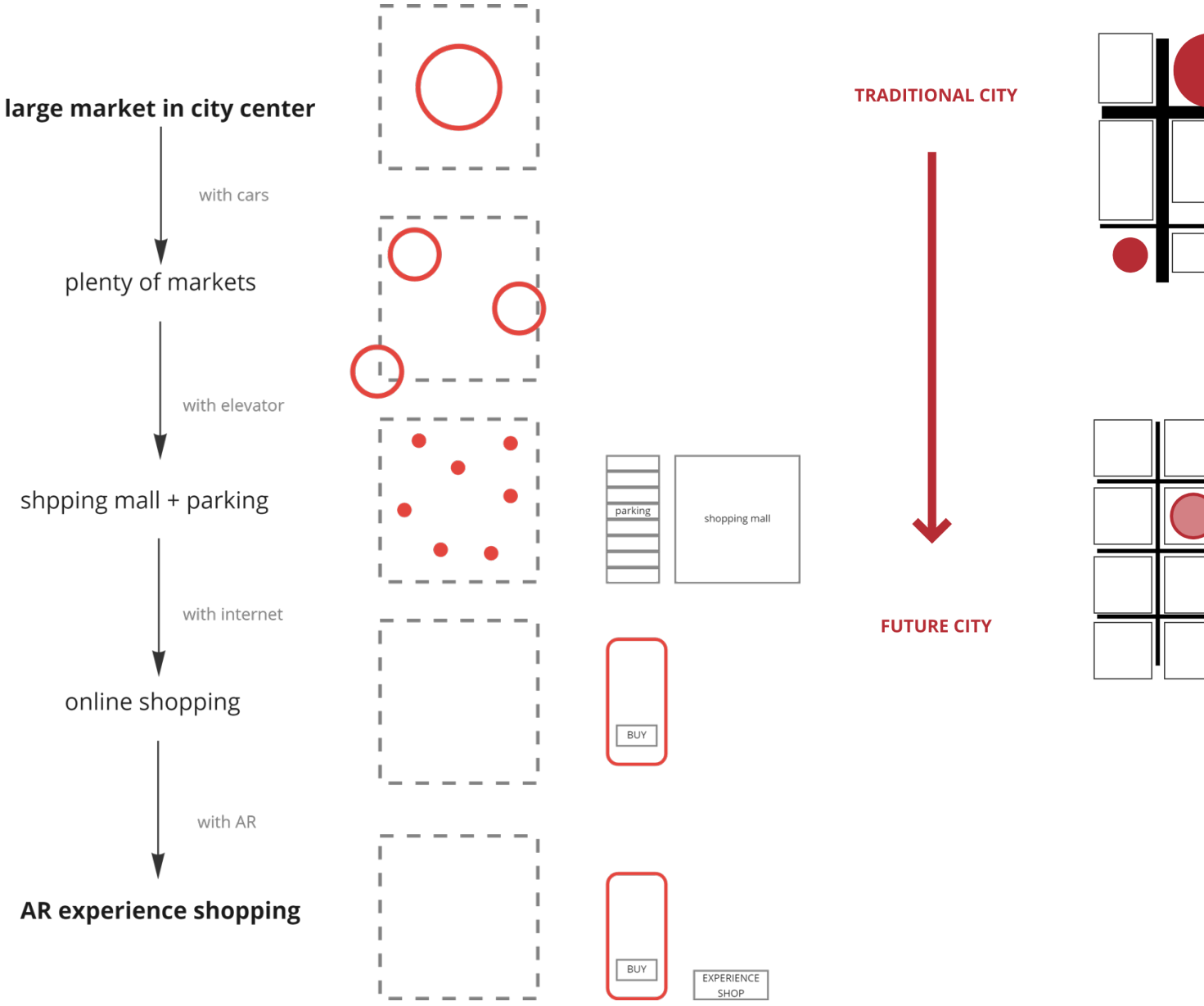
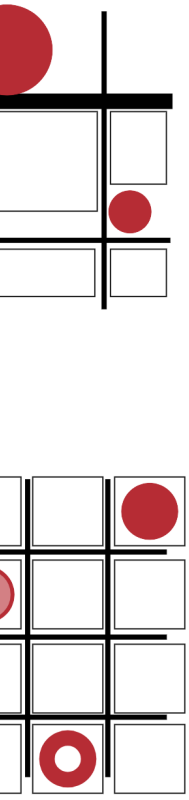
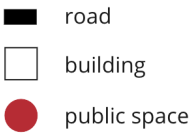



**Fig. 3-3** hypothesis diagram
illustrated by author

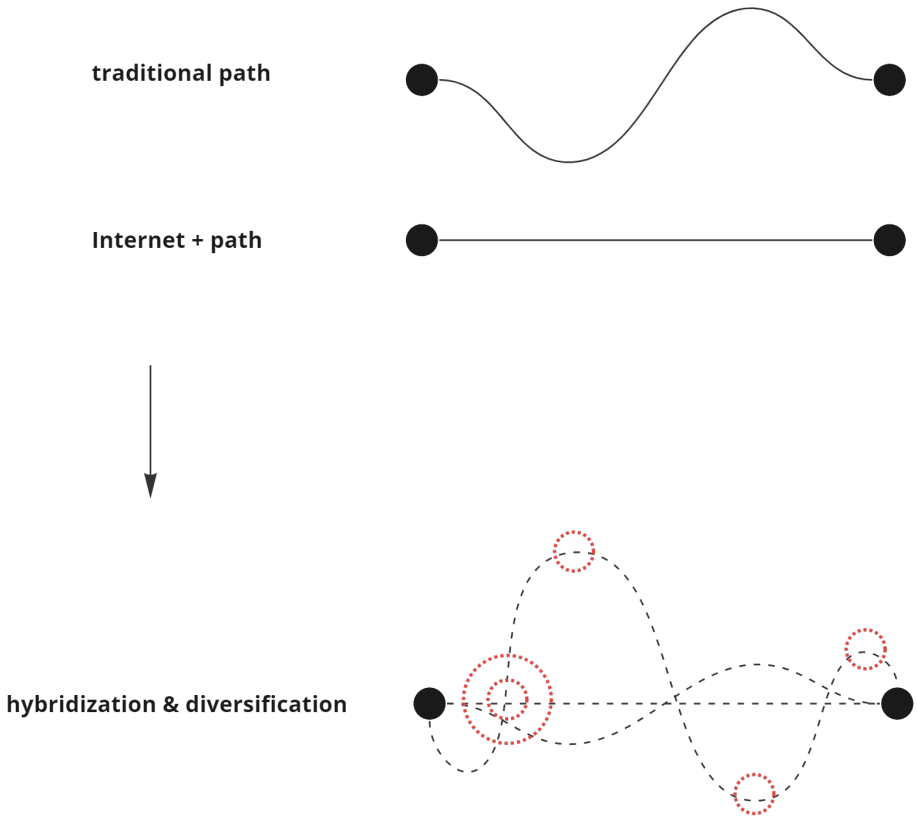
PACE DEVELOPMENT








THE MOBILITY DEVELOPMENT




Hypothesis 1: The evolution of shopping space is influenced by changes in transportation modes and digitalization. With the emergence of cars, the distribution of shopping areas has become more dispersed. As the internet has developed, online shopping has gained prevalence, leading to significant transformations in the physical form of shopping spaces. The future integration of virtual and augmented reality technologies is expected to further reshape the design and layout of shopping spaces.

Hypothesis 2: The digitalization of public space leads to a decentralization of cities and expands the concept of urban public space. Through the integration of virtual information layers and the utilization of big data, urban public space is no longer confined to traditional outdoor parks or visible street spaces. Instead, it has the potential to encompass various floors within buildings or even rooftops, creating new possibilities for social interaction and community engagement.

Hypothesis 3: The mobility of cities will become more complex and diverse due to advancements in digital technologies. The internet enables the emergence of new transportation and mobility options, such as ride-sharing services and on-demand mobility solutions. This increased diversity and complexity in urban mobility patterns will have implications for the design and organization of urban spaces, as well as the overall urban planning and transportation systems.

# Theoretical Reasea
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## 4.1 Spatial transformation
## 4.2 Social considerations
## 4.3 AR Implications
## 4.4 Concept—— AR urbanism

## Introduction

This chapter explores the dynamic relationship between urban development, technology, and the spatial and social characteristics of public space. It aims to investigate the evolving nature of urban environments in the context of technological advancements and the changing needs and behaviors of individuals. The theoretical research focuses on understanding the spatial development of public spaces and their utilization patterns, considering factors such as accessibility, inclusivity, and social interactions. Furthermore, the chapter explores the potential applications of Augmented Reality (AR) as a solution to address the challenges faced by public spaces. By examining these aspects, this chapter provides a theoretical foundation for understanding the intersection of urban development, technology, and public space, and offers insights into the potential of AR in shaping more vibrant, inclusive, and engaging urban environments.

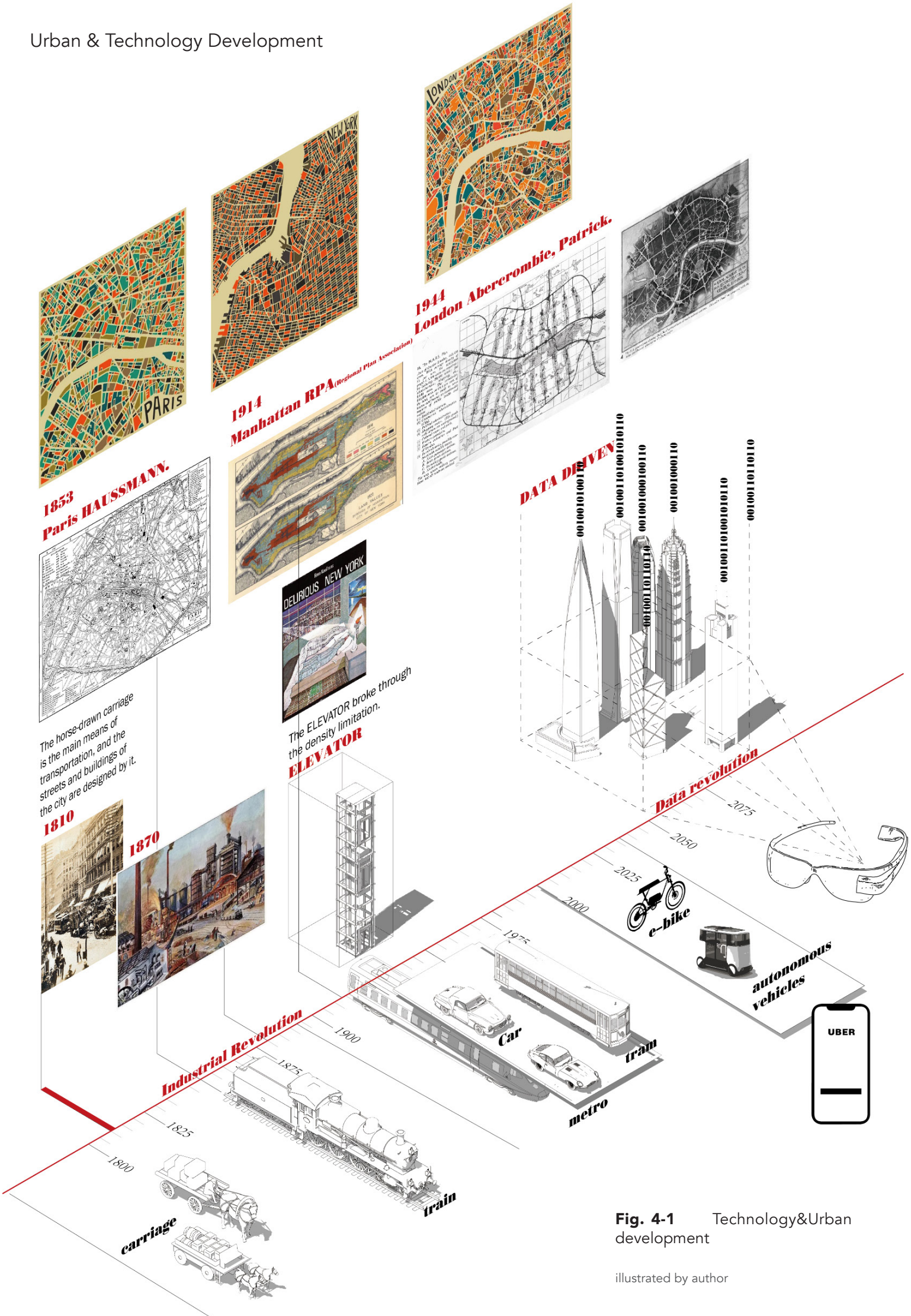



**Fig. 4-1** Technology&Urban development

illustrated by author

# 4.1 Spatial Transformation

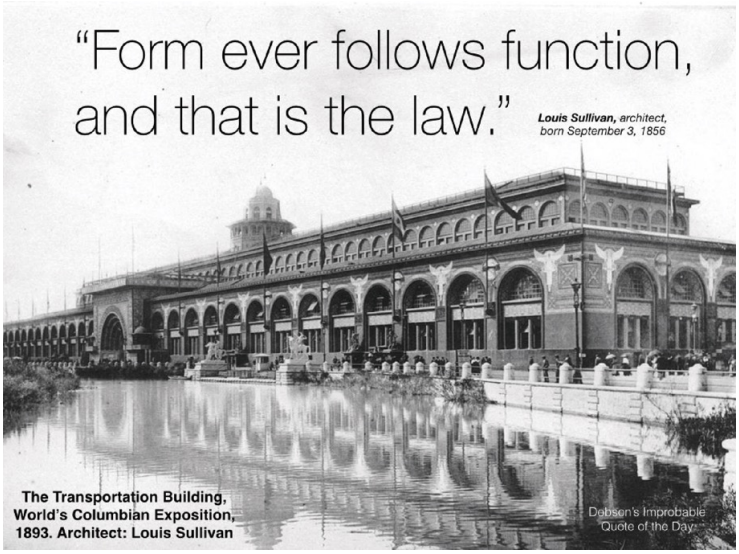
## 4.1.1 towards a digital revolution

And after theoretical research into the history of urban development, I have found that new technologies often have a significant impact on urban patterns.

The emergence of public transport has largely saved resources, while the emergence of shared bikes, online cars and self-driving cars has changed the way people travel and move around the city, which naturally has different spatial demands on the city based on different modes of transport.

After the Industrial Revolution, the invention of the lift made it possible for cities to develop at high densities. In Chapter 4 of Mad New York, "The Double Life of Utopia: Skyscrapers", Koolhaas explains how the use of the lift made skyscrapers an ultra-dense urban complex with a variety of functions. This high density has led to a fragmentation of form and function, where 'form no longer follows function'.

[1] Habermas, J. (1999), The Structural Transformation of the Public Sphere, tr. by T Burger, first printed in 1962, Blackwell Publisher Ltd., Oxford, UK.


As introduced in the chapter of 1.3 AR introduction, AR will have a greater ability to shape the user's city image than the physical world, a holistic city image no longer exists, and the concept of the spatial structure of urban intention is no longer stable.

The data generated by people's actions will form a digital layer on the physical space. The function could be changed following people's behaviour.

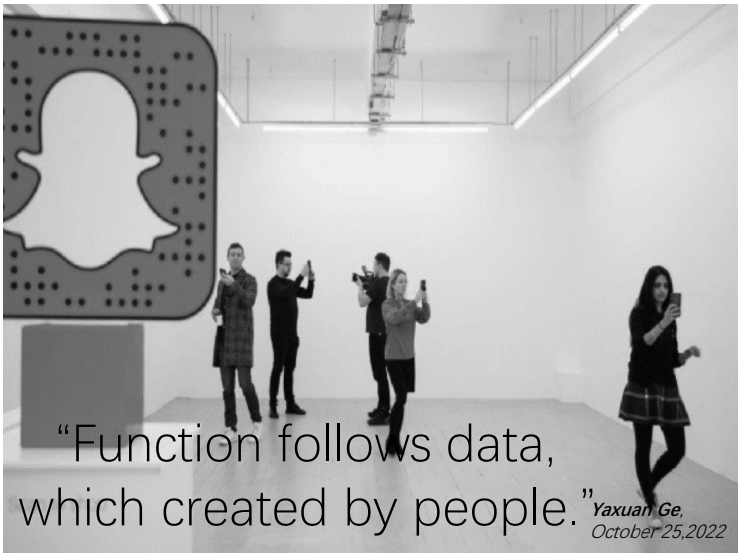




**Fig. 4-2** Future city image

illustrated by author
Picture by Lucas Lindsey.

# 4.1 Spatial Transformation

## 4.1.2 towards a new city image

THE IMAGE OF THE CITY

As the field of mixed reality devices advances, eventually consumer-grade AR devices and applications will enter everyone's lives, and AR will have a greater ability to shape users' urban intentions than the physical world. For future users of AR applications, augmented reality may already be a habitual presence in their lives, with each user's formation of urban intentions at different moments profoundly influenced by the AR application they are using at the time. A holistic urban intention no longer exists and the notion of a spatial structure of urban intention is no longer stable.

FORM & FUNCTION

In addition to changing the large-scale urban imagery, changes in form and function also follow, as each action that people leave behind in the digital world completes the unique database of each individual, the function of space becomes variable and diverse, the function of space is no longer limited by form, and people can get personal recommendations to form the space they need.

The augmented reality could change our city a lot. It brings many possibilities for urban space, it is easier to provide exciting scenarios or flexible function, and a good AR product can bring us a better urban experience.

# 4.2 Social considerations

## 4.2.1 a new defination of public space

Public Space: Jan Gehl's staying space

Jan Gehl believes that the quality of the spatial environment is inseparable from whether public life is active or not, and that creating a good and comfortable spatial environment is conducive to stimulating the development of public life and activities. Stopping space is an important part of public space, which refers to the space that can provide the public with the possibility and opportunity to stay and use, such as various types of streets and squares, etc. It is also the main space that carries the public life and activities in the city, with the characteristics of frequent use, various functions and great potential.
Through careful observation and study of people's behaviour in public spaces, Gayle has discovered hidden regularities in them, and has developed them into a theory that can be used to guide the design of public spaces. His theory can be summarised in three "effects", namely the edge effect, the niche effect and the interface effect.

"The 'boundary effect' is a pervasive phenomenon. Gehl found that "when people choose where to stay, they usually choose the boundary areas of space". He argues that these edge areas are preferred because, firstly, they do not impede the passage of others; secondly, they provide a better view of the space and a sense of psychological security; and thirdly, they provide a convenient way to leave at any time. At the edge of the space, the view allows the observer to see what is happening in the space. At the same time, the edge is often a transitional area between 2 different spaces, allowing people to easily change their field of view of attention. When dealing with the edges of spaces, the relationship between openness and privacy between the two spaces should be grasped, as this is extremely important to facilitate the occurrence and unfolding of activities. In most cases open spaces are preferred to closed spaces and are more comfortable. Therefore, when designing public spaces, taking full advantage of the positive effects of edges can have a positive effect in enriching and enlivening public life.

"The 'niche effect' is a term used for 'concave' spaces. Gehl notes that when the walls of a building consist of columns or stacks forming a 'concave' space, these spaces are often popular and are often spaces where people want to stop and stay, as they can satisfy the psychological need for support and provide a sense of security. Similarly, a column, a sculpture or a tree can be an object of support, creating a psychological effect similar to that of a niche. According to Gayle, this 'partially concealed' space allows people to be hidden in a semi-obscured space, while at the same time providing a good

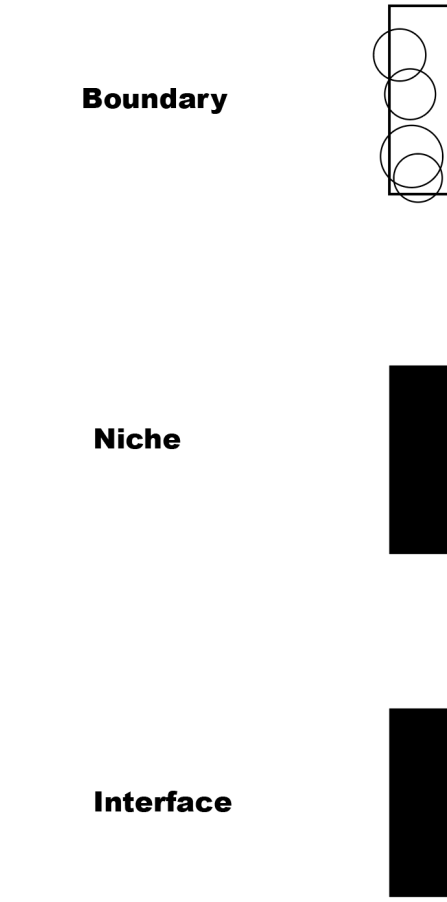
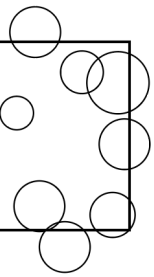
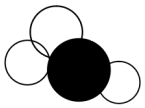
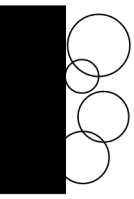



**Fig. 4-3** Staying space from Jan Gehl

illustrated by author







view of the space. For design purposes, recesses in buildings, set-back entrances, porches, verandahs and trees in front gardens all serve the same purpose, providing both protection and a good view. Where such spaces exist in a place, it is sure to be the preferred place for those who want to stop and enjoy public life. The 'niche effect' principle should therefore be followed in the design of public spaces to create spaces that are approachable and encourage more people to use them.

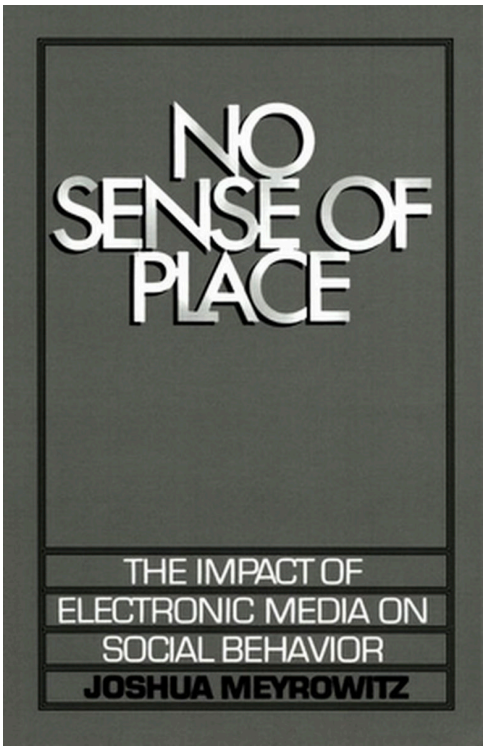
In Gayle's vocabulary, interface is broadly defined as both the street façade, the surface of a building and the ground level. According to Gayle, spaces that are approachable tend to be richly varied and mixed, as people are always looking to capture interesting visual landscapes. He argues that artful and vibrant interfaces will always attract people to stop and look, either voluntarily or involuntarily, and that the very act of stopping implies that something or an activity may be potentially happening. When the interface of a space has a point of attraction, it has the potential to draw people's attention and make them stop and feel the pleasure that the space offers. The interface effect therefore explains why pedestrianised streets are frequented by people on holidays, where stalls bring in some economic revenue and add to the content of the space, making the whole space active as a result. People is people's great joy".

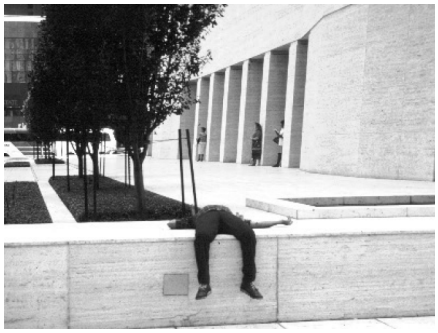
Detailing is an important 'catalyst' for creating the conditions for stopping and lingering in a public space, which in turn leads to the development of activity on the site. Therefore, Gayle emphasises that if a space is deserted and empty, without seating benches, colonnades, plants, trees or the like, and if the façade lacks interesting details such as recesses, doorways, entrances, steps, etc., it is difficult for people to find a place to stop. On the contrary, the best spaces for outdoor stays mostly have irregular façades with a variety of supports

[1] Jan Gehl. Cities For People [M]. Washington: Island Press, 2010: 153-155; 162. [2] (Dan) Jan Gehl. Interaction and Space [M]. He Renke. Beijing: China Construction Industry Press, 2002: 155.

# 4.2 Social considerations

## 4.2.2 'public revolution'

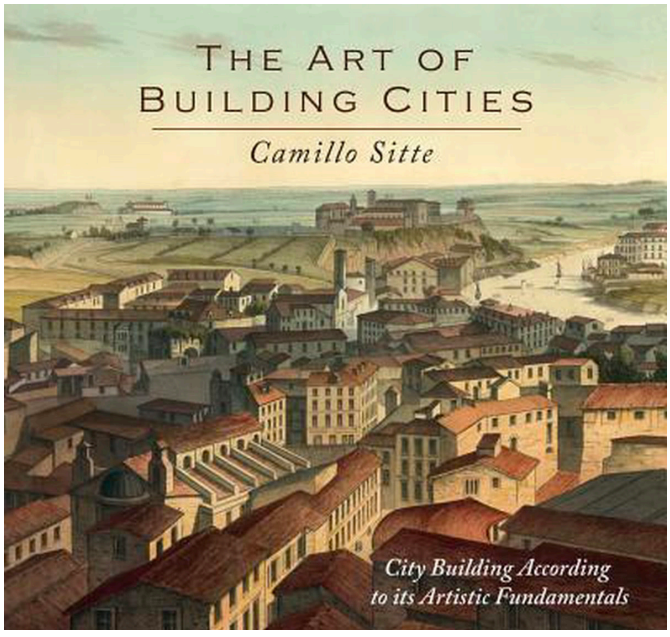


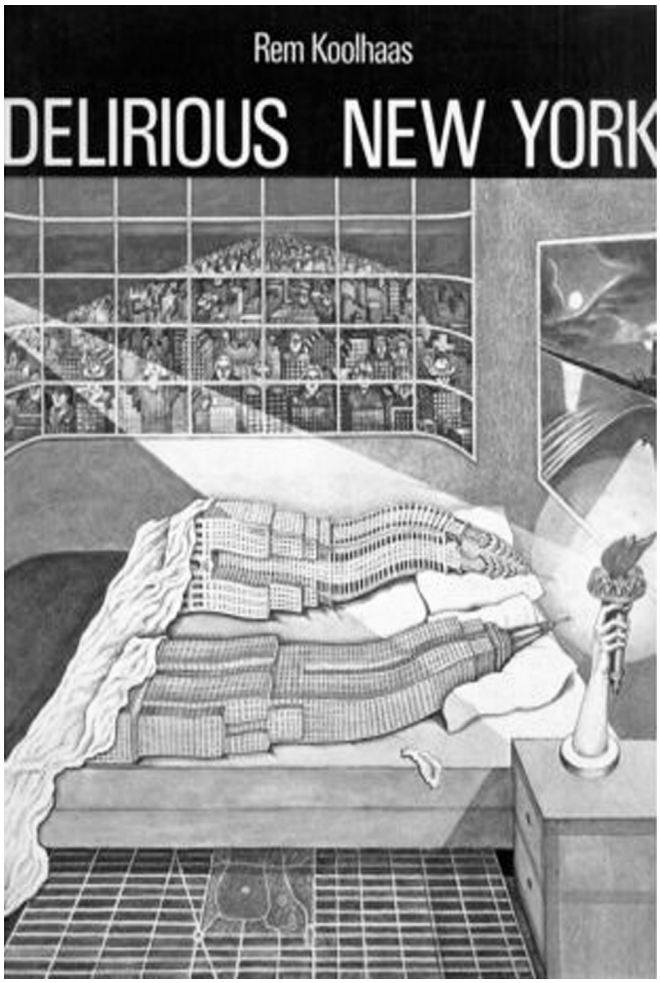



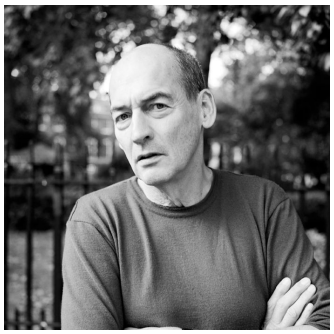
Joshua Meyrowitz 1985 No Sense of Place: The Impact of Electronic Media on Social Behavior

The logic of scene behavior is closely related to the pattern of information flow, and the media reshapes social and material space by reconfiguring the way people send and receive social information.

"The industrial revolution has brought a range of technologies that are changing the way people live, and some traditional spaces are becoming memories or being used for other purposes."





The idea of being able to design cities is based on unexamined philosophical assumptions, and modern transportation and communications, especially the Internet, have made traditional urban spaces a thing of the past.

Human interaction is no longer limited by geographical association and no longer has to be carried out in physical space. And the same situation is actual for human-space interaction. The future public space will be defined by human behaviour when the social interaction happening, not limited by the spatial condition. No matter the space is open or close, center or margin, large or small, it could be 'public space' when it is accessible and inclusive. Thanks to the augmentede reality, the future public space will be visible at anywhere. Peole can easily find a nearest public space and join the activities there.

[1] Bodnar, J. (2015). Reclaiming public space. Urban Studies, 52(12), 2090–2104. https://doi-org.tudelft.idm.oclc.org/10.1177/0042098015583626

# 4.2 Social considerations

## 4.2.3 overlapping interests in a contested arena


**Fig. 4-4** Billboards in shopping streets

illustrated by author
Source: https://www.alamy.com/city-centre-of-rotterdam-netherlands-shopping-street-lijnbaan-pedestrian-zone-with-many-shops-gastronomy-image328725106.html

A public space is a place that is open and accessible to the general public. Roads (including the pavement), public squares, parks, and beaches are typically considered public space. However, new era has lead to a new defination of public space. The emergence of shopping streets allows the combination of public and commercial space.

Pedestrianized shopping streets represent a privileged encounter between public and private spaces, and between their respective interests.

Charles Landry, who offers a place-based understanding of creative cities, proposes that many cities' decision-making processes are dominated by commercial interests, rather than creative or cultural ones. As a result, public space is increasingly validated by private interests that exert a subtle social control over it. The presence of brand and chain stores exacerbates this issue, as decision-making becomes less adaptable and more bureaucratized, eroding the uniqueness and diversity of the urban environment.

Moreover, this corporate appropriation of space is often reinforced by architecture. Iconic projects designed for international appeal may disrupt the natural narrative of a neighborhood, transforming it from a place for the community to a stage for affluent individuals to admire corporate grandeur. In such circumstances, public space is no longer a site of engagement and social interaction but rather a conduit for passive consumerism and economic voyeurism.

[1] C. Landry, The Art of City Making (London: Earthscan, 2006).
[2] D. Harvey,'The Political Economy of Public Space', in: S. Low and N. Smith (eds.), The Politics of Public Space (New York/London: Routledge, 2006), 34.
[3] Landry, The Art of City Making, op. cit. (note 19).
[4] M Friesen (2017) The contested public space of shopping streets: The case of Købmagergade, Copenhagen, Journal of Landscape Architecture, 12:2, 18-31, DOI: 10.1080/18626033.2017.1361082

# 4.2 Social considerations

## 4.2.4 public space without public internet

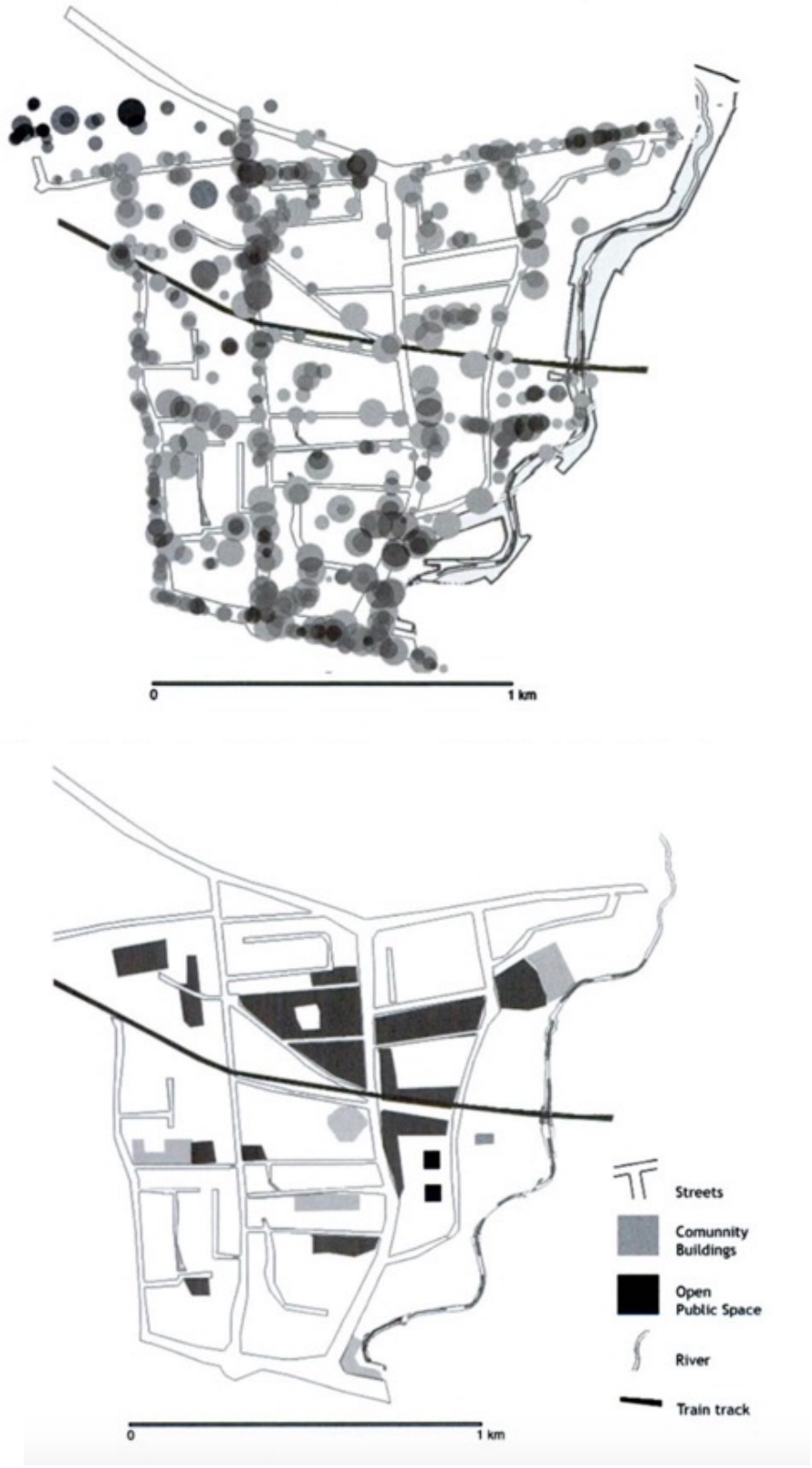



**Fig. 4-5** Density of public and encrypted Wifi nodes and distribution of public spaces

Drawings by Aurigi, Alessandro & Cindio, F..

The article asserts that the distribution of public wifi nodes in the examined area is skewed towards private spaces rather than traditional public domains like green open spaces. Consequently, the provision of wifi access, although extending to public realms such as streets and parks, is not primarily intended for utilization in these locations. Notably, a significant observation in this study is the absence of any coinciding nodes with green open spaces, which traditionally serve as leisure and recreational venues. Thus, the availability of wireless internet access for leisure or relaxation purposes does not align fortuitously with the intended function of green open spaces. This unintentional characteristic stems from the strategic placement of the nodes, often aligning with bustling and utilitarian public spaces.

To exemplify, the central thoroughfare within the study area accommodates twelve public nodes, which facilitate commercial establishments along the street to integrate their physical operations with online connectivity. Nevertheless, there is a conspicuous lack of convergence between the online and offline realms in both the street space and other sites within the study area. This observation underscores the prevailing paradigm of wifi coverage in the examined area, where the utilization and activities in urban public spaces exhibit minimal integration with the corresponding locations of public wireless access points. With a few exceptions, this study reveals an intriguing outcome: the two realms function almost independently, both spatially and socially, with limited overlap between them.

[1] Aurigi, Alessandro & Cindio, F.. (2008). Augmented urban spaces: Articulating the physical and electronic city.

# 4.2 Social considerations

## 4.2.5 commercial behavior in public space

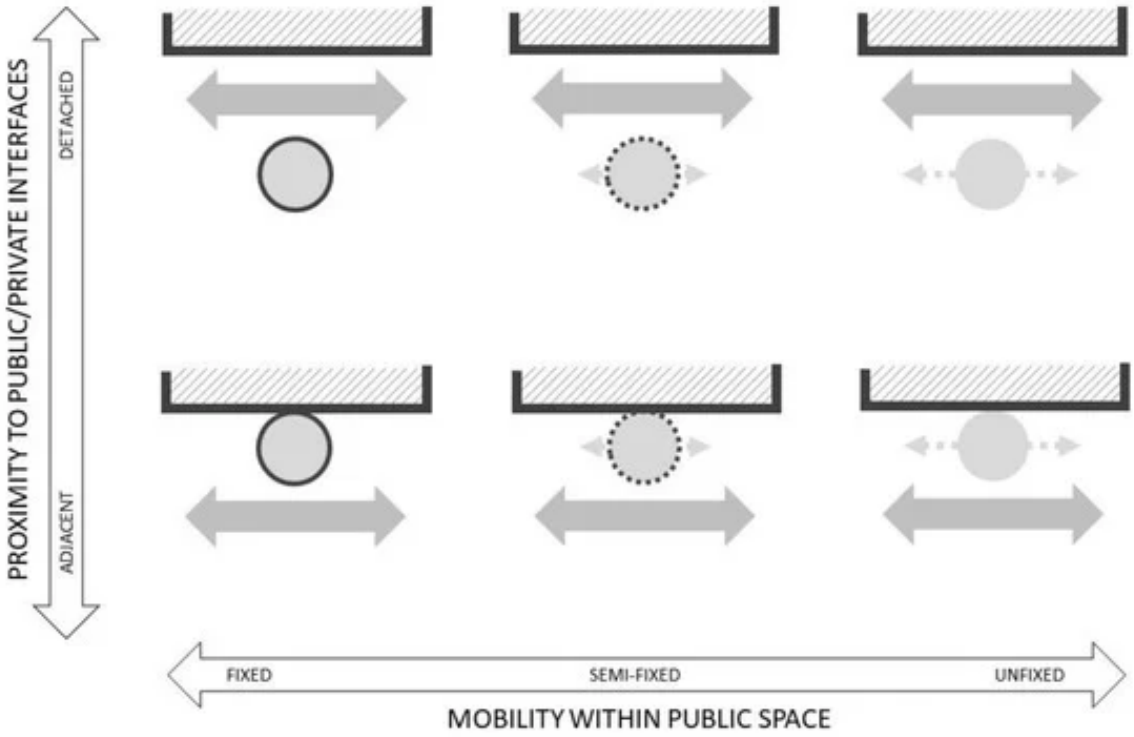



**Fig. 4-6** The relationship between mobility and interface in public space
Drawings by Kamalipour H, Peimani N.

This study introduces a novel typology of street trading, which is defined by a matrix incorporating two primary criteria: mobility within public space and proximity to the public/private interface. Previous typologies have primarily focused on mobility, which refers to the ability of street traders to move within the public realm, categorized as fixed, semi-fixed, or unfixed trading. However, the second criterion presented in this research contributes significantly to the typology.

The public/private interface, also known as the edge of public space, has long been recognized as essential for the social and economic functions of public spaces, as evident in urban design principles such as the "active edge," "edge effect," "activity pockets," and "eyes on the street." In areas with high pedestrian flow, the interface also presents an opportunity for retail activities, functioning as potential or actual shopfronts. The newly proposed typology distinguishes between street traders positioned at the edge of public space and those detached from it, essentially determining whether they become integrated into the edge or remain within the public space itself.

The critical criterion, as depicted in the diagram, revolves around the extent to which pedestrian traffic can freely flow between the street trader and the interface. This distinction sheds light on the positioning and spatial relationship of street traders, emphasizing their interconnectedness with the public/private interface and the implications for pedestrian movement.

[1] Kamalipour H, Peimani N. Negotiating Space and Visibility: Forms of Informality in Public Space. Sustainability. 2019; 11(17):4807. https://doi.org/10.3390/su11174807

Consequently, when pedestrians have the ability to freely navigate between street vendors and the public/private interface, the overall space becomes more public in nature, creating an environment that encourages public engagement and interaction. In this dynamic shopping setting, the distinction between public and private shopping behavior becomes blurred. The fluidity of the space, characterized by the presence of diverse and irregular stalls and street interfaces, prompts individuals to explore and interact with the commercial offerings in a more open and inclusive manner.

Public shopping behavior manifests as individuals freely traversing the pedestrian walking street, exploring various vendors, and engaging in spontaneous interactions with fellow shoppers and local businesses. The open layout and accessible nature of the space facilitate serendipitous encounters, enabling people to discover new products, services, and experiences.

Simultaneously, private shopping behavior also finds its place within this vibrant setting. Shoppers may opt for more secluded areas, such as tucked-away corners or intimate seating arrangements, where they can take a moment of respite, evaluate their purchases, or engage in private conversations. These private spaces, nestled within the larger public realm, offer individuals a sense of personal retreat while still being immersed in the bustling atmosphere of the pedestrian walking street.

The coexistence of public and private shopping behavior within this fluid environment creates a dynamic and multifaceted experience for visitors. People can choose to actively participate in the public realm, engaging with the vibrant social fabric of the street, or retreat momentarily into private enclaves for personal contemplation. This blend of public and private shopping behaviors adds depth and richness to the overall shopping experience, fostering a sense of inclusivity, individuality, and community within the pedestrian walking street.

# 4.3 Challenges & Opportunity

Augmented reality (AR) represents a digital revolution that has the potential to reshape the urban landscape. As AR technology continues to advance, it brings forth a new era where the physical and digital realms seamlessly merge, offering exciting possibilities for transforming our cities.

One of the significant potentials of AR lies in its ability to redefine the city's image by leveraging data. With the integration of AR into urban spaces, the collection and analysis of real-time data can drive decision-making processes, allowing for more efficient resource allocation and enhanced urban planning. This data-driven approach has the potential to create dynamic, responsive, and sustainable cities.

However, as AR reshapes the urban environment, it also challenges traditional definitions of public space. The conventional notion of public space as parks, squares, and streets expands to include digital realms that are accessible and inclusive. AR enables individuals to find and engage with public spaces through digital interfaces, blurring the boundaries between physical and virtual environments. This evolution necessitates a reevaluation of the concept of public space and the need to ensure equitable access and meaningful experiences for all members of society.

Furthermore, the relationship between public and private interests becomes increasingly complex in the context of AR. The fusion of public and commercial spaces, such as pedestrianized shopping streets, raises questions about the dominance of commercial decision-making processes and the potential erosion of the unique character and diversity of urban environments. The main challenge lies in restoring or reinforcing the balance between commercial and social interests in public space. The communicative turn in planning seeks to achieve this goal by promoting a transparent understanding of the

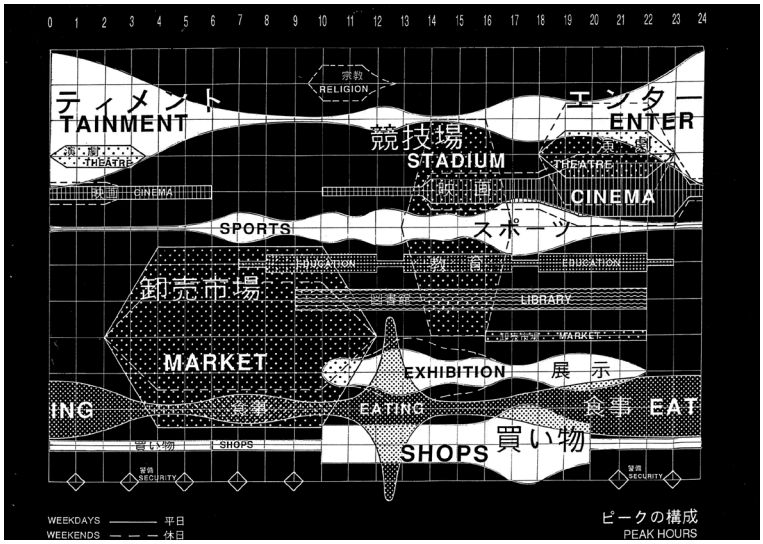
power dynamics that exist in the urban context. This approach is rooted in a postmodernist perspective, which emphasizes reflexivity and awareness of social context and relationships, rather than the modernist pursuit of universal truths and technocratic solutions to a wide range of problems.

While AR offers immense potential for creating engaging, interactive, and personalized urban experiences, it also presents challenges. The integration of AR requires careful consideration of privacy concerns, data security, and ethical implications. The main challenge lies in restoring or reinforcing the balance between commercial and social interests in public space. The communicative planning approach recognizes the presence of multiple, competing interests within the urban fabric and seeks context-specific solutions that consider the perspectives of different actors and the complex layers of interests at play. By addressing these challenges and leveraging the opportunities presented by AR, we can create cities that are dynamic, accessible, and responsive to the needs of their inhabitants.

In conclusion, augmented reality has the power to revolutionize urban spaces by transforming their image, redefining public space, and reimagining the relationship between public and private interests. AR's potential lies in its ability to leverage data, drive decision-making processes, and enhance the urban experience. However, realizing this potential requires thoughtful and inclusive approaches that address privacy, security, and ethical considerations. By embracing AR technology within the framework of communicative planning, cities can navigate the challenges and create equitable and inclusive urban environments. Through this approach, we can harness the power of AR while maintaining a balance between commercial and social interests, ultimately shaping cities that are responsive, inclusive, and reflective of the needs and aspirations of their communities.

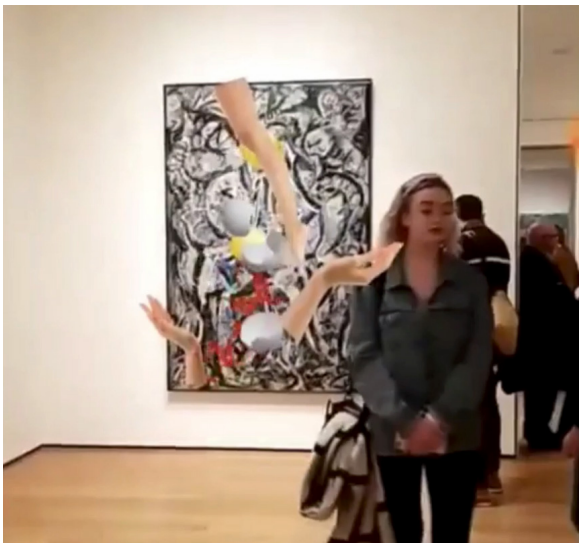
[1] Riether G. (2010), Digital Phantasmagoria: An Urban Space of Intensified Interaction, in Disrupción, modelación y construcción: Diálogos cambiantes - Sigradi 2010 conference, 380-383.
[2] Liao, T., & Humphreys, L. (2015). Layar-ed places: Using mobile augmented reality to tactically reengage, reproduce, and reappropriate public space. New Media & Society, 17(9), 1418-1435.

A digital reshape of public spaces




A time-based programmatic masterplan of Yokohama, OMA (1991).

Enhance social interaction between people



Interactive projection walls and floors
chances to play & learn in aquariums

Towards a Redistribution of Spatial Value

A digitally enhanced public realm, shift both the everyday experiences and political economies of architecture and cities. — Failed Architecture

Personalized information and inclusive space

AR Experiments: Expanding creative possibilities with ARCore
https://www.youtube.com/watch?v=7SwZUNDsWaM

# 4.4 Concept ——AR Urbanism:

## 4.4.1 Towards a Redistribution of Spatial Value

The emergence of AR technology has brought about a new way of interacting with physical space, where the concept of ownership and possession is becoming less relevant. As the journalist mentioned, "Life no longer needs to be an existential question of having or not, but rather an option of having what you want when you want it, and to not when you don't." This shift in mindset does not necessarily entail a move toward a collective property model, where ownership is shared and usage is based on a sharing-based property model. Instead, AR technology provides a new way of accessing and utilizing physical space, allowing individuals to interact with and utilize physical objects virtually without necessarily having to own or possess them. The use of AR technology can make physical space more complex and dynamic, allowing for more direct and efficient interactions with the physical world.

source: https://archis.org/volume/cloud-urbanism/

## 4.4.2 conceptual framework

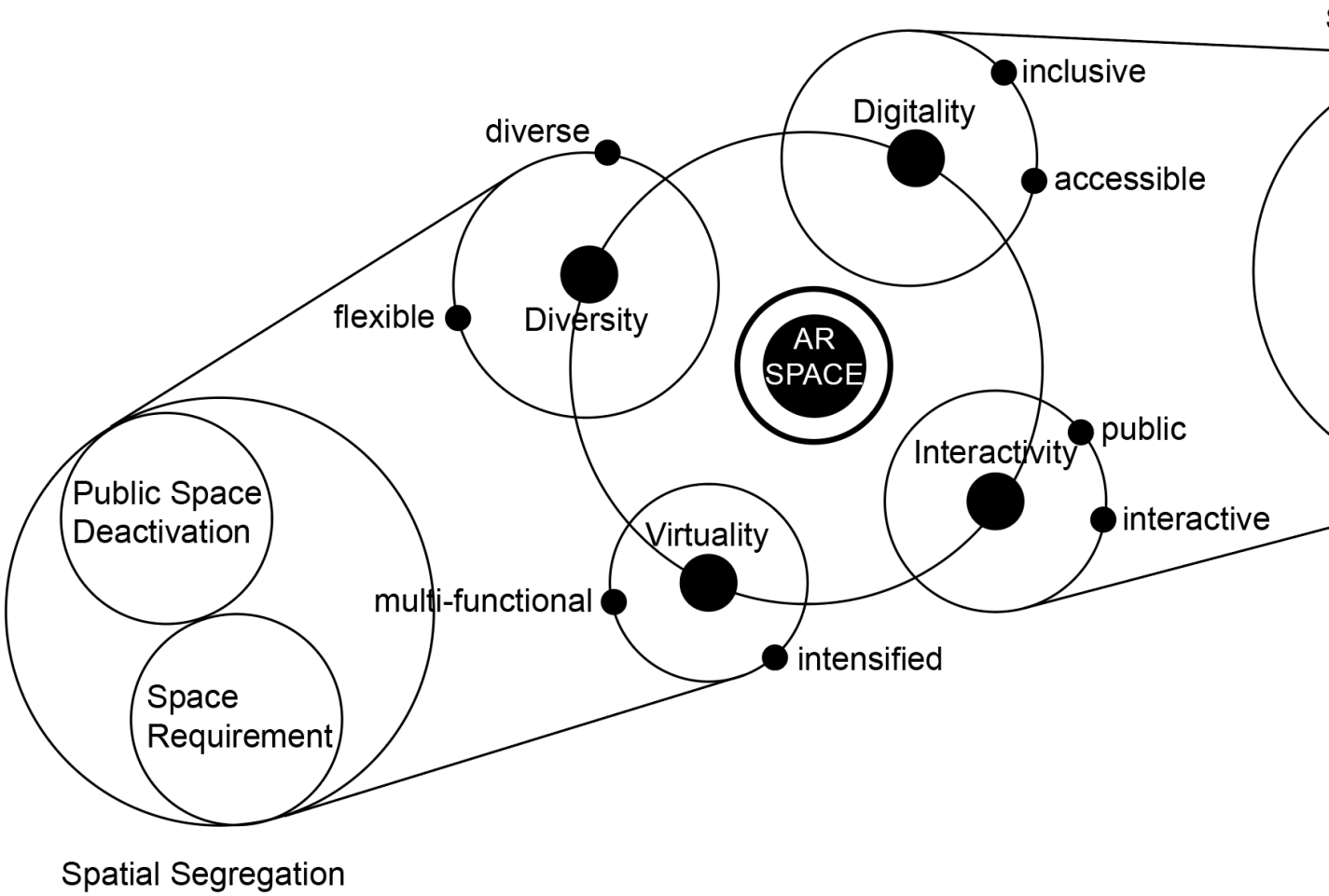
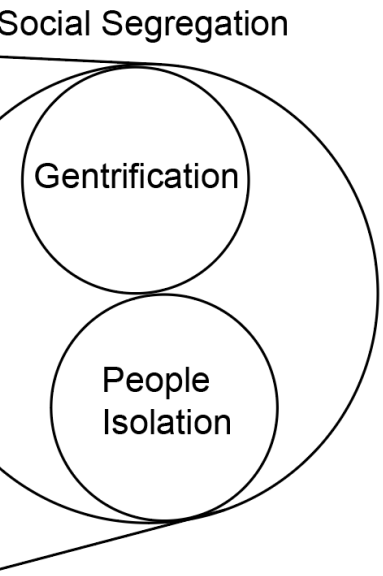



**Fig. 4-7**

illustrated b




The previous chapters delve into the complex issue of urban segregation, encompassing its spatial and social dimensions. Building upon the comprehensive problem analysis presented in Chapter 2, the focus shifts to exploring the potential application of Augmented Reality (AR) as a viable solution. Furthermore, insights derived from the investigation of various AR application scenarios in Chapter 1.3 and the perspectives of renowned scholars who have extensively studied urban presence concerns are incorporated. This synthesis of knowledge enables the development of a conceptual framework that harnesses the potential of AR to address spatial and social challenges within urban contexts. By examining the four distinct qualities of AR and their corresponding spatial characteristics, this chapter aims to establish a robust theoretical foundation that sheds light on the transformative potential of AR in enhancing urban environments, fostering inclusivity, and promoting social cohesion.

Conceptual framework

y author

# Anatomical Atlas

Anatomical Atlas
Anatomical Atlas
Anatomical Atlas


**Fig.5.1** City map of Rotterdam with prospect,
*originally published by Marthaus Sutter, 1740. The Laurenskerk dominates the cityscape However, the height of the towers is exaggerated and so are those of the towers of the town hall and of other churches*

from 'HISTORISCHE ATLAS VAN ROTTERDAM'

## Introduction

The analysis chapter of this study provides a thorough assessment of the site, examining its current issues and potential for design intervention. Through a layered approach of anatomical cartography, the chapter explores the project area, delves into its historical background, conducts an atlas analysis, and investigates relevant case studies. These investigations aim to inform the subsequent design phase by providing valuable insights and a deeper understanding of the site's context. The chapter concludes with a synthesis of key findings, offering a critical reflection on the site's characteristics and guiding the development of a contextually responsive design proposal.


**Fig.5.2** Location map of Rotterdam
*tell the location of the Blaak*

Illustration by the author

# 5.1 Project area

Blaak

As described in sections 1.2.2 and 2.1.2, the open space in the Blaak area presents a unique challenge. Currently, a large portion of this open space is solely utilized for the public market, rendering it underutilized and in need of revitalization as a public space. To address this issue, a thorough analysis of the site's basic conditions is necessary to identify existing problems and uncover its development potential for future design interventions.

This section will conduct a series of cartographic analyses, utilizing desk research, field research, and crowd-sourced interviews in and around the Blaak area. By employing these methods, we aim to identify the development potential of the site and gain a comprehensive understanding of its current state.

Located at the heart of Rotterdam, Blaak boasts various transportation hubs, including railway stations, bus stations, and subway stations. Moreover, it features green spaces, squares, and other public areas. Blaak embraces a diverse range of functions, integrating residential, office, and entertainment facilities. Furthermore, it serves as a prominent landmark that attracts both locals and tourists.

Through the site analysis, we will delve into the intricate details of Blaak's characteristics, studying its existing urban fabric, demographic composition, cultural dynamics, and economic activities. By uncovering the site's unique qualities and challenges, we can lay the foundation for the subsequent design process, ensuring that the proposed interventions align with the area's context and fulfill the needs of its users.

Overall, this site analysis aims to provide valuable insights and inform future design decisions, facilitating the creation of a vibrant, inclusive, and well-utilized public space in the Blaak area of Rotterdam.

1300
1340
1400
1460
1500
1560
1600
1700
1740
1800
1850
1900
1940
2000
2050

fishing city
merchant city
workers
modernist
AR future

1340

1460

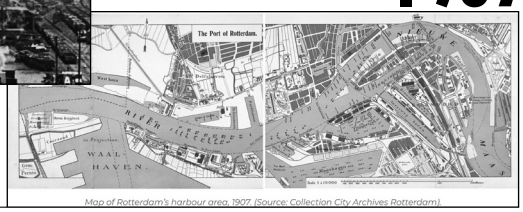
1740

1740

1907

1937

2022




Map of Rotterdam's harbour area, 1907. (Source: Collection City Archives Rotterdam).



**Fig.5.3** History of Rotterdam
*the transformation of Blaak*

Illustration by the author

# 5.2 History

## 5.2.1 Rotterdam

Key time

1340

1560

1740

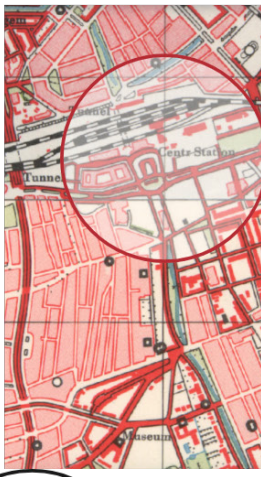
1940

On 7 July 1340, Count Willem IV of Holland granted city rights to Rotterdam, whose population then was only a few thousand. Around the year 1350, a shipping canal (the Rotterdamse Schie) was completed, which provided Rotterdam access to the larger towns in the north, allowing it to become a local trans-shipment centre between the Netherlands, England and Germany, and to urbanize.

During World War II, the German army invaded the Netherlands on 10 May 1940.Adolf Hitler had hoped to conquer the country in just one day, but his forces met unexpectedly fierce resistance. The Dutch army was forced to capitulate on 15 May 1940, following the bombing of Rotterdam on 14 May and the threat of bombing other Dutch cities. The heart triangle of Rotterdam was almost completely destroyed by the Luftwaffe.

Rotterdam was gradually rebuilt from the 1950s through to the 1970s. Because the city centre was largely destroyed, new spatial infrastructure could be built, making it an open and modern city. In 1953 the Lijnbaan was opened, the first car-free shopping street in Europe. The progressive design attracted a lot of international attention. The new Central Station was completed in 1957, with the Groothandelsgebouw from 1953 next to it. The Euromast was erected in 1960 on the occasion of the Floriade.

From the 1980s onwards the city councils began developing an active architectural policy. The harbours were moving westwards and the old environment had to be reshaped. Daring and new styles of apartments, office buildings and recreation facilities resulted in a more 'livable' city centre with a new skyline. In the 1990s, the Kop van Zuid was built on the south bank of the river as a new business centre. Rotterdam was voted 2015 European City of the Year by the Academy of Urbanism. A profile of Rem Koolhaas in The Guardian begins "If you put the last 50 years of architecture in a blender, and spat it out in building-sized chunks across the skyline, you would probably end up with something that looked a bit like Rotterdam."

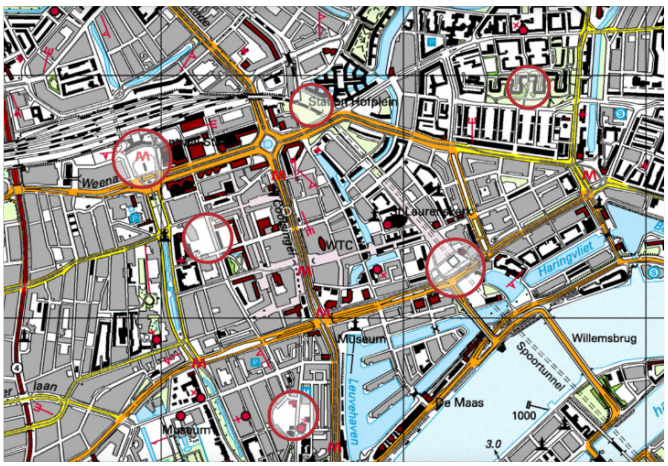


1950

**distribution** Concentrated
**size** large
**character** parks

1960

Concentr
large
parks/sq



2000

**distribution** separated
**size** small
**character** open space

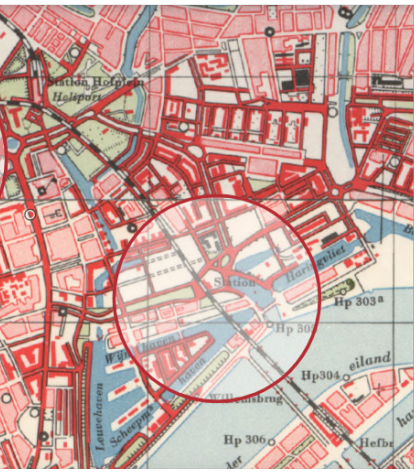
2010

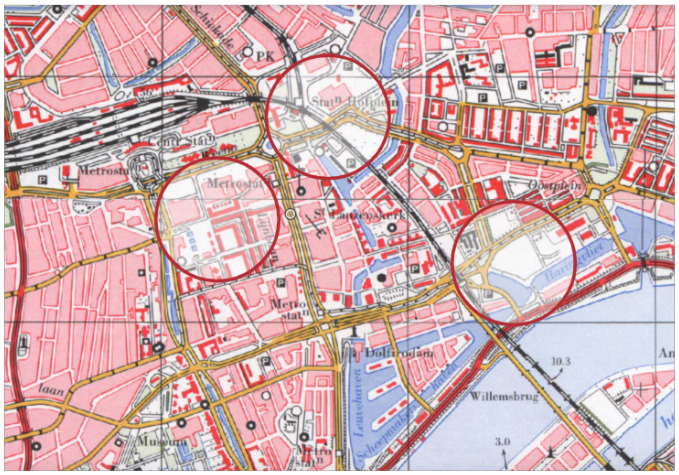
separated
small (bigger
open space

# 5.2 History

## 5.2.2 Blaak

Over time, the distribution of public spaces has tended to become more dispersed, while the scale has become progressively smaller and the categories have become more diverse from a single park.
As discussed in chapter 4.1.1, urban development changes and each technological innovation are inseparable and lead to a different urban layout. By analysing the distribution and



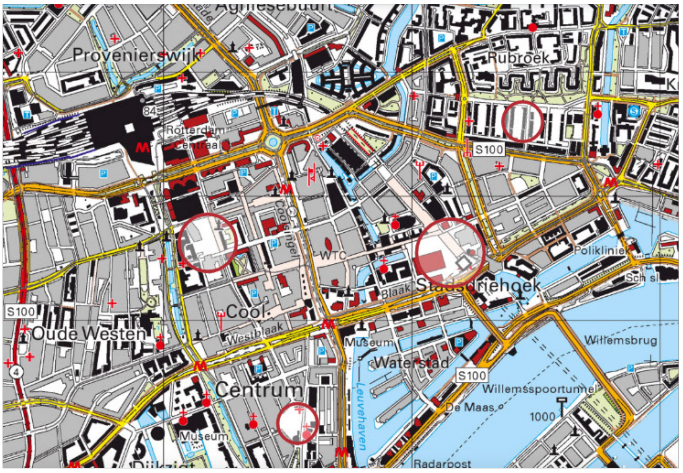


1980

rated (transport oriented)

uares

Concentrated
medium size
green/squares


2021

r)

separated
smaller
open space

**Fig.5.4** History of public space distribution

Illustration by the author

changing character of public space on the site, it can be assumed that the future definition and distribution of public space in the city will have more possibilities, perhaps depending on the development of technology.

# 5.3 Anatomical Atlas

## 5.3.1 Moblity and Infrastructure


**Fig.5.5** Mobility of Rotterdam
*transportation layers*

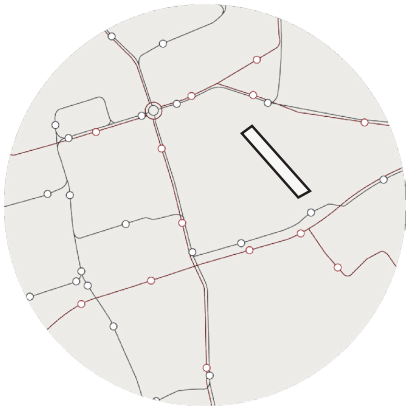
Illustration by the author

blue and green

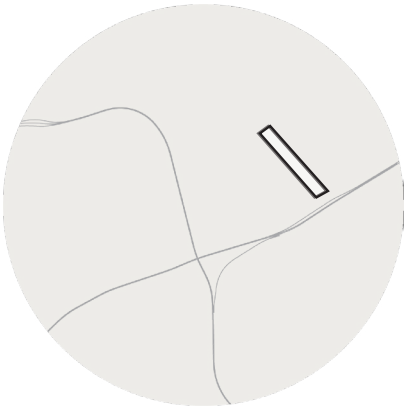
mobility

metro

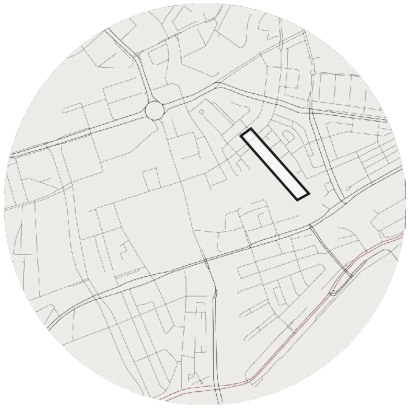
blue and green



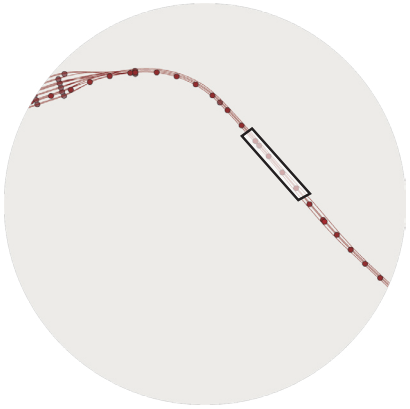
bus



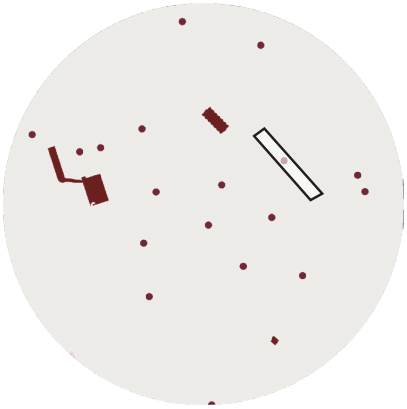
highway



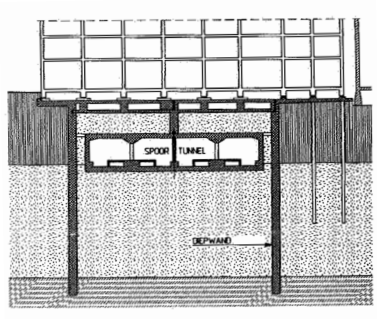
road



train tunnel underground



parking




The mobility in the Rotterdam Blaak area is characterized by its extensive transportation network, including the railway station, bus and tram lines and subway station. These interconnected modes of transportation provide residents and visitors with diverse and convenient options for moving within and beyond the Blaak area, contributing to the overall accessibility and livability of the neighborhood.

In addition to the transportation facilities mentioned earlier, it's worth noting that the open area adjacent to the Blaak station features an underground tunnel specifically designated for NS (Nederlandse Spoorwegen) trains. This underground tunnel provides a direct connection for NS trains passing through the area, which also adds some difficulty and structural constraints to the use of this open space.

[1] Gerritsen, J., & Brassinga, H. 1993-12(P8-16). WILLEMSSPOORTUNNEL ROTTERDAM HET BESTEK 'STATION BLAAK'. Rotterdam: Gemeentewerken Rotterdam.

# 5.3 Anatomical Atlas

## 5.3.2 Distribution of spatial functions

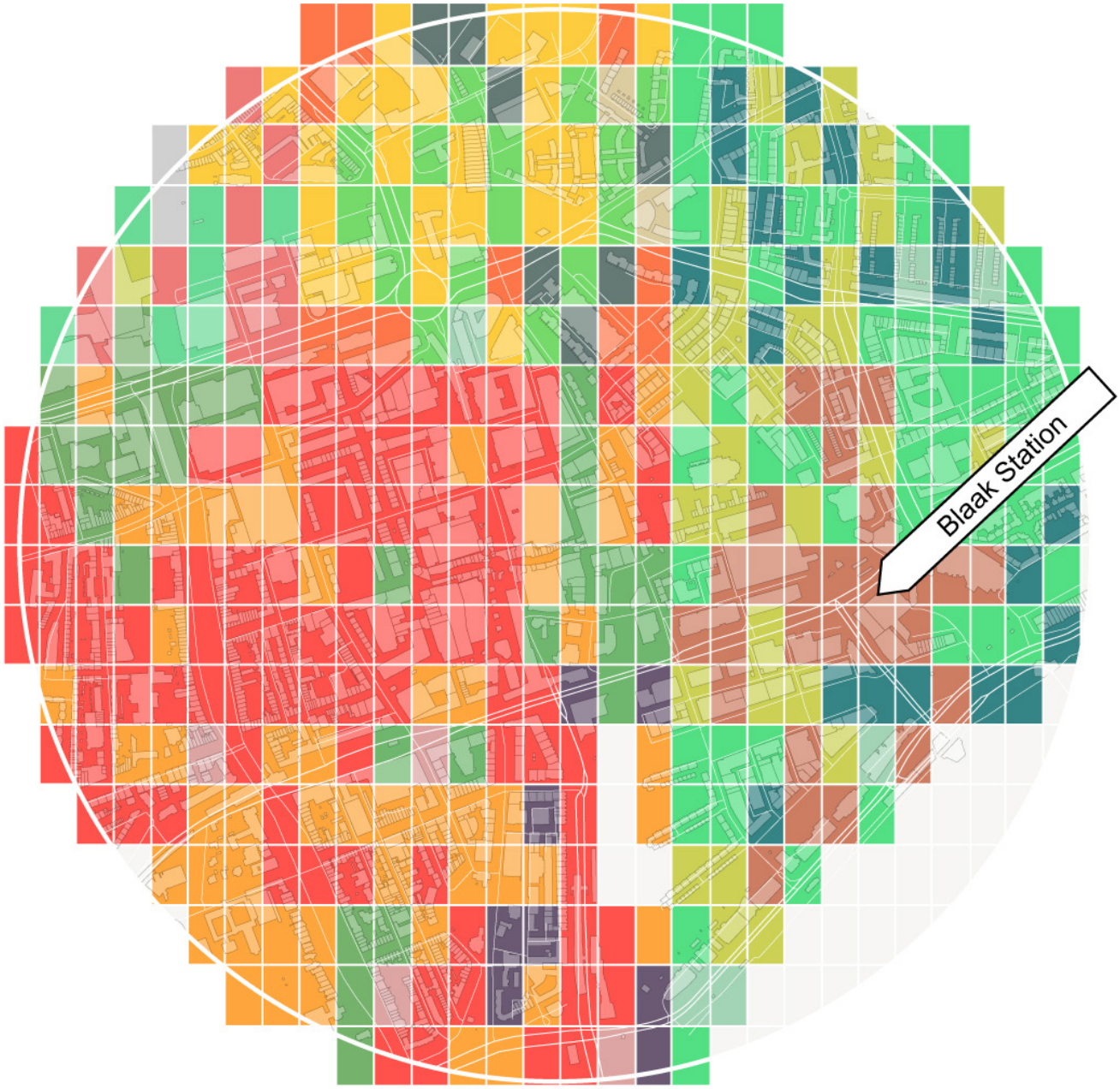
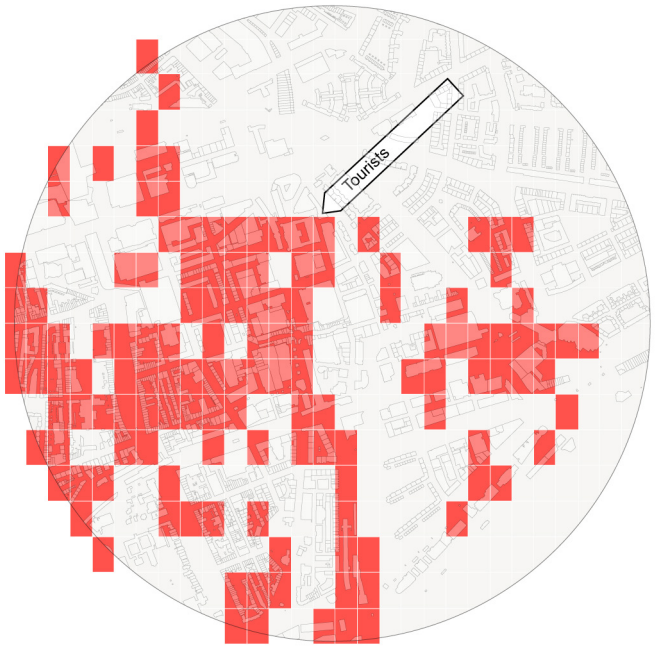
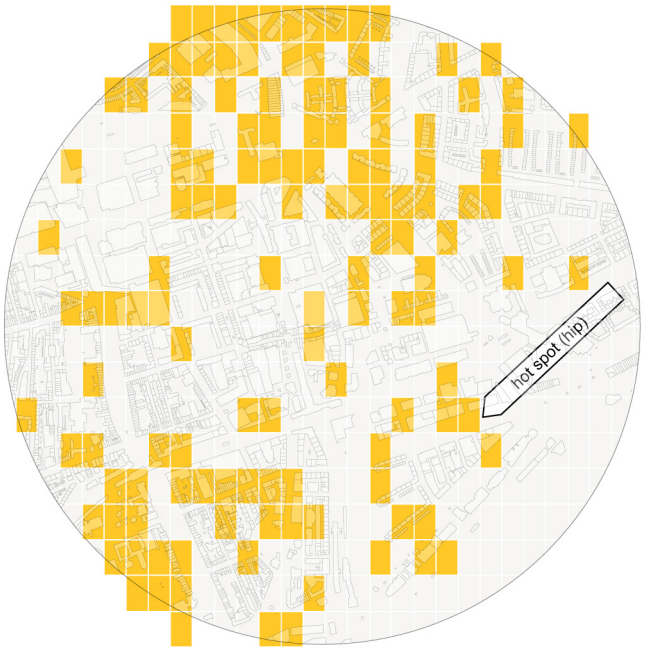


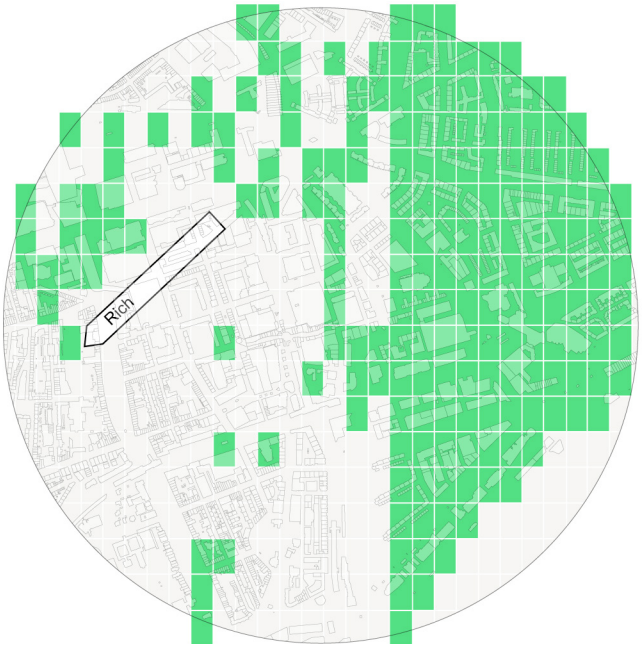

**Fig.5.5** Mobility of Rotterdam *transportation layers*

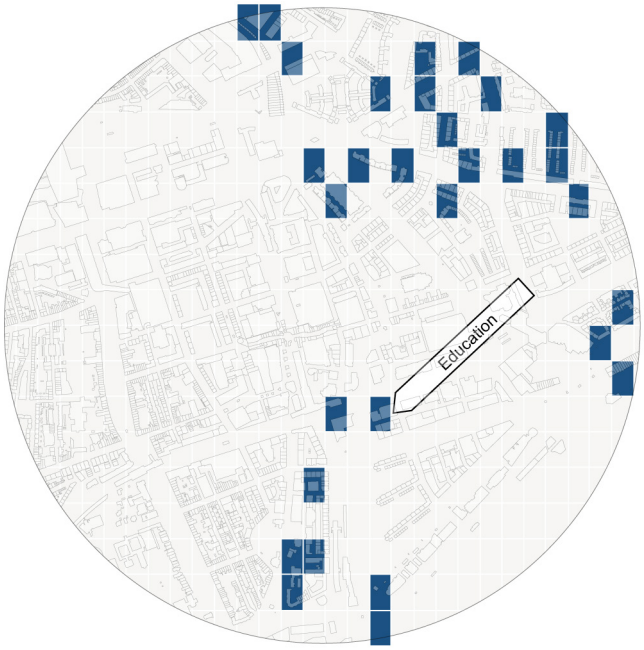
Illustration by the author
Source: https://hoodmaps.com/rotterdam-neighborhood-map © openstreetmap © mapbox

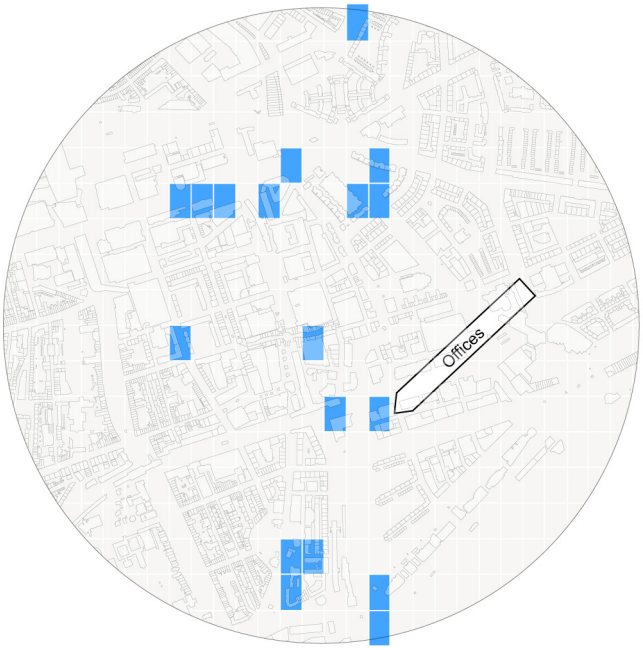
The series of atlases showcasing the distribution of people and infrastructure in the site reveals a diverse mix of individuals, including tourists, young people, and wealthier individuals, clustered in specific areas. However, the infrastructure within the site appears underutilized and lacking in multifunctional spaces to accommodate the diverse demands of its inhabitants. This observation highlights the need for the development of more versatile and inclusive spaces. Analyzing the distribution of people and infrastructure provides valuable insights into the gaps and discrepancies within the site, forming the basis for strategies to enhance its functionality and inclusivity. By incorporating thoughtful urban design and creating adaptable spaces, we can better meet the needs of the site's various user groups, fostering a vibrant and harmonious environment.


Tourists


hot spot (hip)


Rich


Education


Offices


Convenient facilities

# 5.3 Anatomical Atlas

## 5.3.3 Distribution of public space

**Fig.5.6** distribution of public space
*open space and landmarks*

Illustration by the author
https://www.orangesmile.com/geolocation/en/sightsmap_full.php
https://kaartlaag.rotterdam.nl/parkeren#51.9162/4.4655/51.9262/4.5015/brt///
https://www.google.com/maps

Data souce from ©openstreetmap ©mapbox ©kadaster


In the Rotterdam Blaak area, the presence of several prominent landmarks and well-designed public spaces plays a significant role in shaping its unique character. One such landmark is the renowned Cube Houses, an architectural marvel created by Piet Blom, which serves as a popular tourist attraction. The area's vibrancy is further enhanced by the Blaak Market, a bustling hub that transforms the open space into a lively marketplace twice a week, offering a diverse range of goods.

Moreover, the Blaak area boasts meticulously maintained green spaces and squares, providing residents and visitors with opportunities for relaxation and recreation. The notable Blaak Station, featuring its distinctive design and an underground tunnel catering to NS trains, serves as a pivotal transportation hub, seamlessly connecting various modes of public transit. Collectively, these landmarks and public spaces contribute to the overall allure and vitality of the Rotterdam Blaak area, attracting both locals and tourists to engage with the urban environment.

Considering the wealth of landmarks and public spaces, the Rotterdam Blaak area holds immense potential for transformation and revitalization, particularly with its expansive public and open areas.

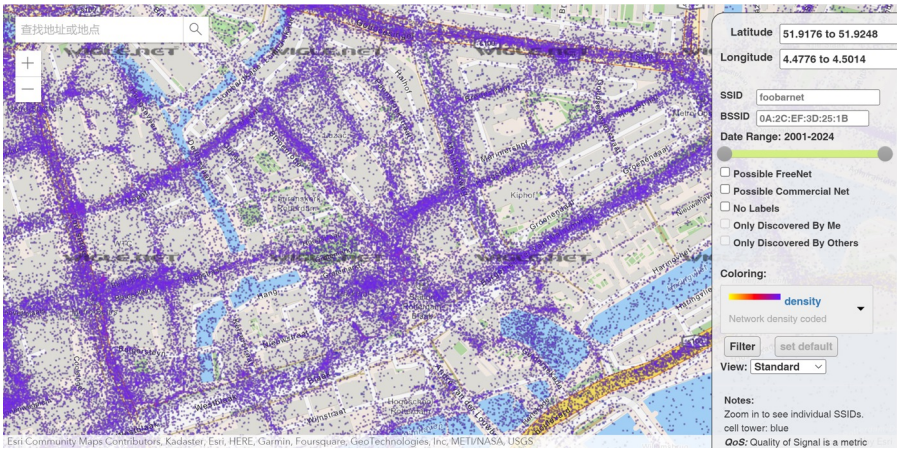
# 5.3 Anatomical Atlas

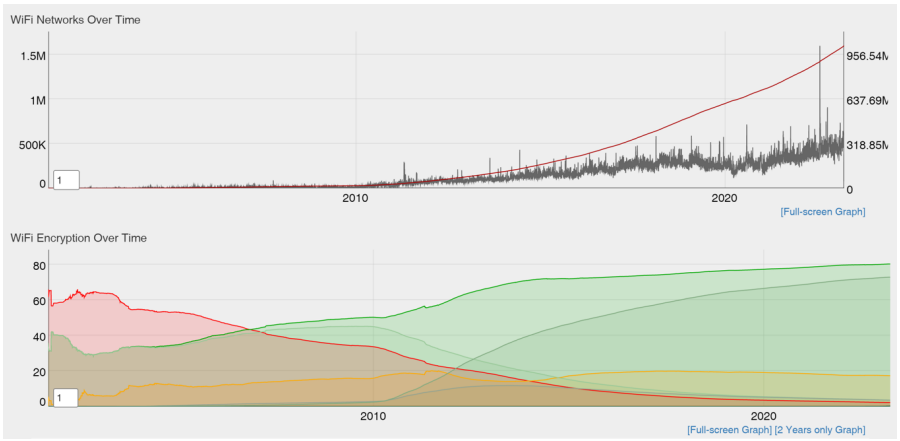
## 5.3.4 Accessibility of Internet

The map reveals a strong and extensive Wi-Fi network signal in the chosen site, indicating its suitability for digital transformation. This robust connectivity lays the foundation for seamless access to digital services, facilitates the integration of innovative technologies, and enhances the user experience. The site's strong Wi-Fi signal makes it attractive for businesses, residents, and visitors, promoting economic growth and fostering a digitally enhanced environment.

**Fig.5.7** WIFI accessiblity

Illustration by the author
data source: https://wigle.net/



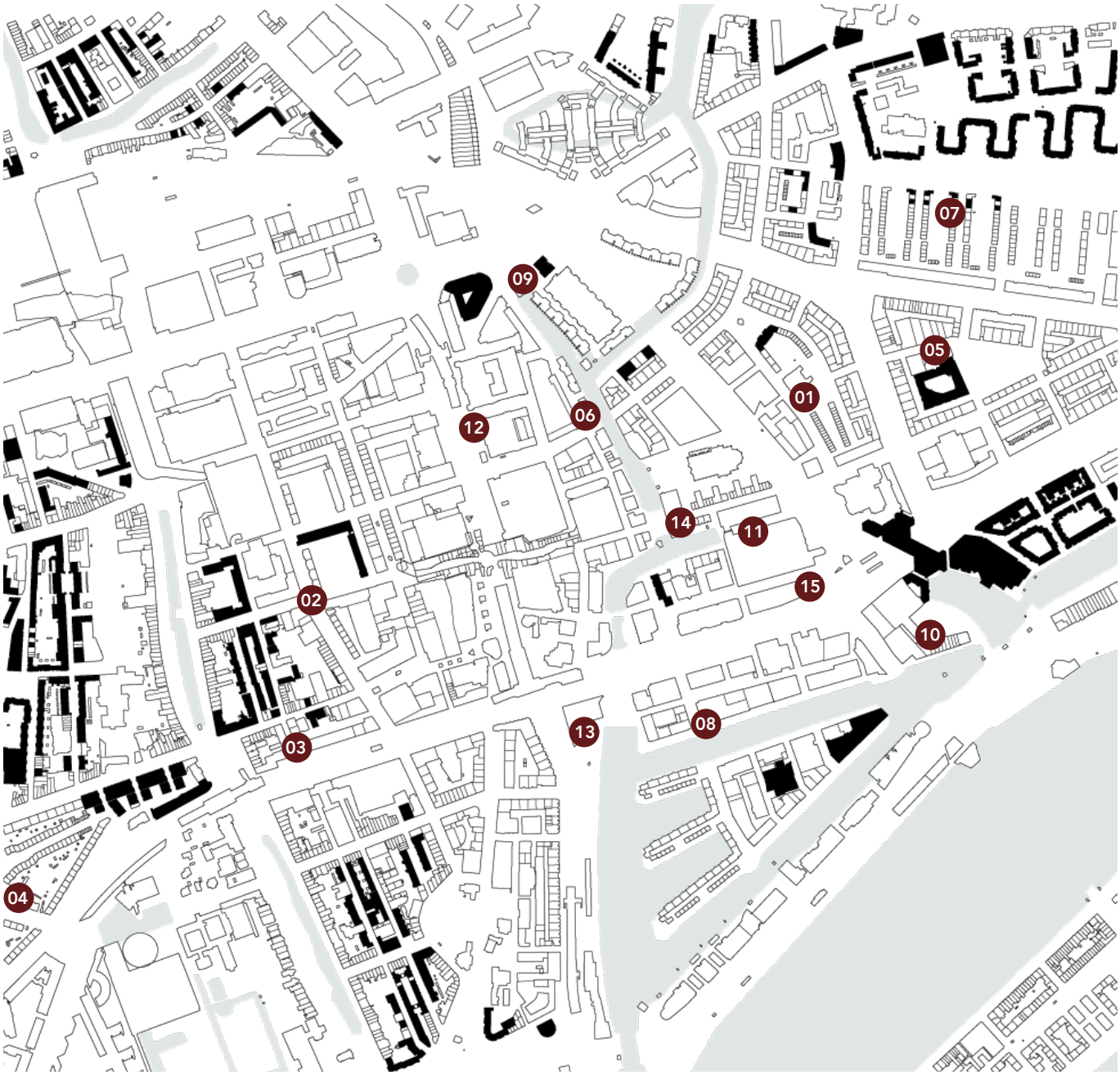

This website exhibits a favorable state of wifi accessibility, wherein comprehensive coverage is ensured across all areas of the venue. Notably, there has been a notable improvement in wifi speeds, denoting an upward trend in internet connectivity. Additionally, there is a gradual rise in the deployment of WiFi encrypted networks, accompanied by a scarcity of unencrypted networks. This suggests an increasing emphasis on network security measures. Consequently, the overall wifi infrastructure in Rotterdam can be deemed robust and effective in facilitating reliable and secure internet access for users.

Regarding the encrypted networks, it indicates a positive trend towards network security. While some networks may be limited to customers of specific shops or establishments, the overall availability of wifi signals and the increasing number of encrypted networks suggests that the majority of users in Rotterdam have access to wifi internet.

However, it's important to note that specific access restrictions or limitations may vary depending on individual wifi networks and their intended usage. Some networks may require authentication or may be limited to customers of certain establishments, while others may offer open access to the public. The level of accessibility can differ depending on the network's configuration and intended purpose.

# 5.3 Anatomical Atlas

## 5.3.5 Social housing and building typology

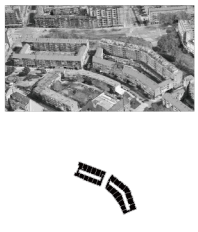



The distribution of social houses indicates a disparity between urban centers and peripheries, with fewer social housing units found in the former. Additionally, a typological study of buildings reveals a shift in building typologies over time, with the collective public spaces of buildings giving way to solitary towers in the cityscape. This evolution highlights the changing urban fabric and the need to address issues of social housing and the loss of communal spaces in urban development.

**Fig.5.9** Social house distribution

Illustration by the author
data source: https://rigo-1.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=-47c54a12fa924be788580aebc3bfd5ab

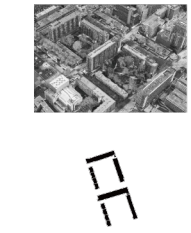
# BUILDING BLOCK TYPOLOGY



**01**

function retailing living

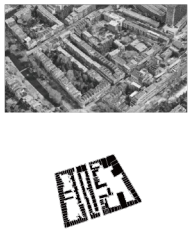
building ages 1954



**02**

function living social house

building ages 1957



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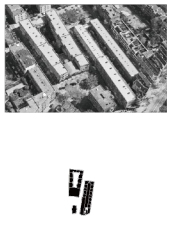
function social house retailing

building ages 1874-1985



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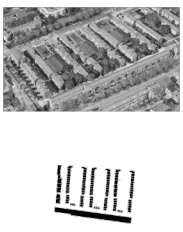
function social house

building ages 1892-1990



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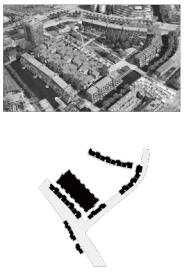
function living

building ages 1941



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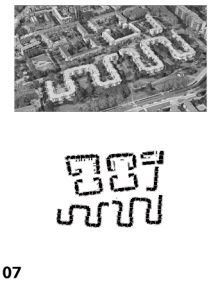
function living

building ages 1978



**07**

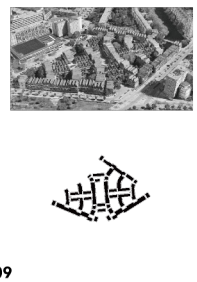
function social house

building ages 1978

**08**

function living

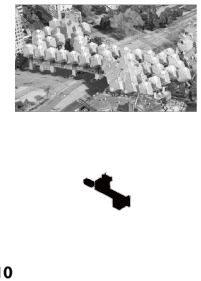
building ages 1981



**09**

function airbnb living

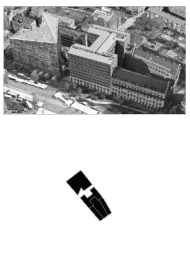
building ages 1983



**10**

function social house

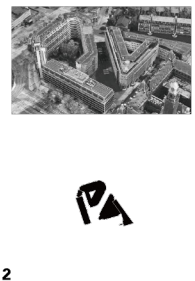
building ages 1984



**11**

function living

building ages 2003 2010 1940



**12**

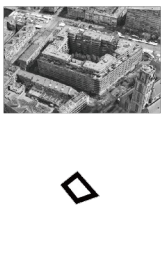
function social house living

building ages 1992

**13**

function living

building ages 1996



**14**

function retailing living

building ages 2007

**15**

function living

building ages 2009

**Fig.5.10** Building block typology

Illustration by the author

# 5.3 Anatomical Atlas

## 5.3.6 conclusion

Historical research has revealed a strong correlation between Rotterdam's urban development and the prevailing technologies of each era. Maps of the city's public spaces demonstrate an increasing decentralization, smaller scales, and greater diversity, hinting at a future trend. With the potential of digital technologies to enhance public accessibility, physical public spaces should also adopt a more decentralized approach.

The Blaak site and its surroundings possess a multitude of attributes, including multifunctionality, a diverse population, reliable internet reception, and a prominent landmark that draws significant visitor traffic. These factors present an opportunity for digital transformation. However, as mentioned in 1.2.2 and 2.1.2, the area lacks sufficient service-oriented facilities and open public spaces. The study acknowledges the presence of pedestrian activity on the site but highlights the limited vitality of the public space. The examination of building typology indicates a gradual disappearance and constriction of the city's collective public spaces.

By utilizing the Blaak site as a project location, the study aims to investigate the influence of augmented reality (AR) on public space utilization. The objective is to create a more diverse, vibrant, open, inclusive, and accessible urban environment. The project seeks to redefine the concept of public architecture in the city and explore potential future models for its development. Through the integration of AR, the project endeavors to enhance the richness and engagement of public spaces, fostering a dynamic and people-centric urban experience.

In conclusion, this analysis underscores the historical link between technological advancements and the evolution of Rotterdam's cityscape. By recognizing the potential of digital technologies and addressing the current deficiencies in public spaces, the project aims to leverage AR to transform the Blaak site into a more inclusive and accessible urban public space. The findings contribute to the exploration of public architecture and offer insights into future possibilities for urban development in Rotterdam.

# 5.4 Case study

## 5.4.1 Fun Palace

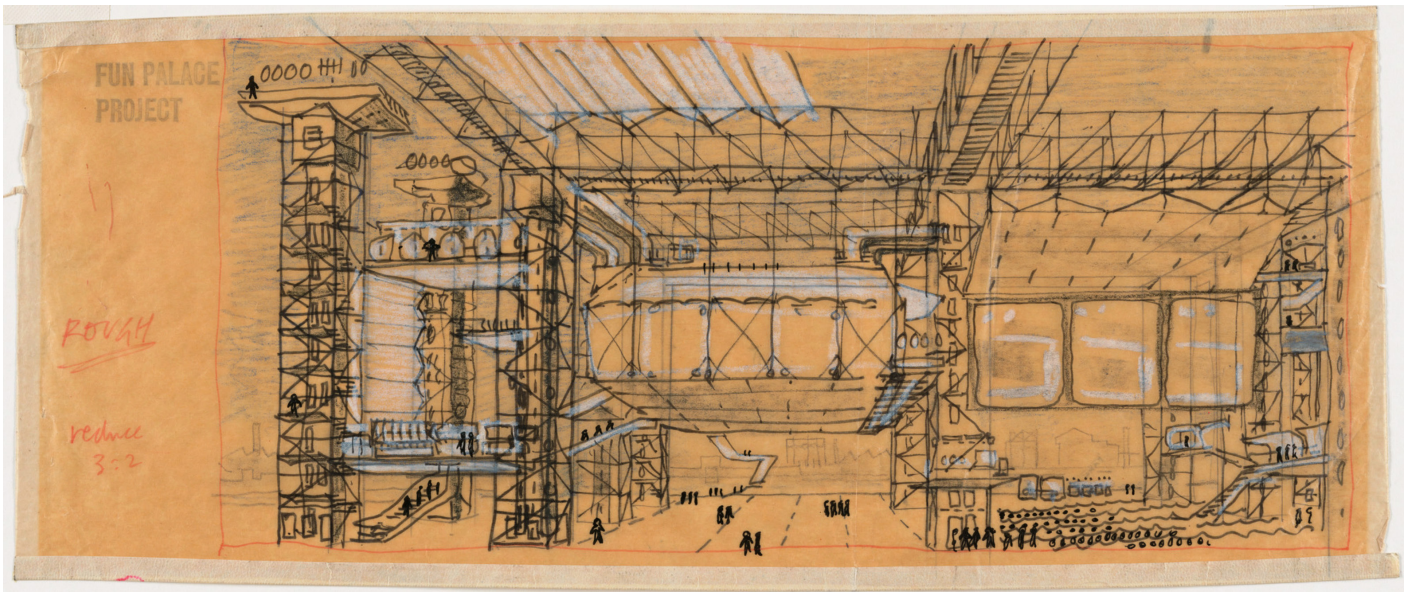



**Fig.5.11** Cedric Price
Fun Palace for Joan Littlewood
Project, Stratford East, London,
England (Perspective)
1959–1961

Fifty years ago, critic Ruth Langdon Inglis wrote a brief article for Art in America about an unusual architectural project designed by Cedric Price for a site in East London. In the piece, Joan Littlewood, a radical theater producer and the cocreator of the project, described her intention to build, using a mix of public and private funds, a new kind of cultural center appropriate for modern life. It would be a:
helium-balloon dream . . . where the British worker can realize his potential for self-expression by dancing, beating drums, Method-acting, tuning in on Hong Kong in closed-circuit television, action painting . . . the "First Giant Space Mobile in the World."1

This dream, conceived in the "swinging London" of the early 1960s, was called the Fun Palace. Though the design never left the drawing board, the Fun Palace is one of the most ambitious and original manifestations of many of the ideas that defined postwar leisure architecture, and that continue to inform the design of cultural institutions in the digital age.

Price and Littlewood saw impermanence and informality at the heart of their project, which they described for A.i.A. as a "short-term experimental toy with built-in expendability—a total lifespan of no longer than ten years." Flexibility, change, and growth were prized over monumentality and durability. The building's appearance could change radically from day to day, a departure from modernist architectural practice, which sought to define built environments a priori, on the basis of formal or theoretical models of idealized social space. 2

Critically review the concepts and ideas behind the design of Cedric Price's "Fun Palace"

The Fun Palace serves as a notable case study that has inspired and informed the design of AR Neutral Building and architecture. This visionary project, although never physically realized, embodied innovative ideas that continue to resonate in the realm of contemporary architecture and cultural institutions.

One of the key inspirations drawn from the Fun Palace is its emphasis on flexibility and adaptability. Price and Littlewood envisioned a building whose appearance could radically change from day to day, departing from the rigid principles of modernist architecture. This departure from a fixed design allowed for a more fluid and responsive space that could accommodate multiple activities and engage with its users in dynamic ways.

In the context of AR Neutral Building design, the influence of the Fun Palace is particularly relevant. By embracing augmented reality and other advanced technologies, the concept of flexibility can be reimagined as an activity that takes place within the building rather than the building itself. This approach aligns with the need for robust structures that can accommodate a wide range of activities and adapt to evolving user needs.

The Fun Palace's vision also challenges the traditional notion of museums as static repositories of knowledge and masterpieces. Instead, it advocates for a reconceptualization of museums as sites of production and reproduction, where human agency and interaction with architecture are prioritized. This idea resonates with the AR Neutral Building concept, which aims to enhance human experience, foster engagement, and provide adaptable spaces for various cultural activities.

In conclusion, the Fun Palace's innovative approach to architecture, with its emphasis on flexibility, adaptability, and user engagement, has served as a significant source of inspiration for the design of AR Neutral Building and architecture. By embracing the possibilities offered by augmented reality and other emerging technologies, buildings can become more robust, accommodating diverse activities and promoting interactive experiences. The Fun Palace remains a powerful testament to the importance of architectural design that enhances human agency and supports the ever-evolving nature of cultural spaces in the digital age.

[1]. Ruth Langdon Inglis, "Architecture: The Fun Palace," Art in America, January–February 1966, p. 69.
[2]. Joan Littlewood, "A Laboratory of Fun," New Scientist, May 14, 1964, pp. 432–33.

# 5.4 Case study

## 5.4.2 Pompidou

**Fig.5.12** Centre Pompidou in Paris faces four-year closure for repair works

https://www.dezeen.com/2021/01/26/centre-pompidou-paris-four-year-closure-repair-works/

The Centre Pompidou, designed by architects Renzo Piano and Richard Rogers, is a pivotal case study that holds significant academic relevance in the context of AR Neutral Building. Described by Piano as a "big urban toy," the Pompidou features expansive column-free spaces spanning six floors, making it Europe's largest museum for modern art. It also encompasses a public library and a center for music and acoustic research.

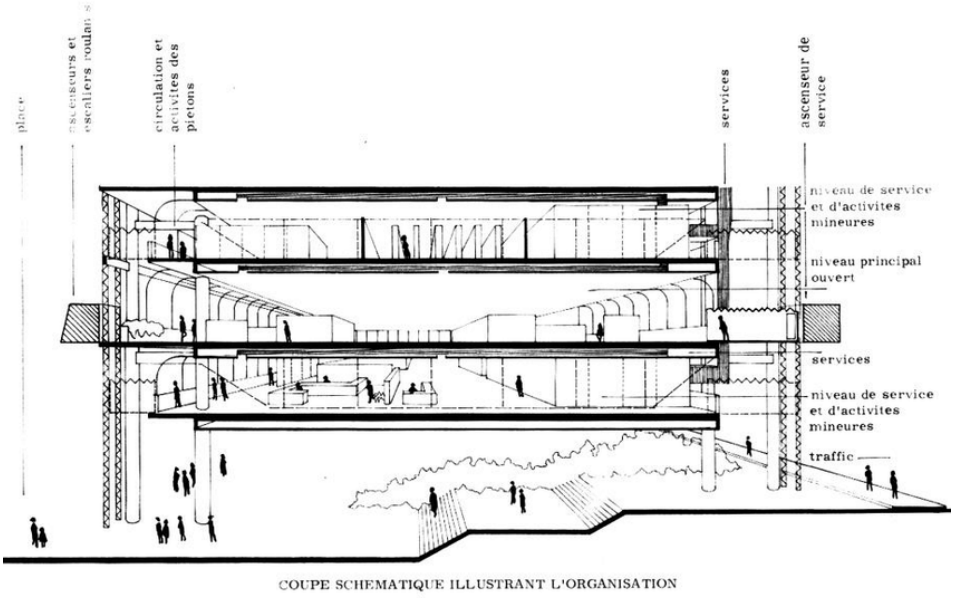
Piano and Rogers' design approach, which emphasizes adaptability and flexibility, aligns with the principles of the Fun Palace and has been widely discussed in academic circles. As Rogers stated in an interview, "We said that we'd make massive floors, which were the size of two football pitches with no vertical interruptions... theoretically you can do anything you want on those floors." This concept of open, flexible spaces resonates with the ethos of the Fun Palace and its emphasis on user agency and customization.

Furthermore, the Pompidou's response to the digital age showcases its academic relevance in the realm of technological advancements. As Piano noted, the library underwent significant changes during the building's lifespan due to the rise of information technology: "when we started there were books and by the time we finished it, books were almost finished because of IT." This recognition of the evolving nature of information consumption and the need for adaptive spaces highlights the foresight of the Pompidou's design.

https://ocula.com/magazine/art-news/centre-pompidou-to-shutter-for-five-years/

Moreover, the planned renovations of the Pompidou, including addressing structural issues and incorporating "phygital" experiences, provide additional relevance to the concept of AR Neutral Building. The proposed upgrades align with contemporary discussions surrounding the integration of physical and digital media to create immersive mixed-reality experiences. These adaptations showcase the Pompidou's commitment to remaining relevant and engaging within the evolving cultural landscape.

In conclusion, the Centre Pompidou's architectural approach, its acknowledgment of technological shifts, and its ongoing renovations contribute to its significance as a practical case study. By embodying the principles of adaptability, user agency, and integration of digital technologies, the Pompidou serves as an influential source of academic discourse for designing buildings, such as the AR Neutral Building, that can accommodate diverse activities and remain adaptable in the face of societal and technological changes.



COUPE SCHEMATIQUE ILLUSTRANT L'ORGANISATION

**Fig.5.13** Pompidou section
Piano+Rogers and Ove Arup & Partners, Centre National d'Art et de Culture Georges Pompidou, 1971-77. Schematic section, October 1971 (RSHP Archives, London)

https://www.researchgate.net/figure/Piano-Rogers-and-Ove-Arup-Partners-Centre-National-dArt-et-de-Culture-Georges_fig4_324389654

# Design
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## 6.1 Design Concept
## 6.2 Design Components
## 6.3 Physical Design
## 6.4 Virtual Design

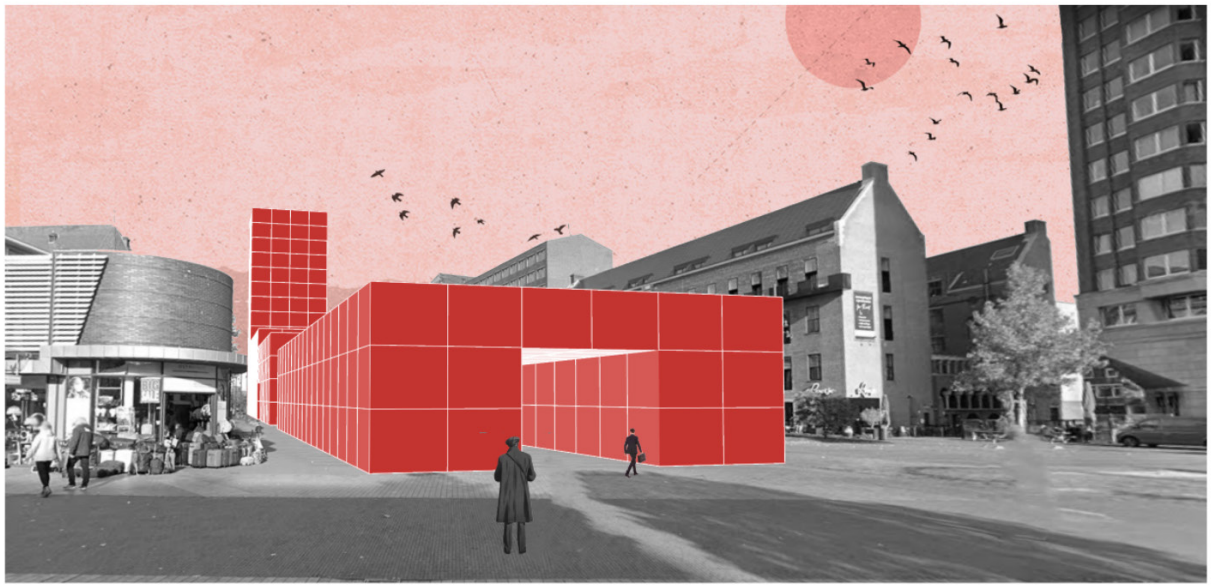


**Fig.6.1** Conceptual drawings
The phygital building with access function

Illustration by the author

## Introduction

This chapter presents a cohesive and innovative design solution for the project. It begins by introducing the design concept, which provides a clear vision and objectives for the design process. Then explorations of the design components, which encompass the key elements and features of the proposed design. It further delves into the physical design, emphasizing the importance of creating inclusive, adaptable, and sustainable spaces. Simultaneously, the chapter addresses the virtual design dimension, highlighting the integration of augmented reality and digital technologies to enhance the user experience. Overall, the design chapter showcases a comprehensive approach that merges physical and virtual elements to create an engaging and transformative environment.

# 6.1 Design Concepts

Virtual and Physical layers of activities

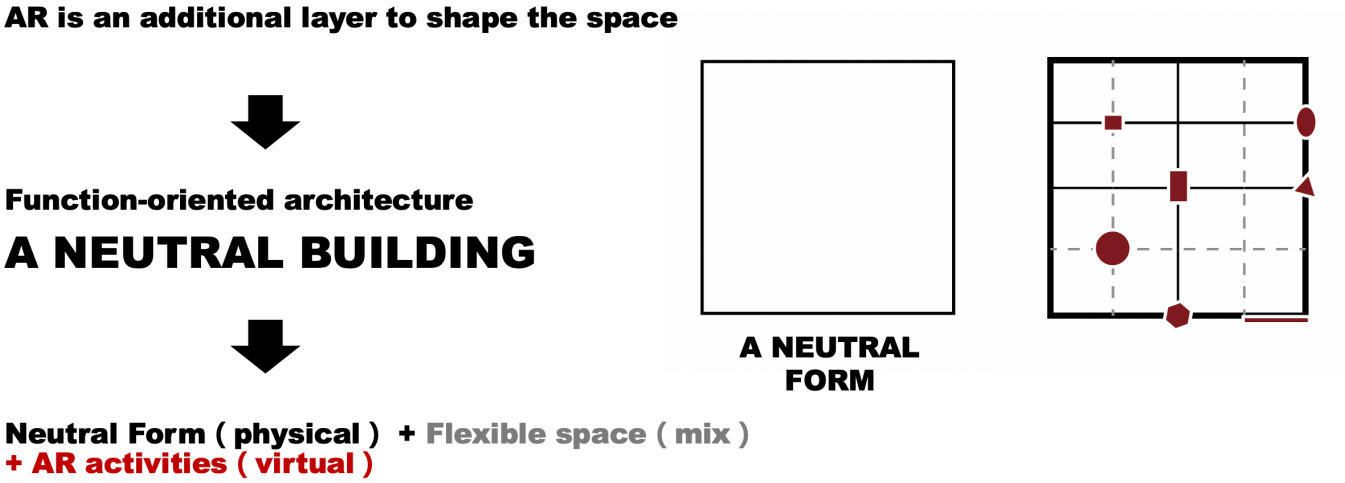



**Fig.6.2** Design Concept the neutral form

Illustration by the author

The design concept revolves around leveraging augmented reality (AR) as a digital layer to shape and enhance urban spaces. In this vision, a crucial element is the development of "neutral" buildings that serve as versatile containers, accommodating multiple functions and activities within the urban fabric. These buildings act as a physical foundation, emphasizing inclusivity and neutrality, while the digital component offers diversity and flexibility. Together, they form a hybrid, or "phygital," space that seamlessly integrates the physical and digital realms.

The core idea is to utilize AR technology to enrich the urban experience, allowing users to interact with their surroundings in innovative and dynamic ways. By integrating AR into the built environment, public spaces become immersive and adaptable, creating new possibilities for engagement and interaction. However, to support this vision effectively, the physical aspects of future public spaces and buildings need to embrace inclusivity and neutrality. These spaces should be designed to accommodate a diverse range of activities, ensuring accessibility and a sense of belonging for all individuals.

The neutral buildings act as the backbone of this concept, providing the necessary infrastructure and flexibility to host various functions and adapt to evolving needs. They serve as blank canvases for the digital layer to unfold, allowing for endless possibilities and personalization. The digital aspect, on the other hand, brings dynamism and adaptability, enriching the urban environment with interactive elements and immersive experiences.

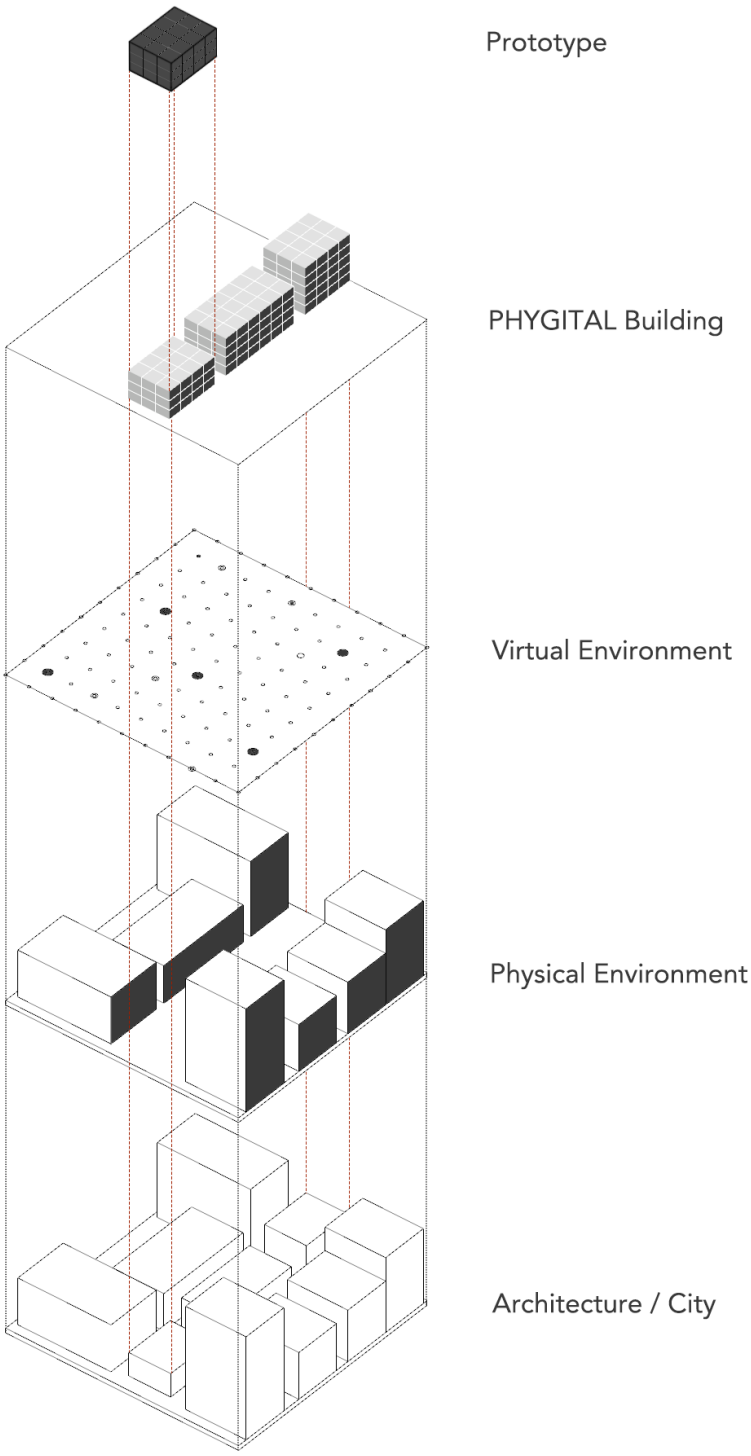



**Fig.6.3** Prototype
the phygital building

Illustration by the author

By combining the physical and digital realms, a phygital space is created, offering a harmonious fusion of the tangible and virtual worlds. This design concept envisions a future where AR-neutral buildings serve as the foundation for a vibrant and inclusive urban landscape. The physical space embraces neutrality and inclusivity, while the digital layer brings diversity and flexibility. Together, they form a seamless and engaging urban experience, redefining the relationship between people, architecture, and the surrounding environment in the digital age.

# 6.2 Design Components

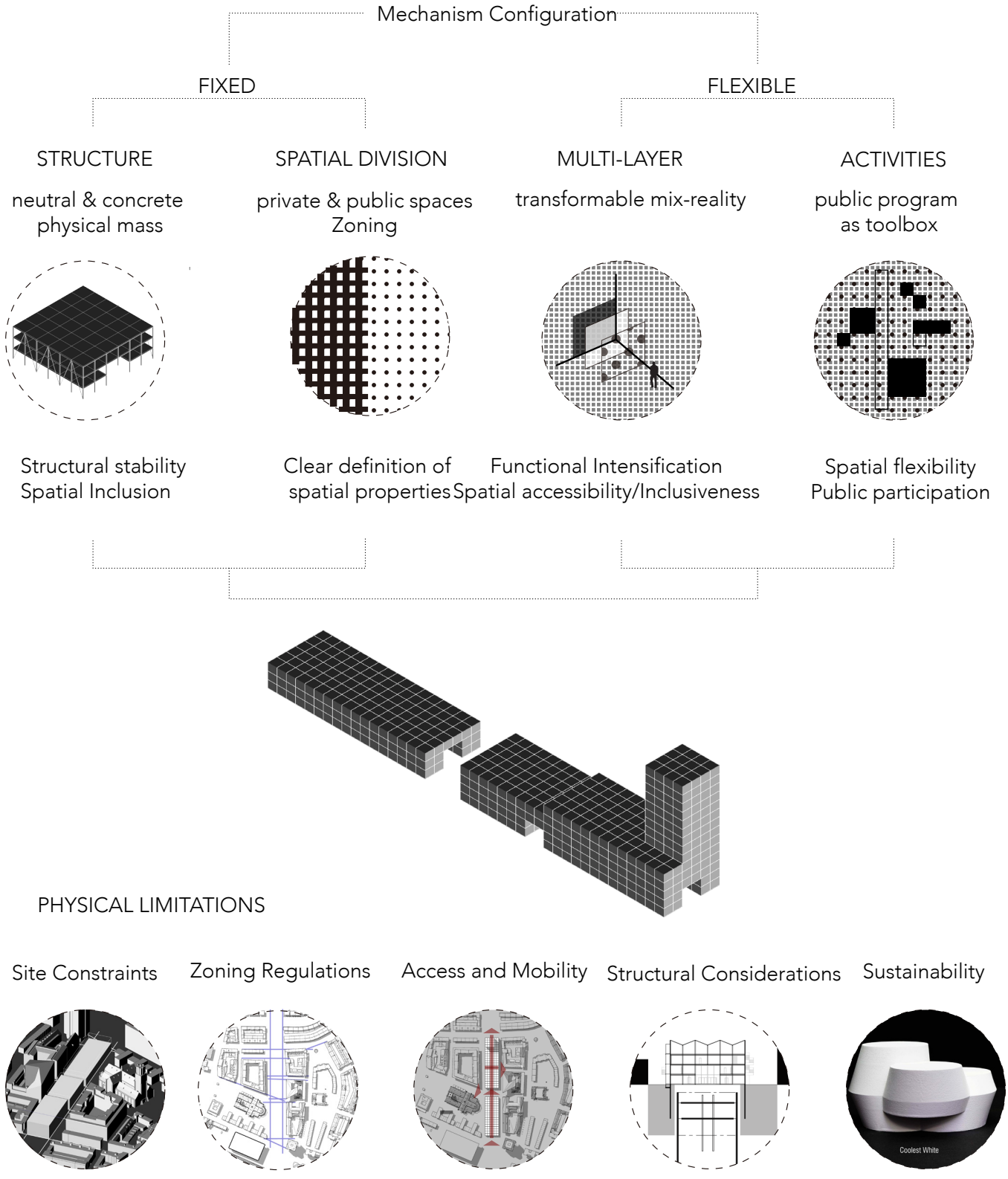



**Fig.6.4** Design components

Illustration by the author

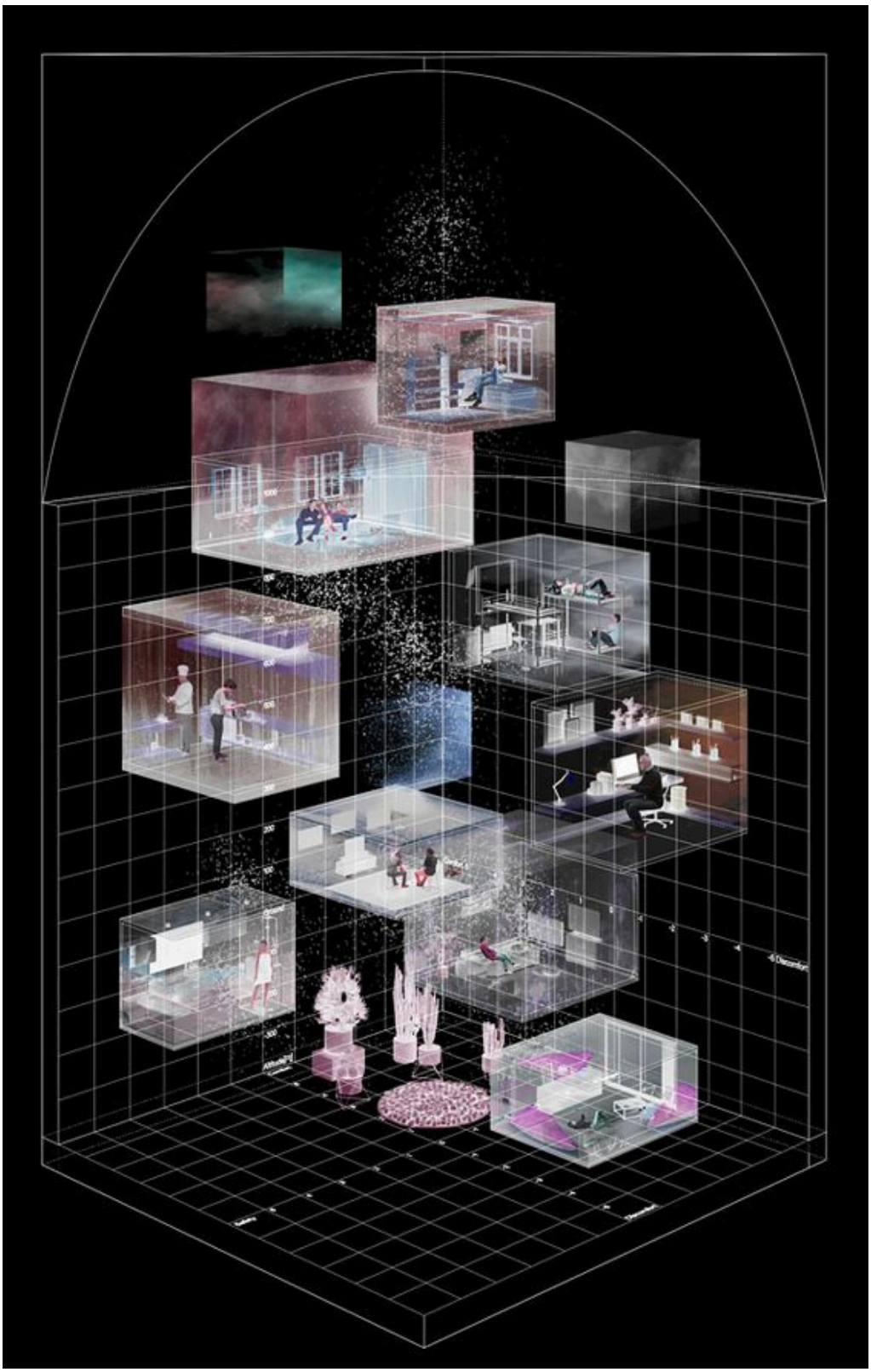


**Fig.6.5** Virtual and superimposable spaces

Illustration by Lydia Kallipoliti and Xiaoxiao Zhao, Microcosms: A vast array of disconnected contained living units, 2020.

# 6.3 Phsical Design

## 6.3.1 designing physical limitations

When designing a building to adapt to the surrounding urban fabric, there are several physical limitations that must be taken into account. Here are a few examples:

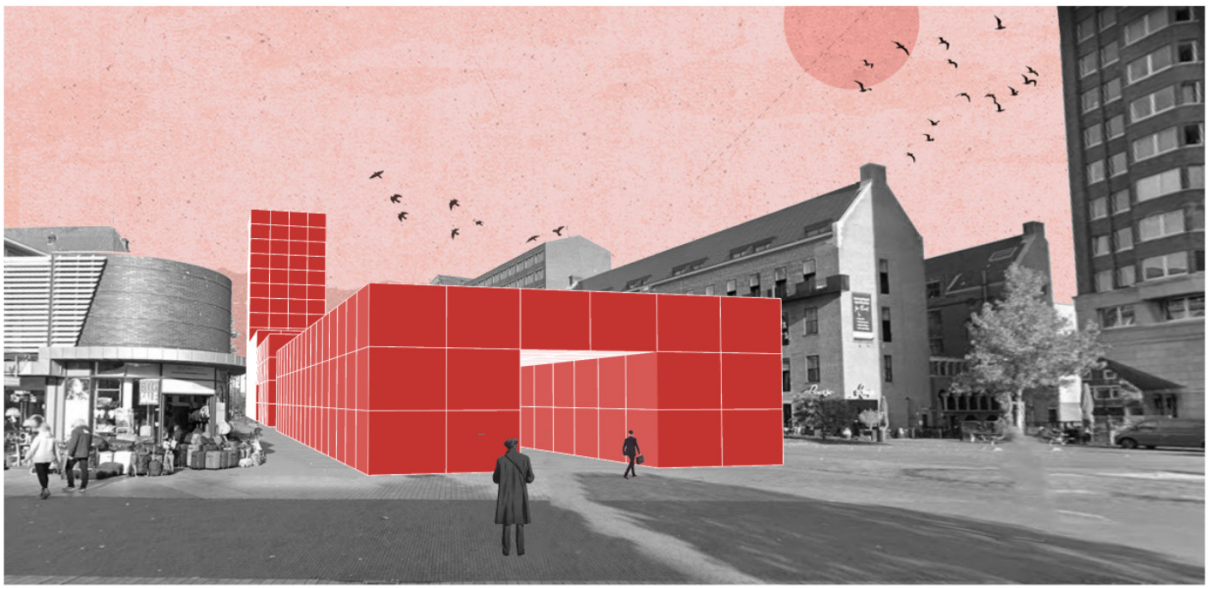
Site Constraints: The size, shape, and orientation of the site can limit the design and placement of the building. The building must be designed to fit within the available space and take into account any site-specific issues, such as topography, geology, and environmental factors.

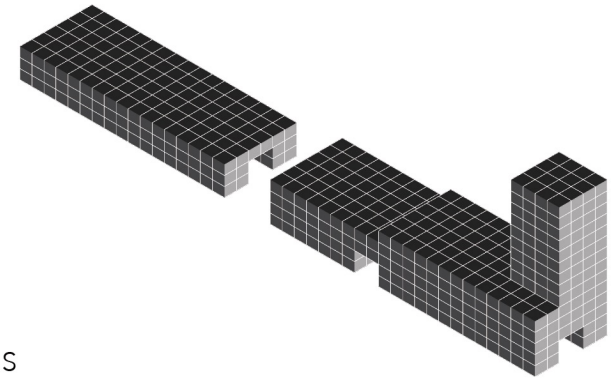
Zoning Regulations: Zoning regulations can impose physical limitations on building design, such as height restrictions, setbacks, and other site-specific requirements. The building design must comply with these regulations to ensure that it can be built and occupied legally.

Access and Mobility: The building design must take into account access and mobility requirements, such as entry and exit points, parking, and transportation infrastructure. The building should be designed to accommodate different modes of transportation, such as pedestrians, cyclists, and vehicles.

Structural Considerations: The building design must take into account structural considerations, such as the foundation, load-bearing walls, and roof. The building must be designed to withstand the forces of nature, such as wind, rain, snow, and earthquakes.

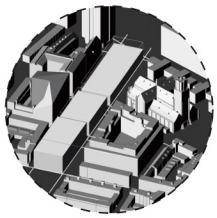
Sustainability: The building design must be sustainable and energy-efficient, taking into account factors such as natural light, ventilation, and insulation. The building should also be designed to minimize its environmental impact, such as through the use of renewable energy sources and green materials.



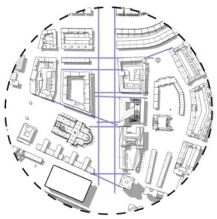


PHYSICAL LIMITATIONS

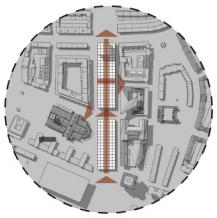
Site Constraints



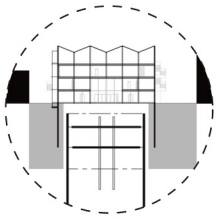
Zoning Regulations



Access and Mobility



Structural Considerations



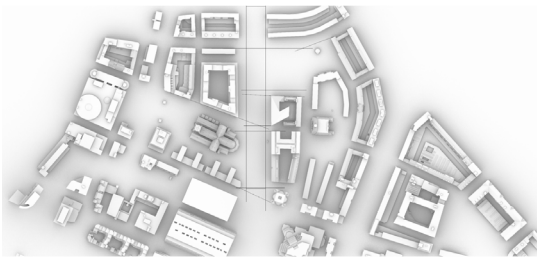
Sustainability

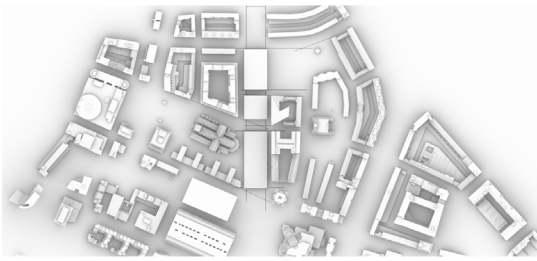

**Fig.6.6** Physical Design components

Illustration by the author

## 6.3.1.1 Site Constraints

When embarking on a construction project, it is essential to consider the various constraints and regulations that may impact the design and placement of the building. Two crucial factors to consider are site constraints and zoning regulations.





Site constraints encompass the size, shape, and orientation of the site. These factors can impose limitations on the overall design and placement of the building. The design must be tailored to fit within the available space while considering site-specific issues such as topography, geology, and environmental factors. Understanding and accommodating these constraints are crucial for creating a functional and harmonious building that integrates seamlessly with its surroundings.

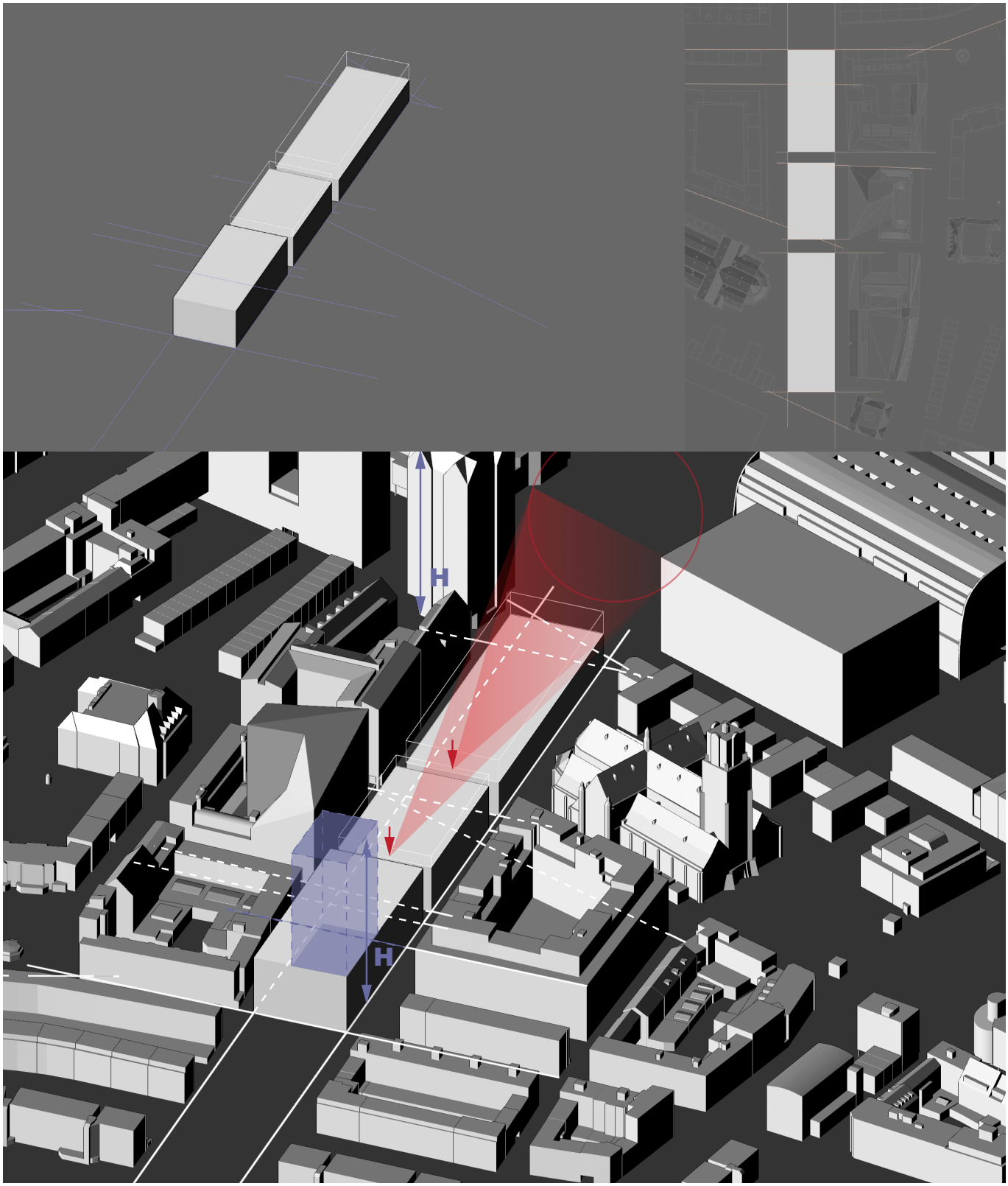
Zoning regulations play a significant role in dictating the physical aspects of building design. These regulations are established by local authorities to manage land use and ensure compliance with specific requirements. They may include restrictions on building height, setbacks, and other site-specific criteria. Compliance with zoning regulations is essential to ensure that the building can be legally constructed and occupied. Adhering to these regulations is crucial for maintaining the integrity of the project and avoiding potential legal complications.

By carefully considering site constraints and adhering to zoning regulations, architects and designers can navigate the complexities of the project site and create a building that is not only aesthetically pleasing but also functional, safe, and in compliance with local regulations. This comprehensive understanding of site-specific factors sets the stage for a successful and harmonious construction project.

## 6.3.1.2 zoning Regulations

**Fig.6.7** zoning regulations

Illustration by the author



### 6.3.1.3 Access and mobility

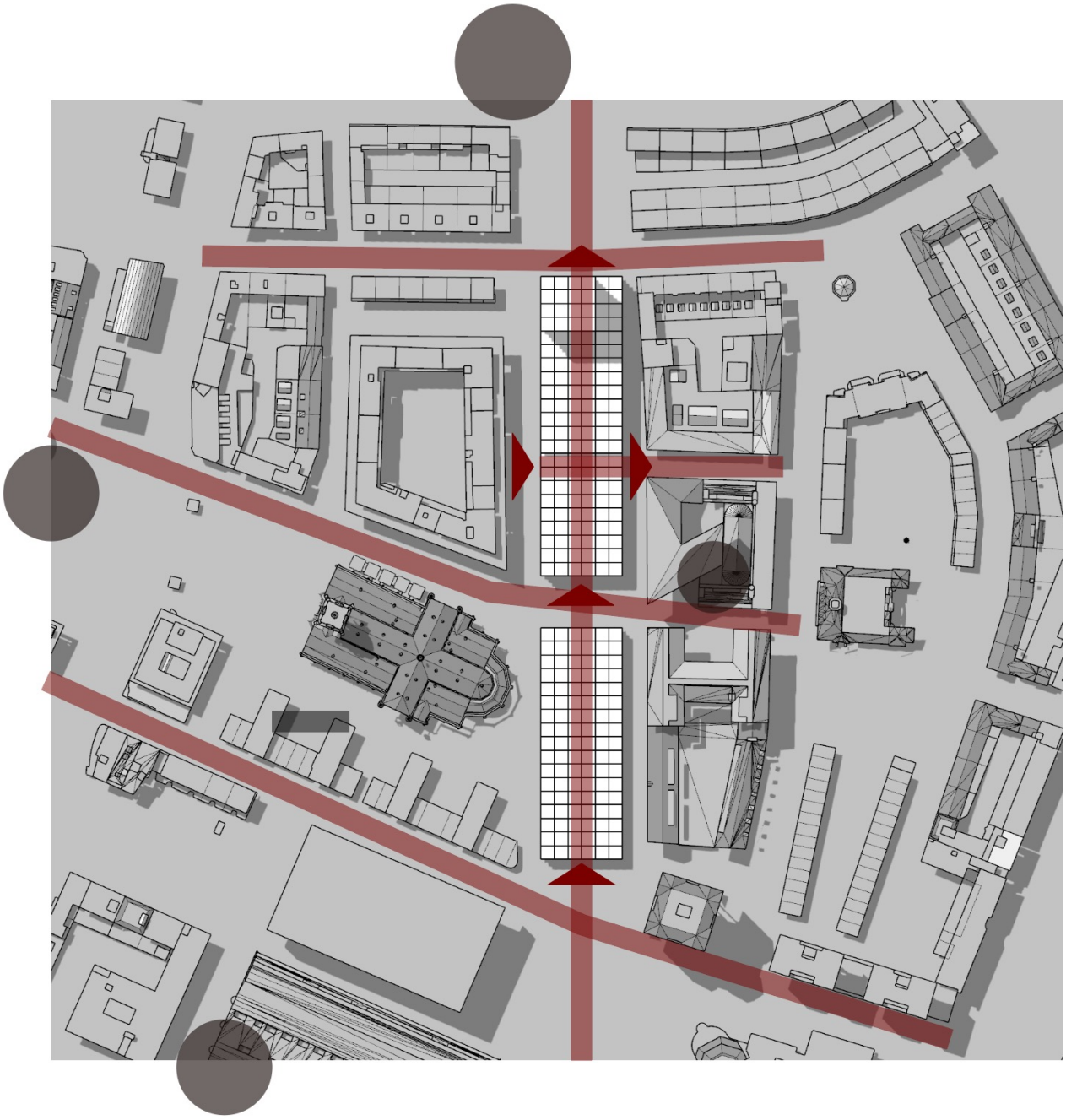
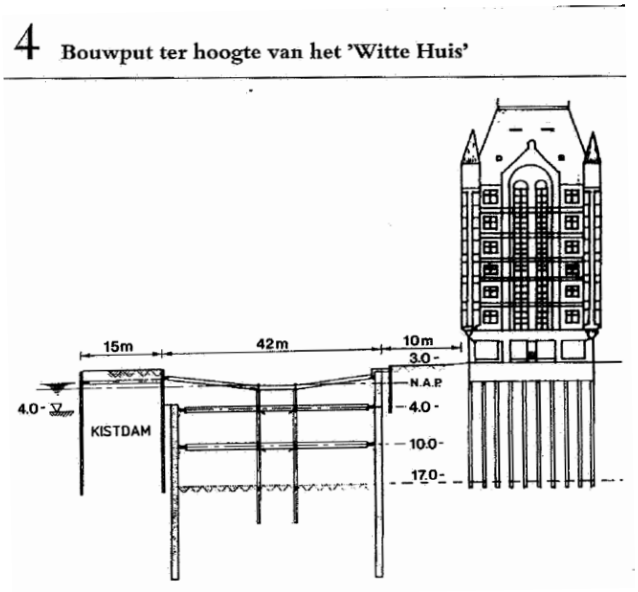


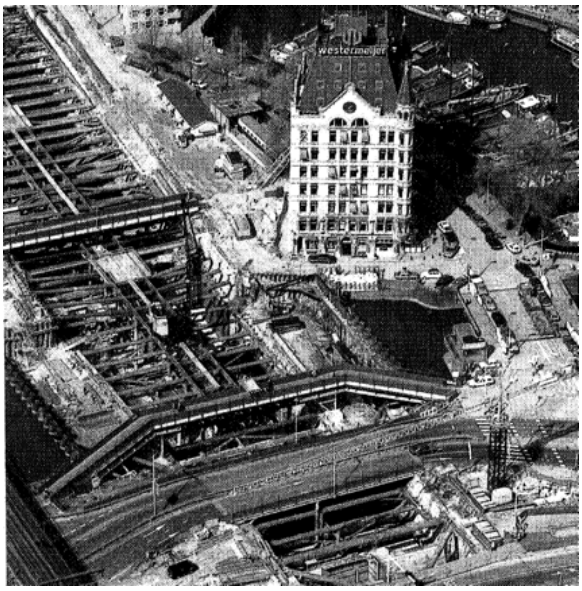
**Fig.6.8** Mobility and Parking

Illustration by the author

## 6.3.1.4 Structural COnsiderations

The Willemsspoortunnel, as can be assumed, is an approximately 3 km long four-track tunnel that runs under the Nieuwe Maas and Koningshaven rivers in the heart of the city of Rotterdam.
Construction started in 1987 and in September 1993, the tunnel was commissioned as a two-track. The third and fourth tracks will be ready for use in September 1994.



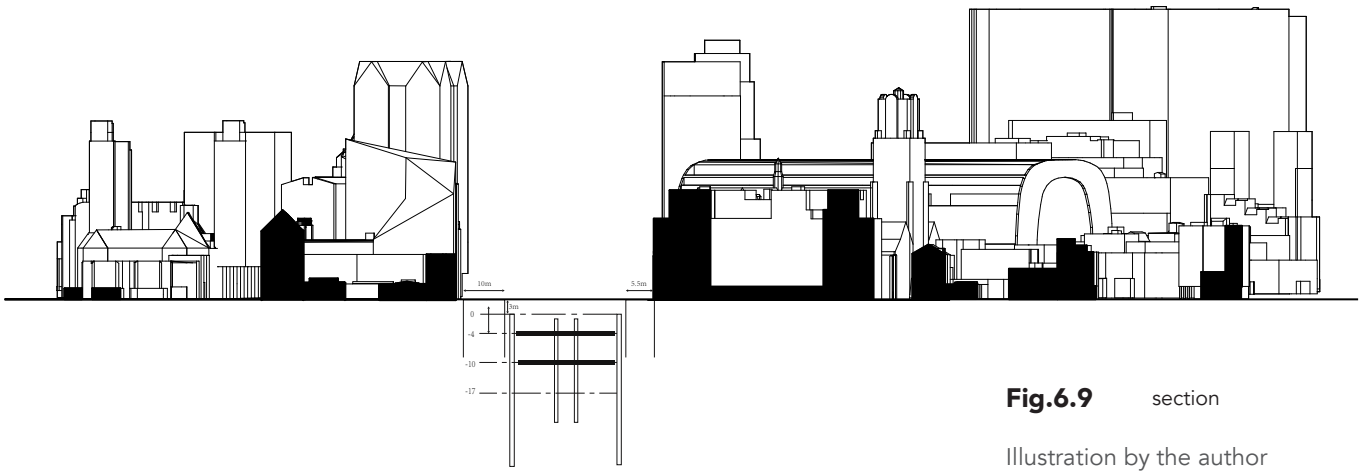


**Fig.6.9** section

Illustration by the author

[1] Gerritsen, J., & Brassinga, H. 1993-12(P8-16). WILLEMSSPOORTUNNEL ROTTERDAM HET BESTEK 'STATION BLAAK'. Rotterdam: Gemeentewerken Rotterdam.

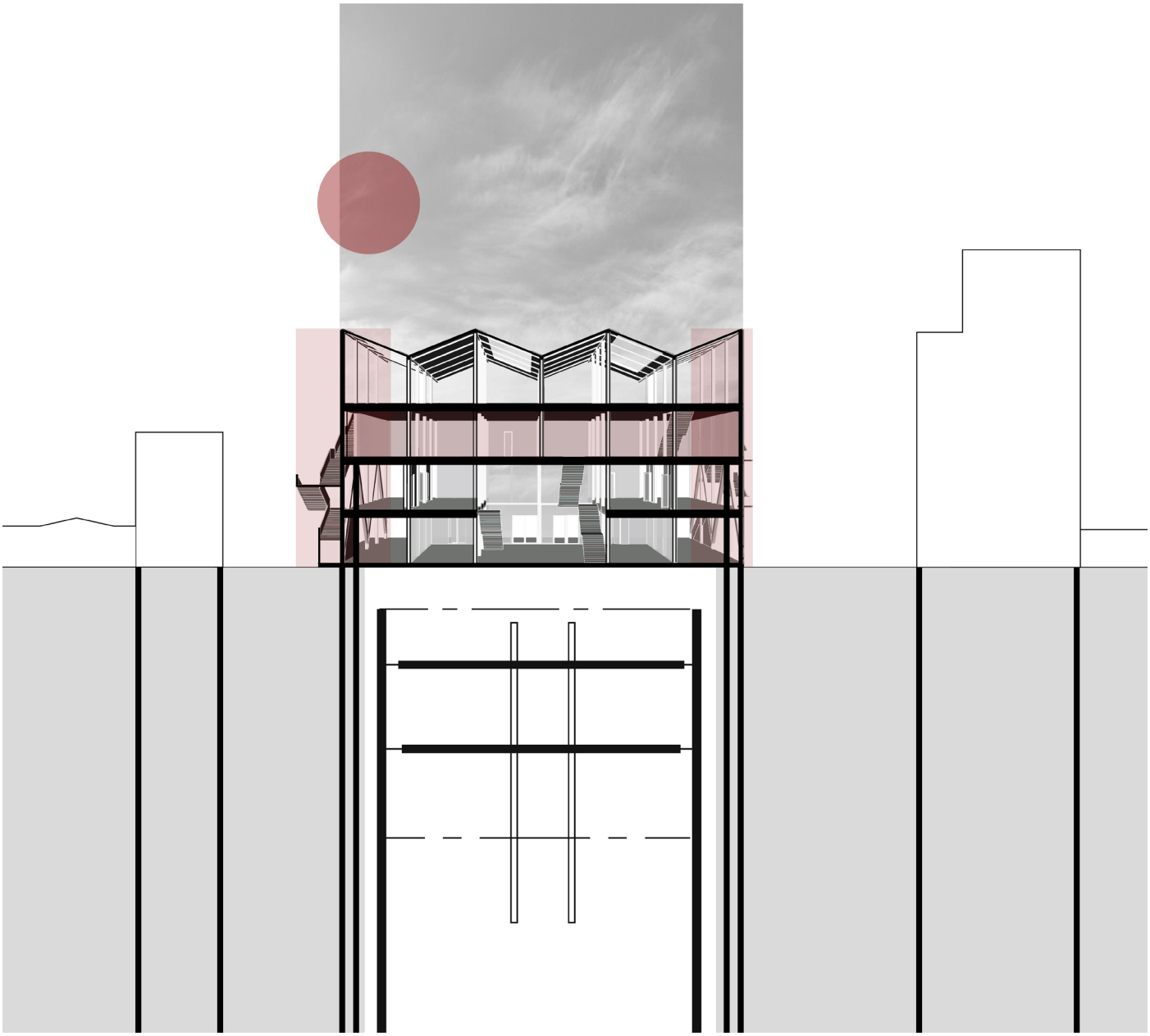


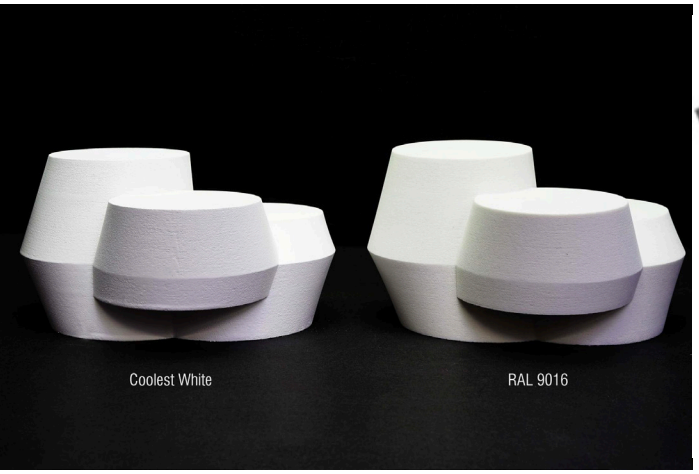
**Fig.6.10** Section Detail
The exterior reinforcement of the building is depicted by the light red section, while the grey area represents the buildable portion of the underground area.
Illustration by the author

## 6.3.1.5 Sustainability —material&roof

UNStudio and Monopol Colors have collaborated to create 'The Coolest White,' a long-lasting paint that combats the urban heat island effect and shields buildings from excessive solar radiation. This fluoropolymer-based paint, designed for metallic facades and structures, provides exceptional corrosion protection and surpasses existing standards with its high Total Solar Reflectance (TSR) value.

Roof design plays a crucial role in optimizing sustainable features such as rainwater harvesting, natural lighting and ventilation, integration of renewable energy technologies, and enhanced thermal performance. A well-designed roof allows for efficient rainwater collection, maximizes natural light and ventilation, accommodates renewable energy installations, and enhances thermal efficiency. Considering these factors during roof design ensures an environmentally friendly and energy-efficient building.

In conclusion, 'The Coolest White' paint offers effective protection against solar radiation, while thoughtful roof design maximizes the potential of sustainable features, leading to a more sustainable and energy-efficient building.



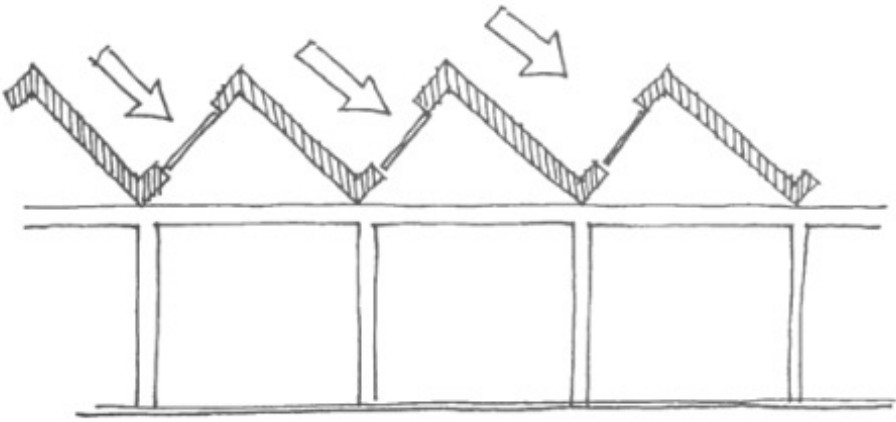
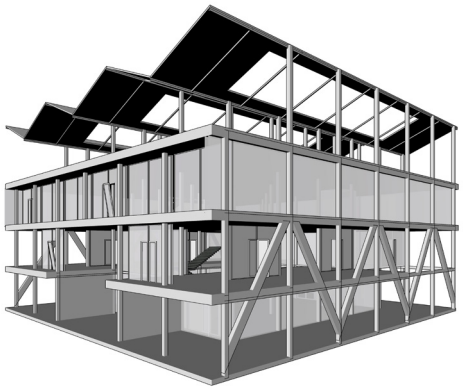



**Fig.6.11** Sustainable Materials & Roof diagram
Coolest White Painting
https://www.unstudio.com/en/page/12254/coolest-white-wins-architizer-a-award

# 6.3 Physical Design

## 6.3.2 neutral building prototype



The design of the physical neutral prototype is driven by the need to provide a stable and adaptable framework that supports the dynamic nature of AR activities. Each design element serves a specific purpose in enhancing the AR experience and creating a versatile environment for both public and private interactions.

The folded roof design not only adds aesthetic appeal but also serves as a rainwater harvesting system. It efficiently collects and stores rainwater, promoting sustainability and reducing reliance on external water sources. Additionally, the folded roof design allows for natural lighting and ventilation, creating a comfortable and energy-efficient interior space.

Internal staircases play a crucial role in facilitating movement and circulation within the building. They provide convenient access to different levels, encouraging exploration and interaction between users. Fixed traffic spaces are strategically positioned to ensure efficient flow and minimize congestion, enhancing the overall user experience.

External staircases provide additional access points and connect the building with its surroundings. They promote connectivity and engagement with the external environment, creating seamless transitions between indoor and outdoor spaces. Reinforced concrete staircases offer durability, support, and stability, ensuring the safety of users while accommodating varying traffic loads.

The slab-column system adopts a modular design approach with dimensions of 6x6 meters. This modular design allows for flexibility and adaptability in configuring the interior space to accommodate different activities and functions. It provides a versatile layout that can be easily reconfigured to suit changing needs and preferences.

The facade features translucent glass, which not only enhances the aesthetic appeal but also allows for natural light to penetrate the interior. This creates a bright and inviting atmosphere while maintaining privacy. The facade is designed to be AR adaptable, providing a surface for digital projections

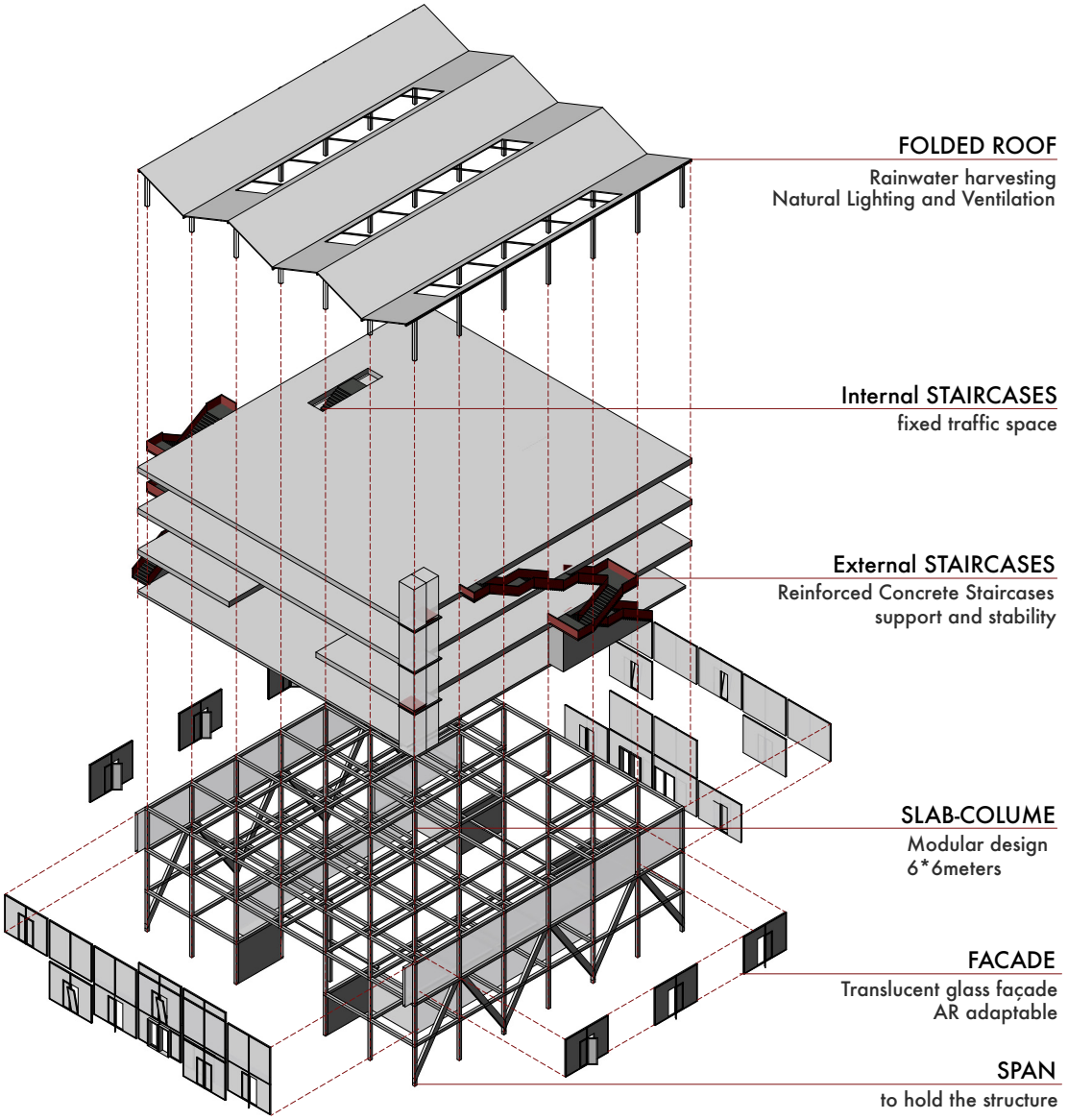



**Fig.6.12** Physical prototype

Illustration by the author

and interactions, seamlessly integrating the virtual and physical elements.

To ensure structural integrity and support the weight of the building, a robust span structure is incorporated. This structural system efficiently distributes the load, allowing for spacious and open interior spaces. It provides a solid foundation for hosting AR activities and accommodating various installations and equipment.

In conclusion, the design of the physical neutral prototype takes into consideration the need for stability, adaptability, and neutrality in facilitating AR activities. The combination of folded roof design, rainwater harvesting, natural lighting and ventilation, internal and external staircases, reinforced concrete structures, modular design, AR-adaptable facade, and a robust span structure creates an environment that seamlessly integrates the physical and digital realms, offering an engaging and immersive AR experience.

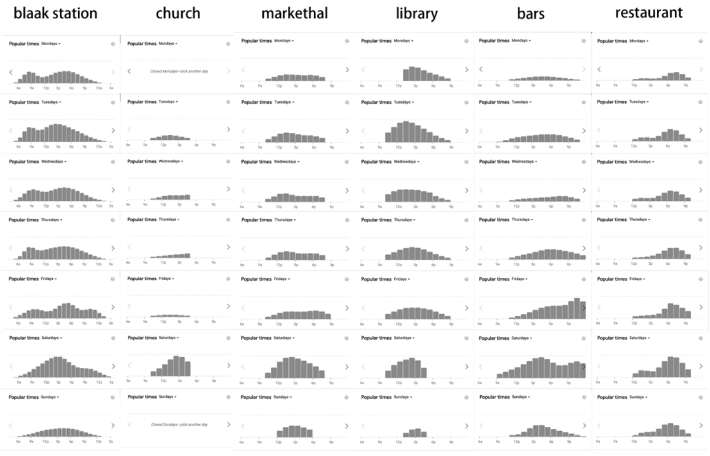
# 6.4 Virtual Design

## 6.4.1 program and timeline

Based on the analysis of the diagram illustrating the general busy time of a day and the distinction between weekdays and weekends, it is evident that there are two periods of concentrated activity. These findings highlight the dynamic nature of activities, which vary depending on the day and night, and the ever-changing demands of people throughout different times of the day. In this context, AR-adaptive public buildings offer a promising solution to cater to these evolving needs effectively.

Looking ahead, the utilization of IoT big data can play a significant role in analyzing the flow of people and the level of activity in the surrounding functions. Through collaborative analysis, the primary functions that should be incorporated within AR buildings can be identified, and a corresponding schedule can be established. Consequently, the mobile virtual space will undergo transformations, and the fixed public space can adapt its primary functions in response to evolving demands. The immersive nature of AR enables the reinvention of space, facilitating the creation of diverse and enriched experiences.

Overall, AR technology enables the intensive utilization and decentralized distribution of space and resources. It enhances accessibility to information and desired resources, while simultaneously fostering a more diverse and enriched use of space. By leveraging AR, opportunities arise for reshaping the ambience and functionality of public spaces, ultimately contributing to a more dynamic and responsive urban environment.



# Timeline

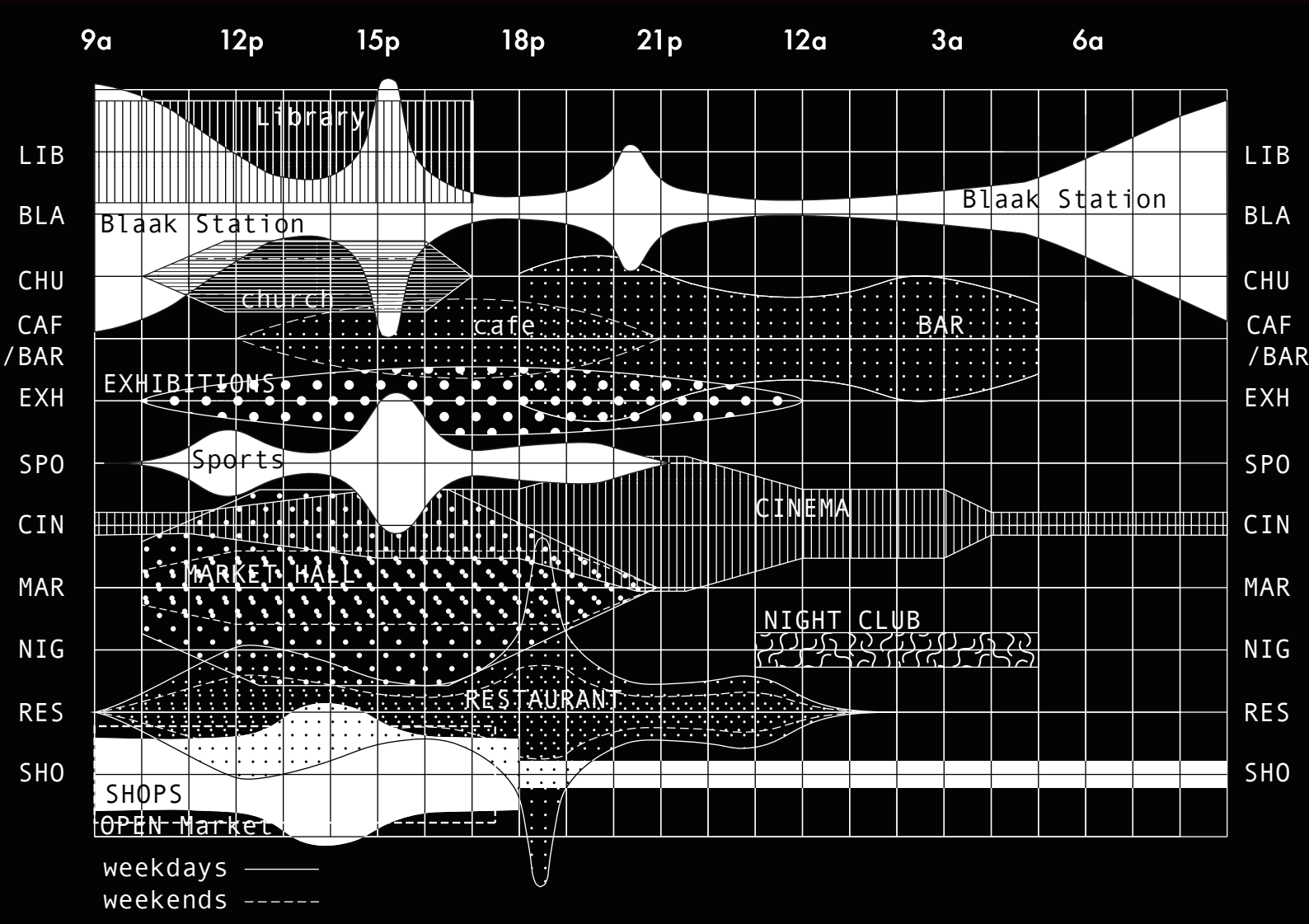
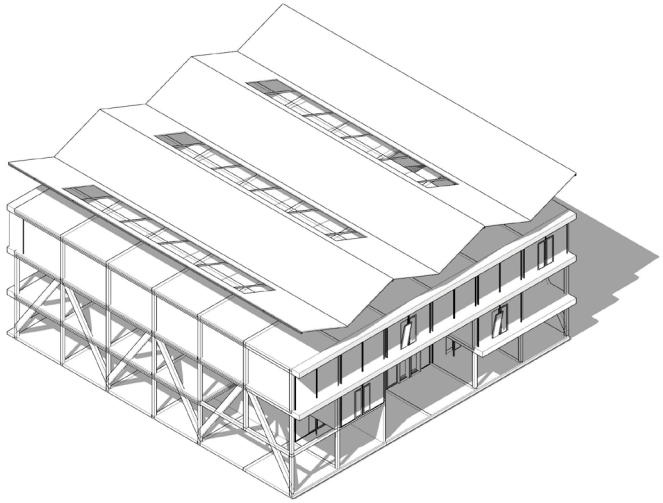



**Fig.6.13** Timeline in Blaak
Illustration by the author

The timeline diagram illustrates the activity time mapping of the Blaak site, showing when different activities occur based on their timing and busyness. This comprehensive visual representation enables a better understanding of the site's dynamics throughout the day, aiding in the optimization of site usage. By identifying patterns and trends in activity scheduling and highlighting peak periods, the diagram supports effective resource allocation, space utilization, and informed decision-making for the site's design and programming.

# 6.4 Virtual Design

## 6.4.2 Spatial typologies



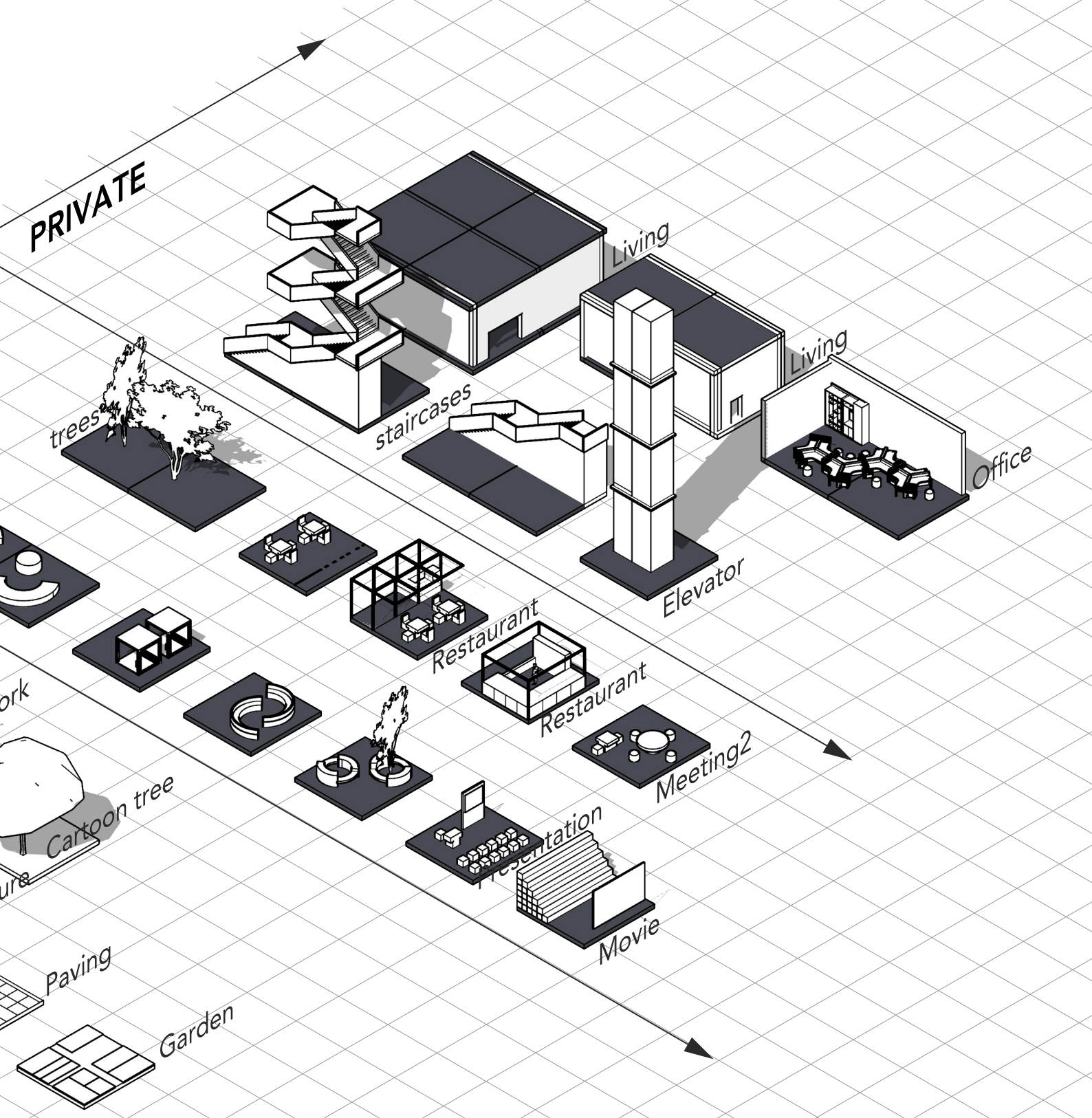



**Fig.6.14** Spatial types

Illustration by the author

# 6.5 Conclusion

The design process for the project began with a thorough analysis of the physical environment, taking into consideration various site constraints such as zoning regulations, access and mobility requirements, structural considerations, and sustainability aspects. These constraints played a crucial role in shaping the design approach, ensuring that the resulting architectural solution would be neutral, robust, and inclusive. By carefully studying and understanding the site's limitations, a design prototype was developed to effectively address these constraints and create a harmonious integration with the surrounding environment.

In addition to site constraints, the analysis also encompassed a comprehensive examination of the types of activities and projects expected to take place on the site. This evaluation led to the identification of different space types that could cater to the diverse physical and virtual needs of the users. The design concept incorporates these identified space types, allowing for a versatile and adaptable environment that can accommodate various activities. By considering the specific requirements of both physical and virtual spaces, the design aims to provide an integrated solution that effectively supports and enhances the functionality and experience of the users.

To ensure the seamless integration of physical and virtual spaces, the project emphasizes the importance of conducting augmented reality (AR) experiments. These experiments serve as a means to evaluate and test the design outcomes, focusing on how the physical and virtual activity spaces can effectively work together. The assessment includes examining the potential conflicts or contradictions that may arise and establishing principles and guidelines for selecting and organizing the different space types. Through this iterative process, the project aims to create an environment that optimizes the utilization of physical and virtual spaces, promoting a cohesive and immersive experience for the users while adhering to the site's constraints and design objectives.

# Evaluation
Evaluation
Evaluation
Evaluation

## 7.1 AR Experiment
## 7.2 Design Principles
## 7.3 Implementations
## 7.4 Different Scenarios

## Introduction

In the evaluation chapter, AR experiments are utilized to assess the effectiveness and coherence of the design prototype and the synergies between different spatial types. The aim is to derive design principles and address potential challenges that may arise during the implementation of digital transformation. Furthermore, the implementation of architectural prototypes and the exploration of various activity types within specific site contexts offer alternative perspectives for evaluating the design. Through these evaluation processes, a comprehensive understanding of the design's viability and adaptability can be achieved, informing future decision-making and refining the design approach.

# 7.1 The AR Experiment

## 7.1.1 framework

### 1. Introduction

Provide an overview of the research goal, highlighting the development of design principles and the exploration of people's attitudes towards virtual public spaces, AR application scenarios, and interaction behavior in AR buildings.
Research Objectives

Clearly state the objectives of the experiment, which include:
a. Developing design principles for AR buildings.
b. Observing people's attitudes towards virtual public spaces and physical public spaces in AR buildings.
c. Observing people's attitudes towards public and private in AR buildings.
d. Exploring AR application scenarios and their impact on user experience.
e. Investigating interaction behaviors within AR buildings.

### 2. Experimental Setup

a. Initial Building Structure
Describe the three-story initial building structure with a 6x6 grid layout, where each grid measures 6m x 6m x 4.8m (height).
b. Activity Types
Explain the two categories of activities: virtual (AR-based) and physical.
Virtual: Describe the 10 virtual public functions utilizing AR technology.
Physical: Explain the 12 physical public functions and 5 private functions.
c. Participant Interaction
Outline the procedure of participants wearing VR glasses to navigate the building, select activities, and interact with the AR environment.
d. Data Collection Methods
Explain the methods used to collect data, including observations, surveys, and interviews.

### 3. First Round Experiment

a. Data Collection
Describe the data collected during
ing observations of people's attitu
interaction behaviors.
b. Analysis
Explain the analysis process, focus
and insights related to people's att

### 4. Second Round Experime

a. Application of Design Principles
Explain how the design principles
applied in the second round exper
b. Redesign Process
Detail how participants used the
redevelop the initial building struct
c. Results and Evaluation
Discuss the improved coherence ar
redesigned building structure.
Present findings related to people'
public and private, AR application
iors in the updated AR environmen

### 5.Conclusion

Summarize the key findings of the
oped design principles and the ob
and feedbacks, AR application scen
Discuss the implications of the fin
ment of AR buildings, emphasizin
user attitudes and behavior in crea
ronments.
By incorporating these additional
sign, the structure now encompa
principles, as well as the observat
tudes towards virtual public spac
interaction behaviors in AR building

the first round experiment, includ-
des, AR application scenarios, and

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dings for the design and develop-
ng the importance of considering
ting immersive and engaging envi-

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asses the development of design
ions and analysis of people's atti-
es, AR application scenarios, and
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| | | | |
|---|---|---|---|
| **Preparation** | **Introduction:** | Provide an overview of the research goal and its focus on design principles and people's attitudes in virtual public spaces, AR application scenarios, and interaction behavior in AR buildings. | |
| | **Research Objectives:** | Clearly state the objectives of the experiment, including developing design principles, observing attitudes towards virtual and physical public spaces, studying attitudes towards public and private spaces, exploring AR application scenarios, and investigating interaction behaviors in AR buildings. | |
| | **Experimental Setup:** | Initial Building Structure: | Describe the three-story building structure with a grid layout, where each grid measures 6m x 6m x 4.8m (height). |
| | | Activity Types: | Explain the two categories of activities (virtual and physical) and provide details about the functions within each category. |
| | **Participant Interaction:** | Outline the procedure of participants wearing VR glasses, navigating the building, selecting activities, and interacting with the AR environment. | |
| | **Data Collection Methods:** | Describe the methods used to collect data, including observations, surveys, and interviews. | |
| **Process** | **First Round Experiment:** | Data Collection: | Explain the data collected during the first round, including observations of attitudes, AR application scenarios, and interaction behaviors. |
| | | Analysis: | Describe the process of analyzing the collected data to identify patterns, trends, and insights related to attitudes and interaction behaviors. |
| | **Second Round Experiment:** | Application of Design Principles: | Explain how the design principles derived from the first round were applied in the second round. |
| | | Redesign Process: | Detail how participants utilized the design principles to optimize and redevelop the initial building structure. |
| | **Results and Evaluation:** | Discuss the improved coherence and user experience observed in the redesigned building structure, along with findings related to attitudes, AR application scenarios, and interaction behaviors. | |
| | **Conclusion:** | Summarize the key findings of the experiment, including the developed design principles and observations of attitudes, AR application scenarios, and interaction behaviors. | |
| | | Discuss the implications of the findings for the design and development of AR buildings, emphasizing the importance of considering user attitudes and behavior in creating immersive and engaging environments. | |

**Fig.7.1** the framework of AR experiment

Illustration by the author

# 7.1 The AR Experiment

## 7.1.2 Confict and optimization

The research entailed two distinct experiments focused on the design of augmented reality (AR) buildings. In the first experiment, a three-story initial building structure was constructed with a grid layout of 6 by 6. Each grid space measured 6m by 6m with a height of 4.8m. Participants were equipped with virtual reality (VR) glasses and were tasked with navigating the building to engage in various "activities" randomly assigned to different grids. These activities encompassed both virtual public functions (10 in total) using AR technology and physical public functions (12 in total), along with five private functions.

Following the initial experiment, a comprehensive analysis of the findings was conducted, drawing upon spatial conflicts encountered during the activities and feedback provided by the participants. This analysis yielded a set of design principles that encapsulated both the spatial considerations and the positive experiential aspects expressed by the participants. Building upon these principles, a second round of experimentation was undertaken, wherein participants were tasked with redesigning the initial building structure using the principles derived from the first experiment.

The results of the second round of experimentation demonstrated a greater level of coherence and reasonableness in the redesigned building structure. Furthermore, the participants' feedback regarding their experience within the AR building improved notably. Overall, this iterative experimental approach aimed to establish fundamental rules for the development of AR buildings. By integrating insights gained from spatial conflicts and participant feedback, this research contributes to the advancement of the design process for AR buildings, providing a clearer understanding of the factors and principles necessary for optimal user experience and functionality.

**Fig.7.2** Experiment records

Photograph by the author

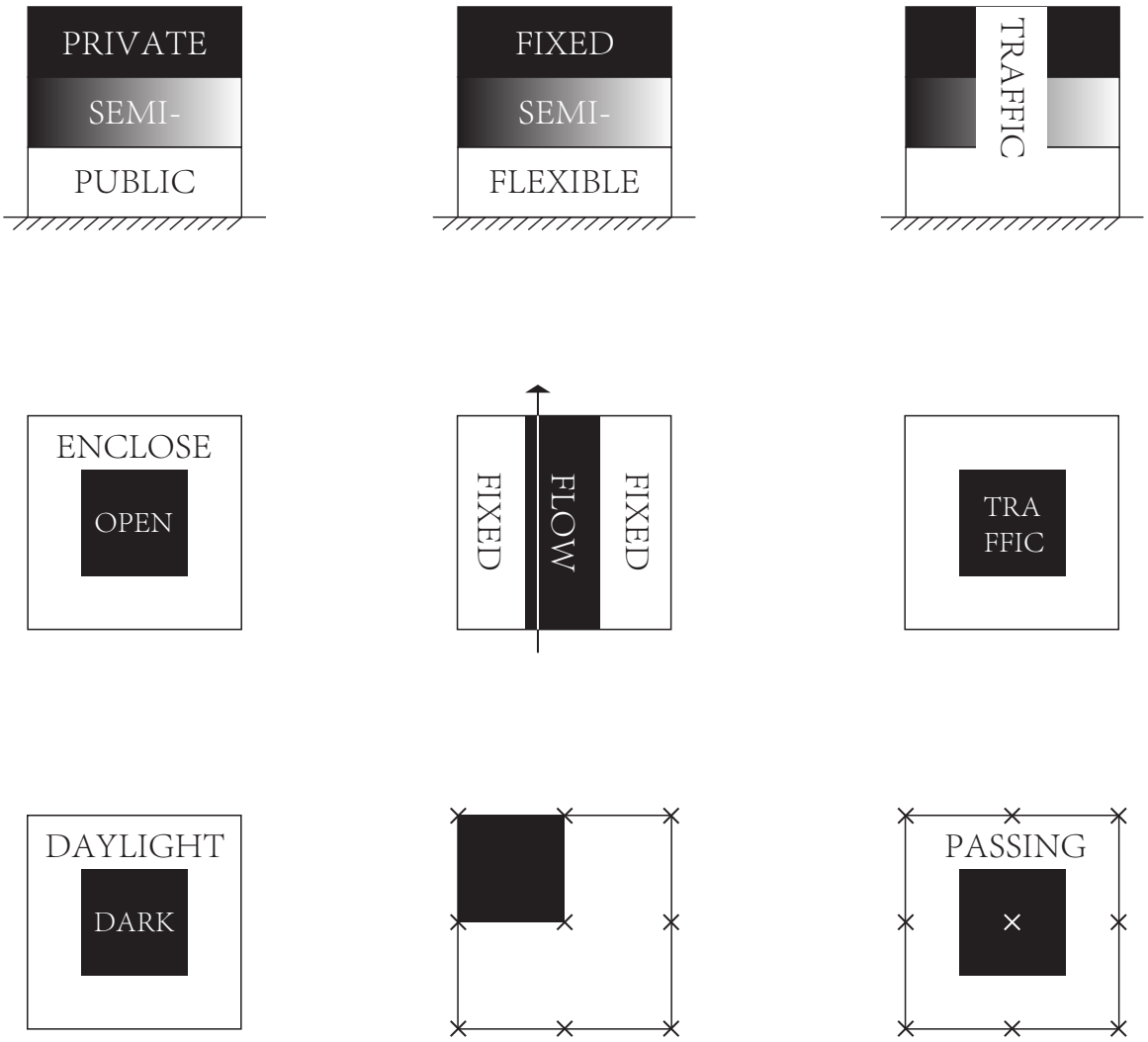
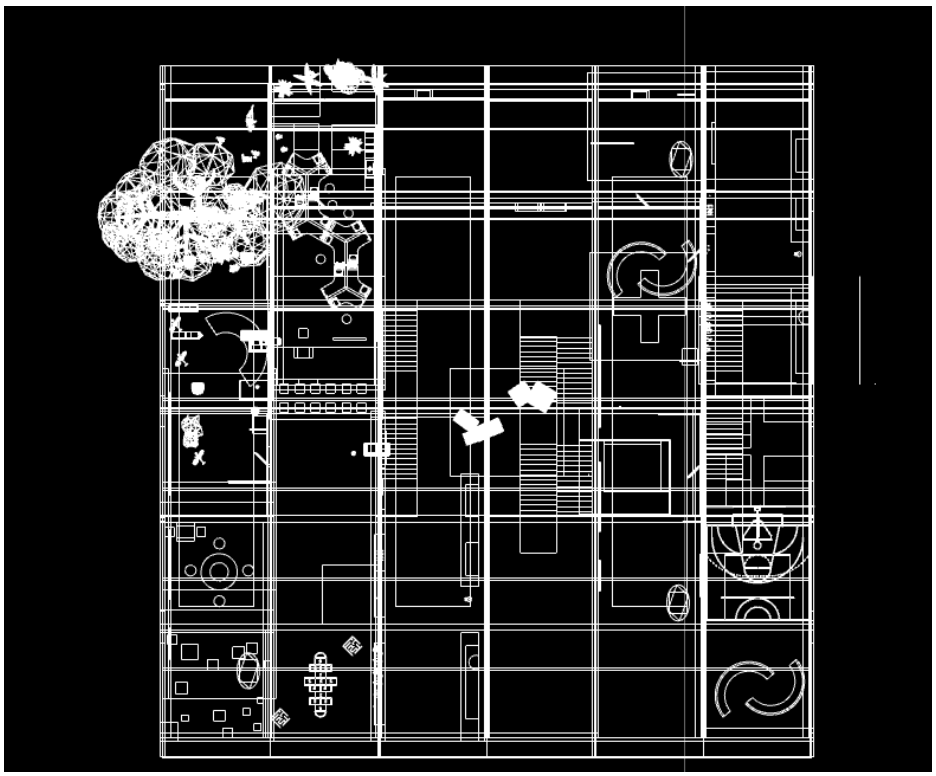


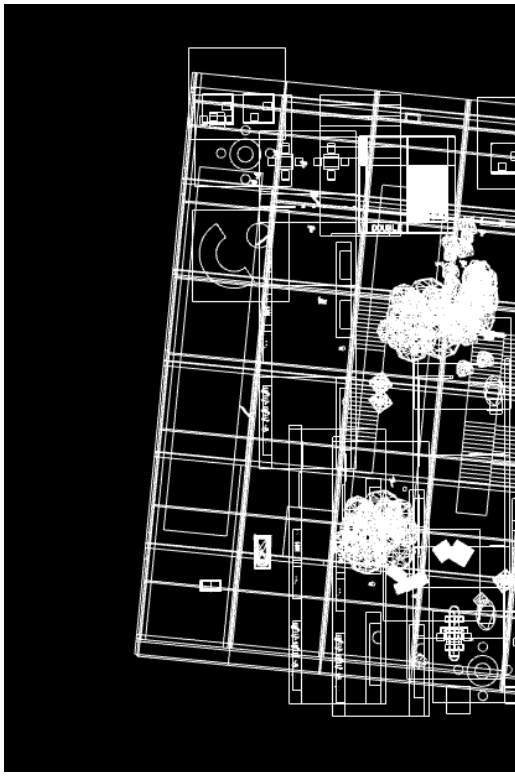

**Fig.7.3** Basic rules after 1st round

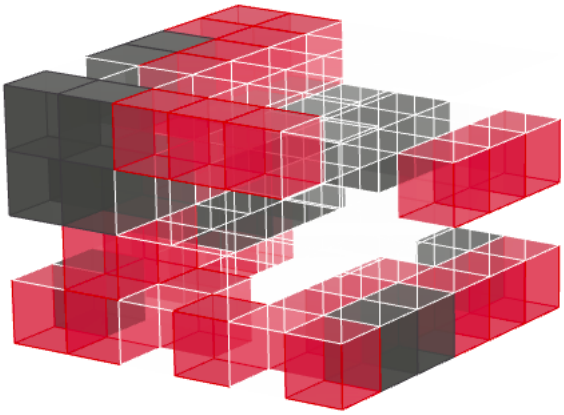
Illustration by the author

# 7.1 The AR Experiment

## 7.1.3 Results of the experiment







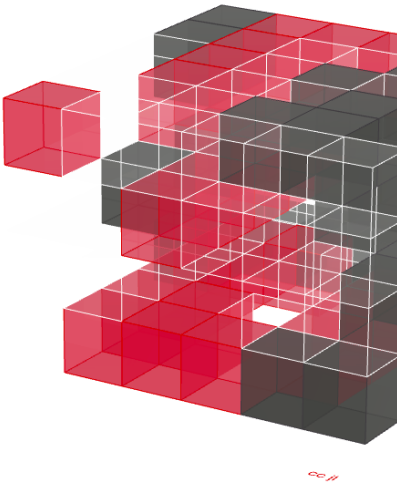
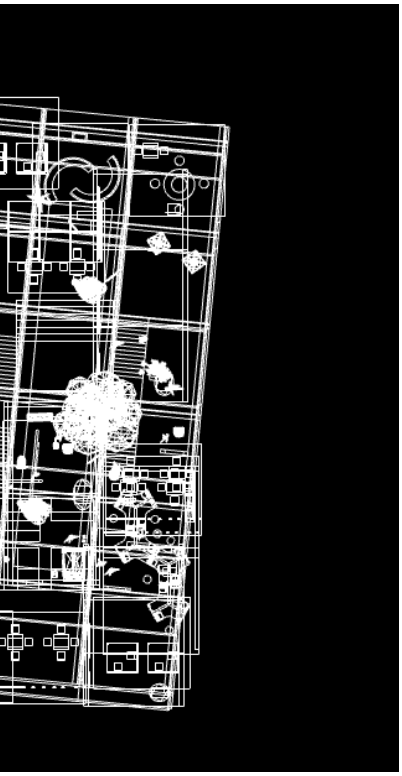
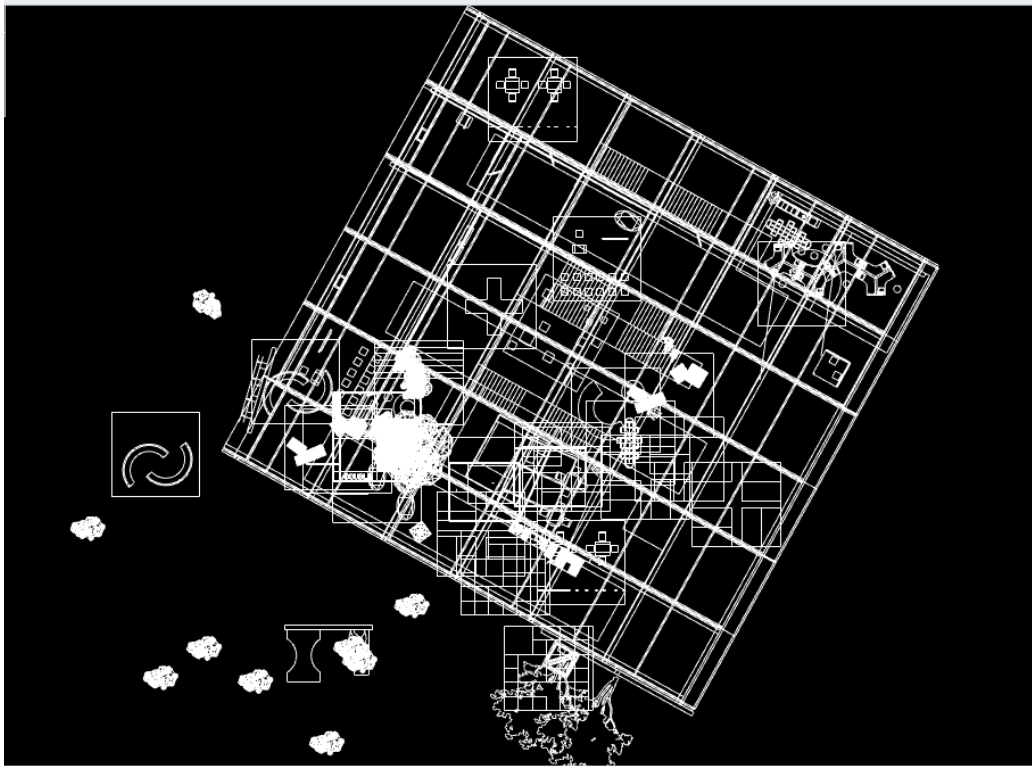
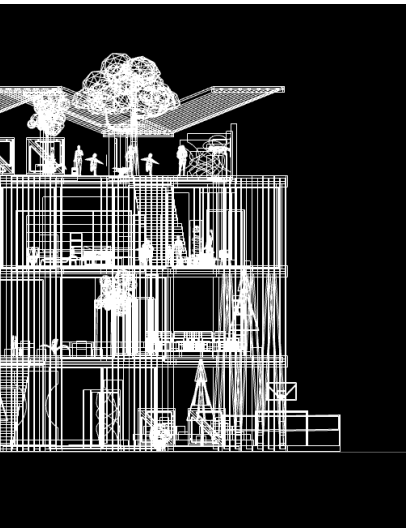
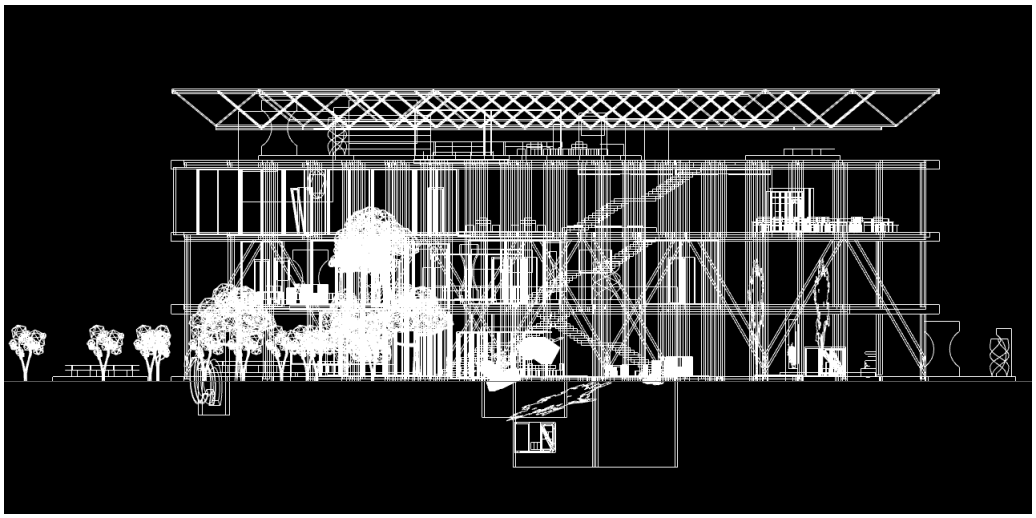


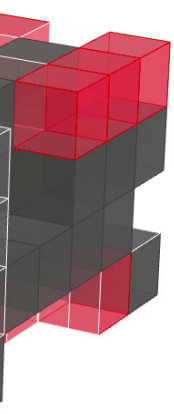
**Fig.7.4** Experiment model records
Illustration by the author

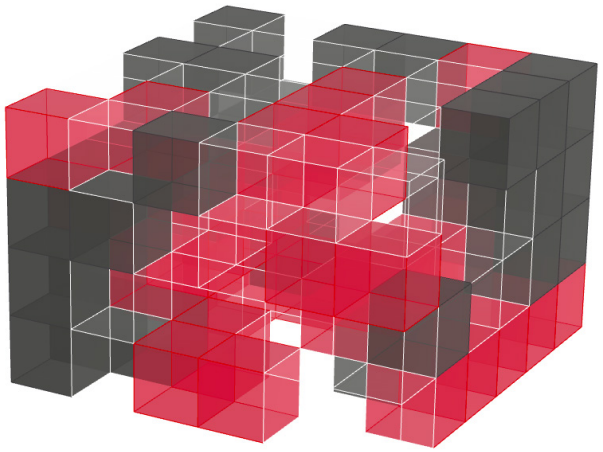


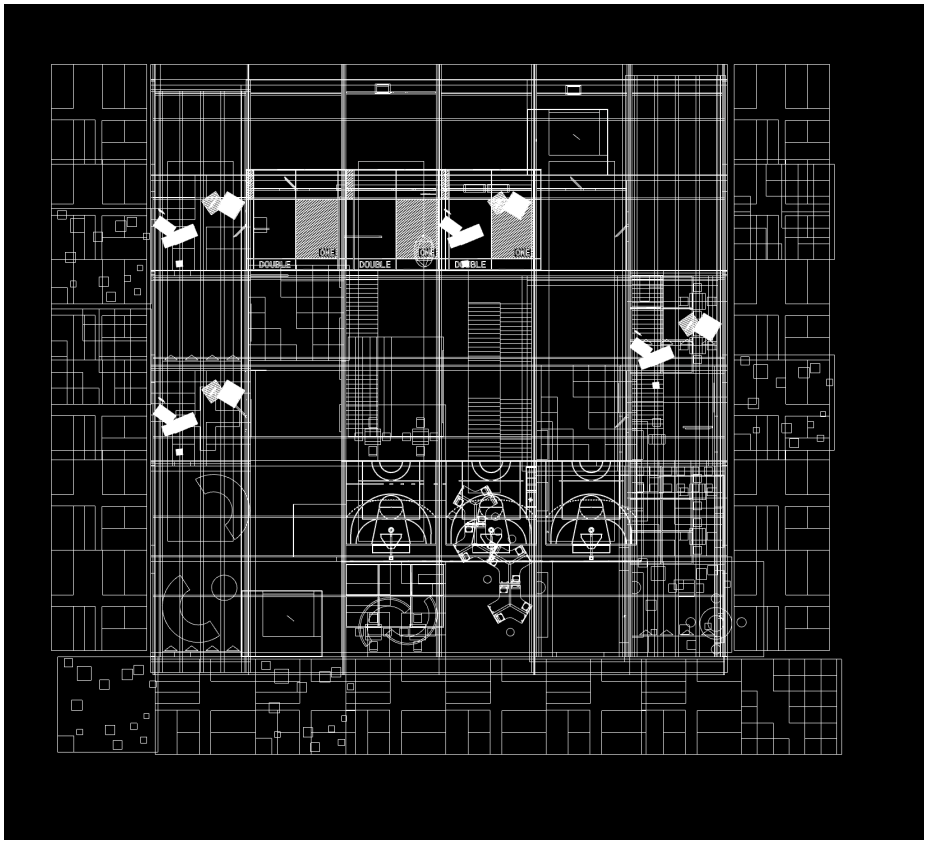


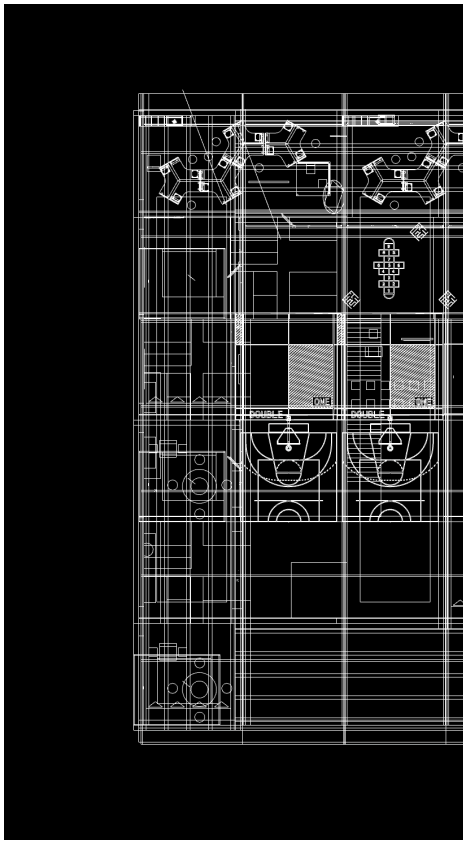


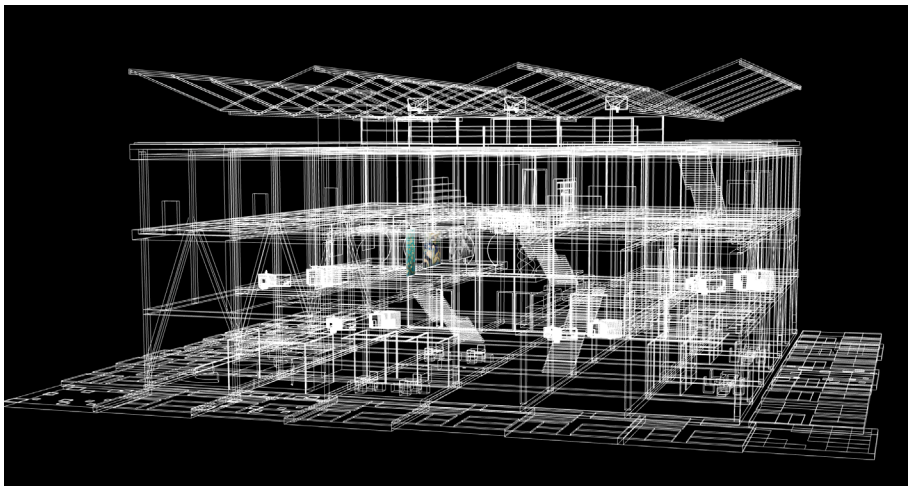


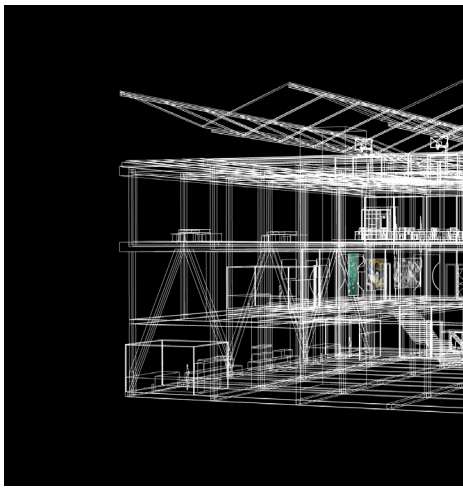


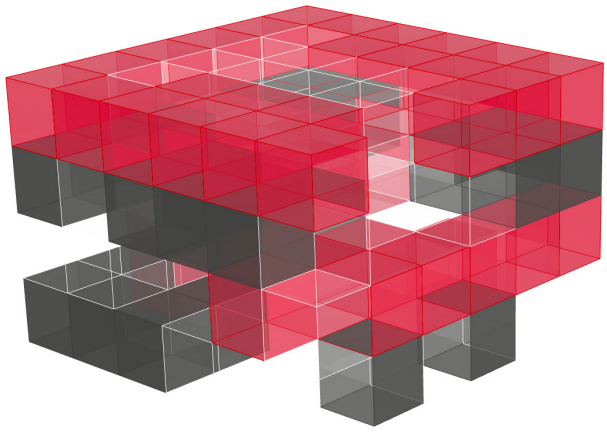










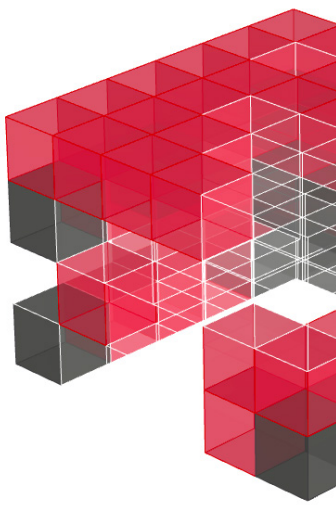
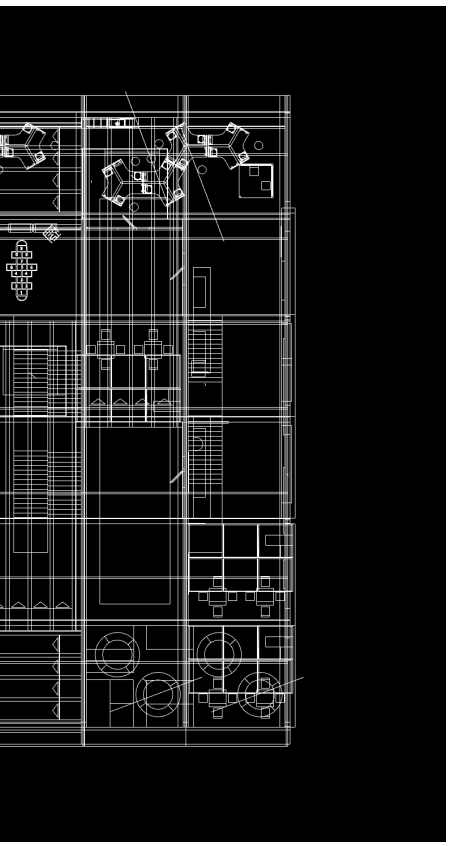
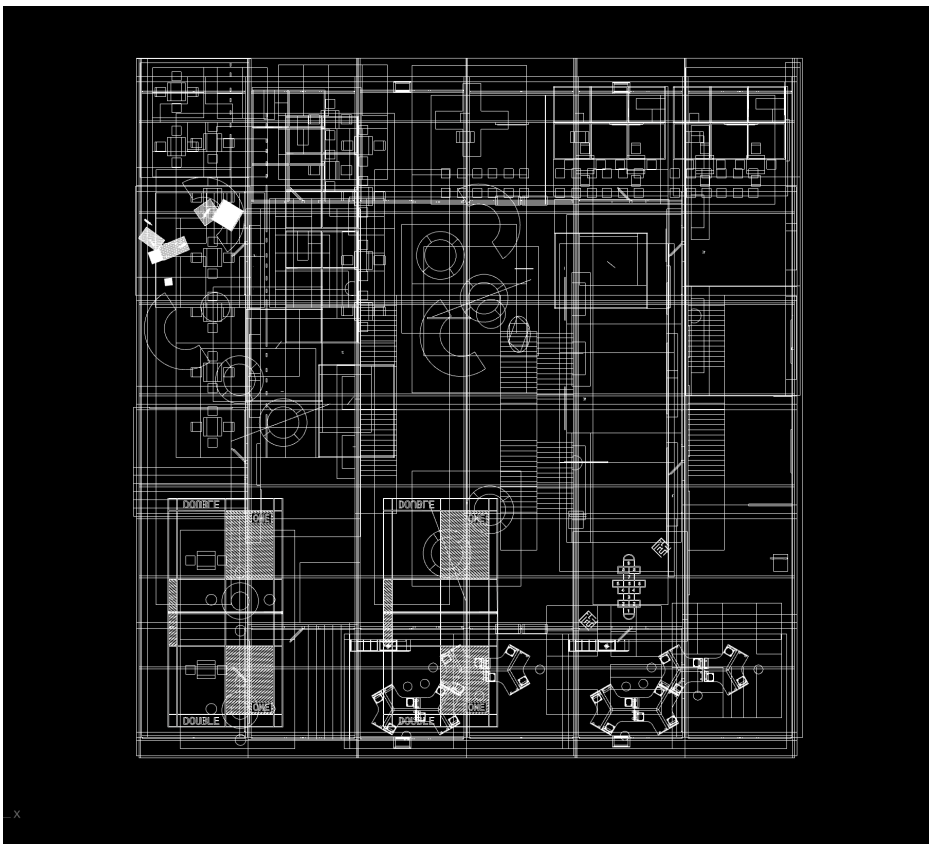


**Fig.7.5** Experiment model records
Illustration by the author

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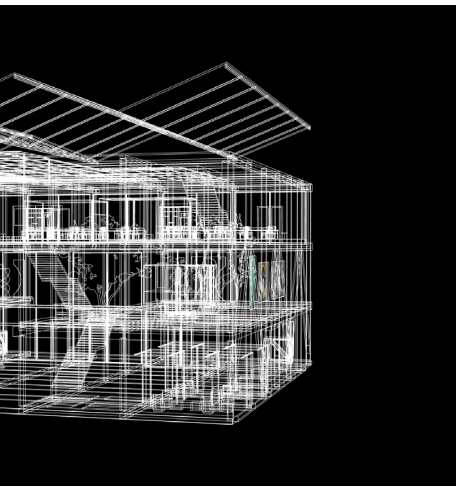
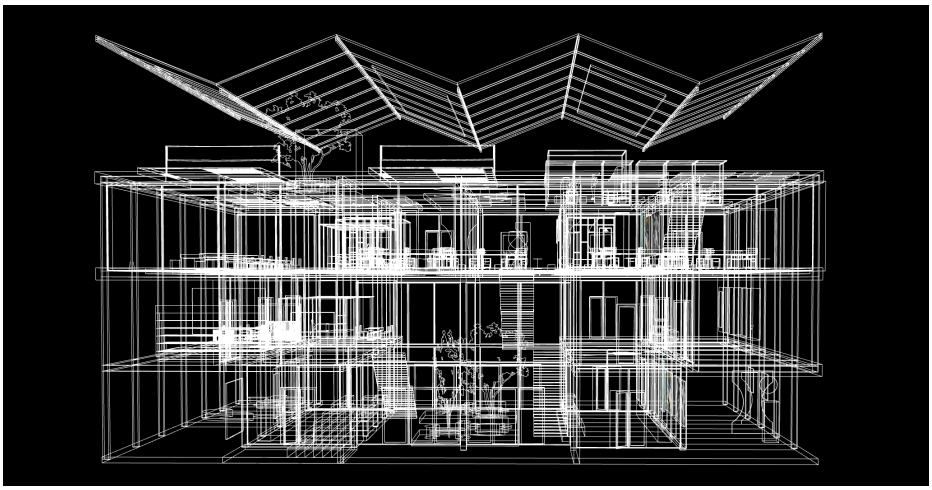
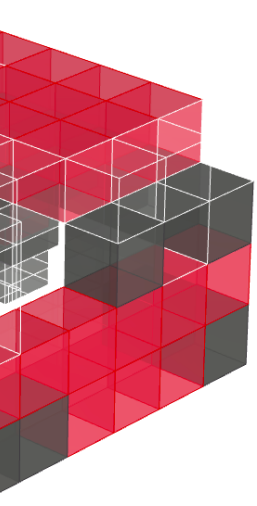
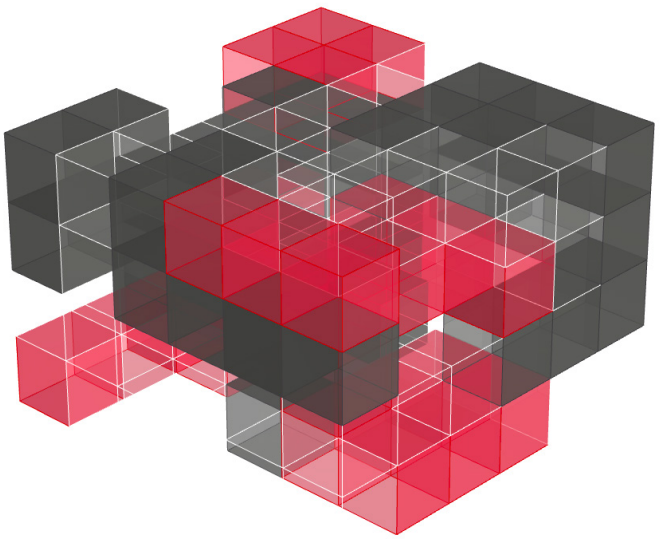
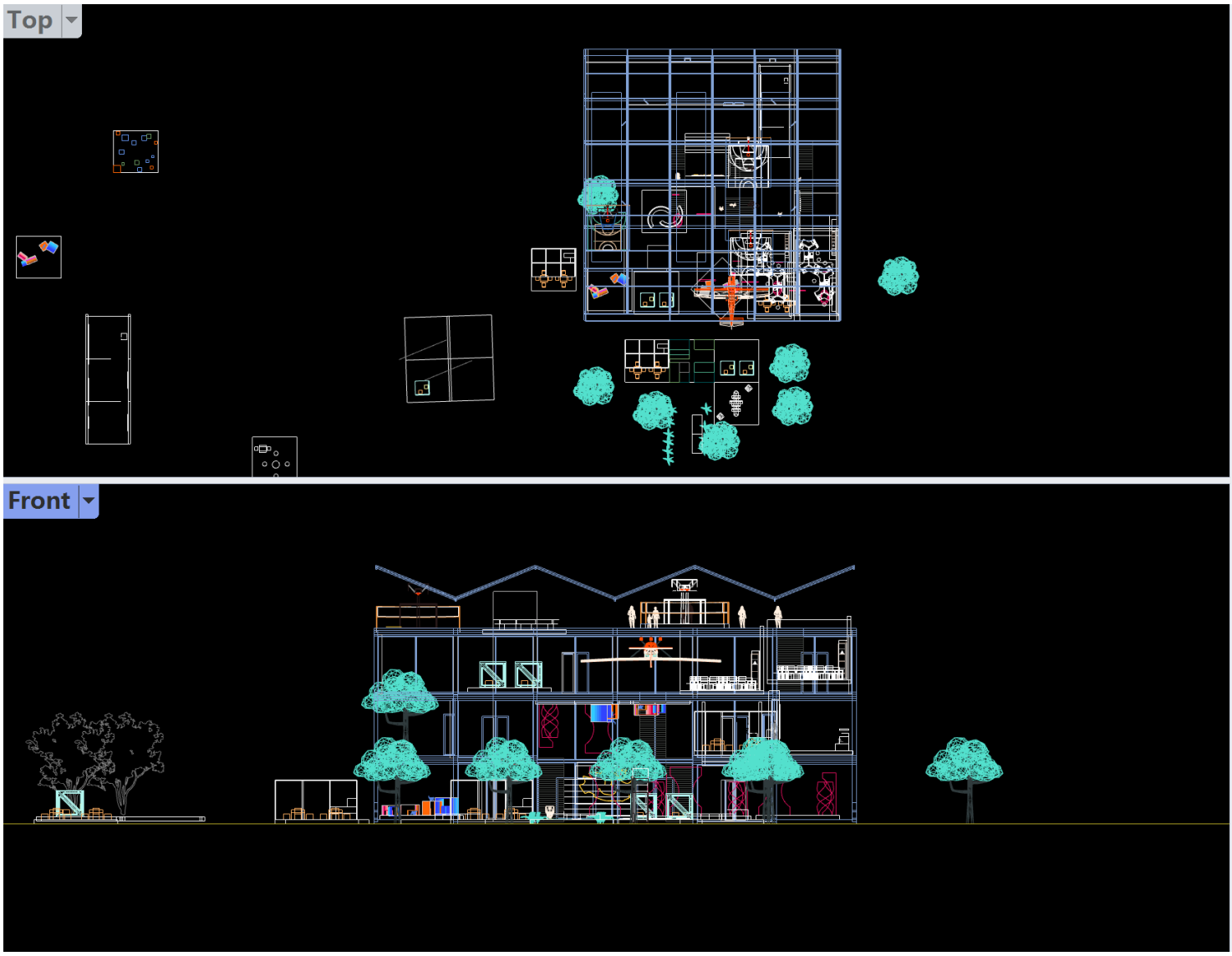
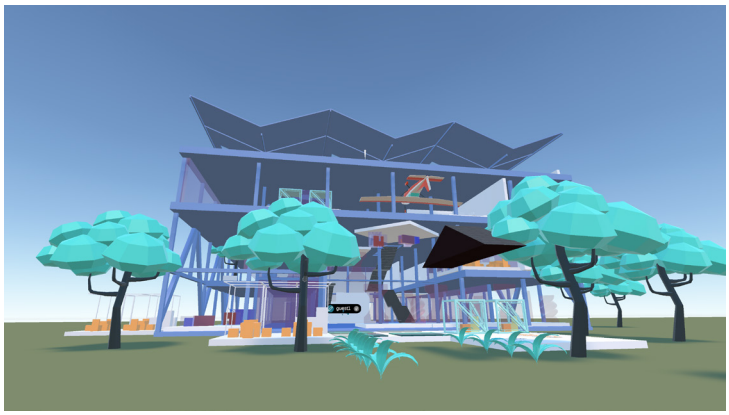










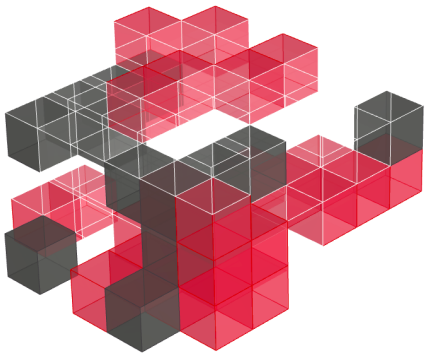
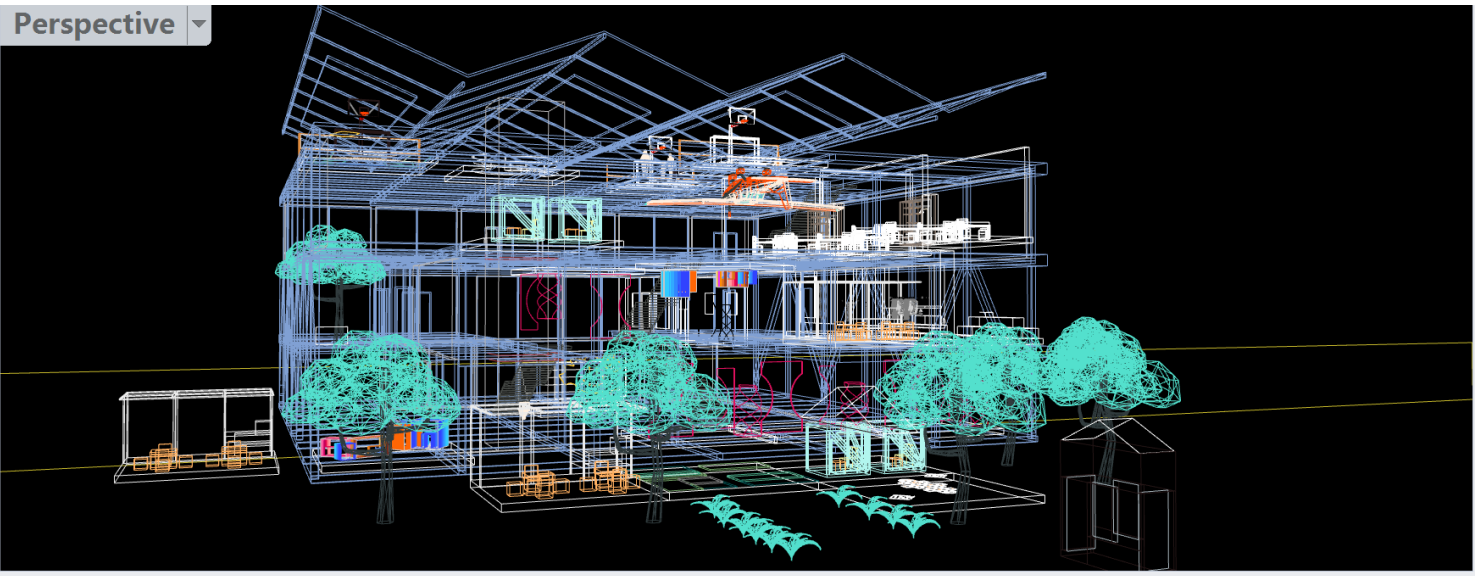
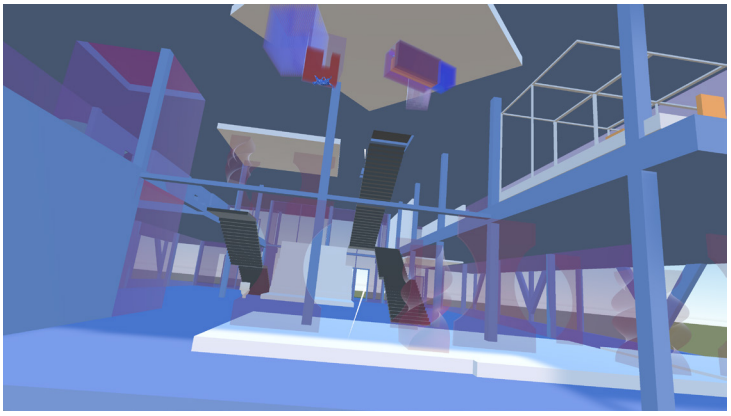
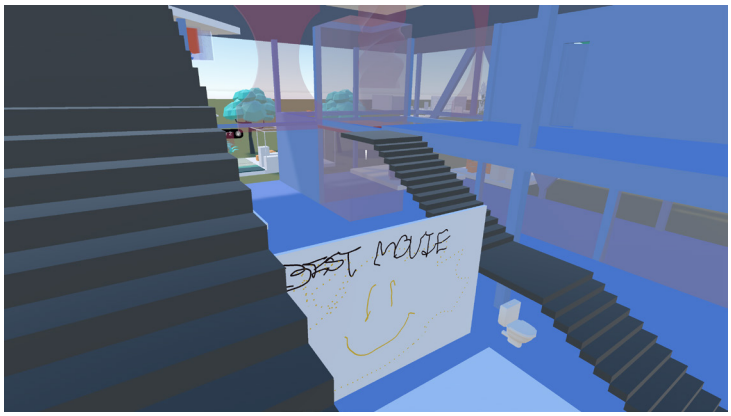


**Fig.7.6** Experiment model records
Illustration by the author









One group of experiments was selected for further documentation and detailed demonstration, where participants were free to change the colours and lighting of the buildings and activities, add elements from various model libraries and interact with various activity types.
There was a virtual artwork display placed on the roof as a decorative space and a self-creation with a paintbrush on a whiteboard in the hall.

# 7.1 The AR Experiment

## 7.1.4 Analysis of experimental results

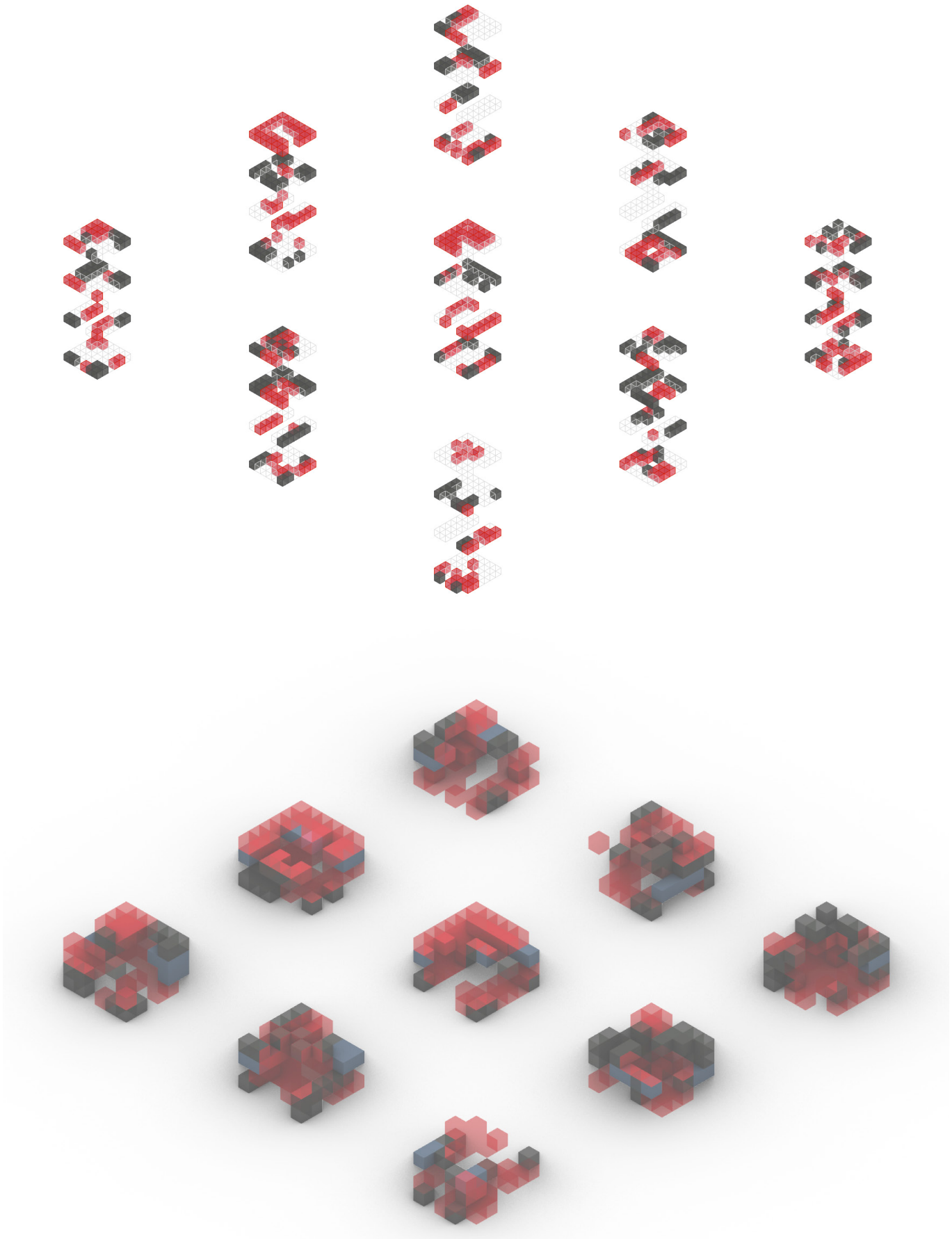
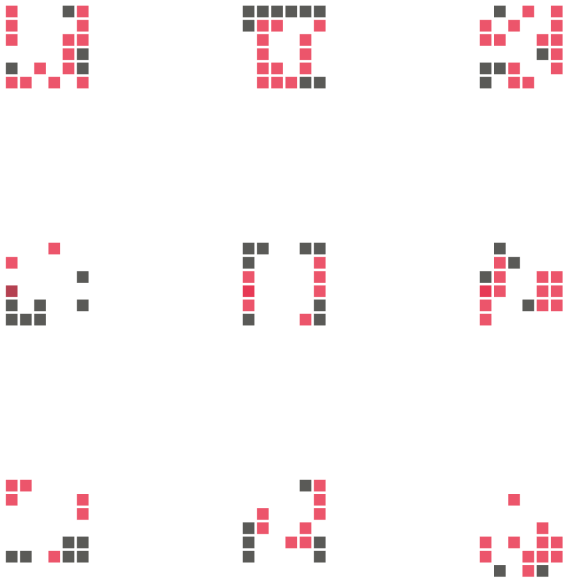
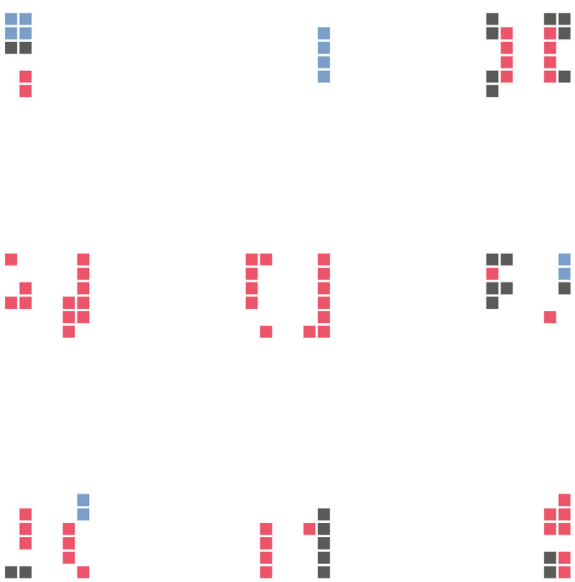


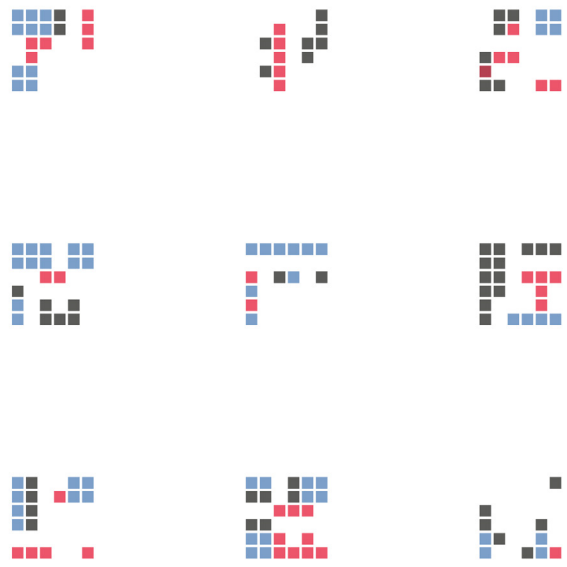
**Fig.7.7** Distribution of spatial types
Illustration by the author



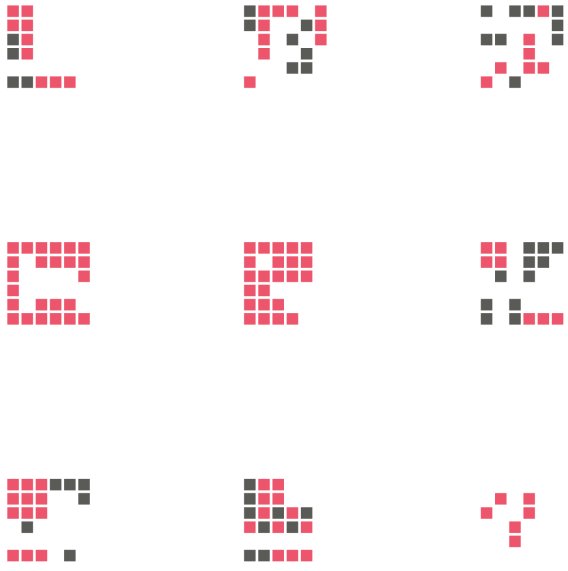
0 floor
51 physical grid + 88 virtual grid



1 floor
37 physical grid (12 private)
+ 56 virtual grid



2 floor
111 physical grid (60 private)
+ 42 virtual grid



roof top
59 physical grid + 112 virtual grid

- physical (private)
- physical
- virtual

private 2F>1F>0&R
physical 2F>R>0>1
virtual R>0>1F>2F

# 7.1 The AR Experiment

## 7.1.5 Participant feedback and experiment records

*I see people placing features on the other side, which can be interesting to me, and I get curious about the spaces that others create.*

*I feel that it is interesting for me to be able to choose my space independently and to be able to perceive other people's spaces when I set them up.*

*It felt a bit confusing to be in a randomly arranged environment, maybe not very well thought out, some guidance would have been better.*

*I would like the ar to have a wider choice of materials, an illustrated gallery, a grocery*

*I like the roof space the most, it is very comfortable to put some casual functions on it.*

*I feel that open and walkable public spaces are friendly to me, I'm curious and want to see the spaces left by others, even if they don't interest me, it doesn't bother me, I'm just passing by.*

*The difference between the physical and virtual spaces didn't seem to make much difference to me, the difference wasn't very obvious*

*The surrounding environment of the model influences my subjective perception of the communal nature of the space*

*It will be nice to be able to appreciate that there were changes at different times of the day.*

*The small modules themselves are comfortable and airy enough to make people want to stay and the atmosphere of the space inspires a desire to interact with the people around.*

*The fourth floor balcony is my favourite area, it feels perfect for some relatively quiet relaxation and can attract a lot of people with the right lounging facilities.*

*If i see someone(stranger)already using the space, I will avoid to meet other ppl. but I will have a look when the others left.*

*The relationship between the modules and the building is very harmonious and highly operational and flexible. The classification of the modules according to public-private is very clear and efficient.*

*Throughout the subjective process of operation, it is hoped that AR will help users to bring about a greater sense of belonging to the space.*

*The diverse, disparate spaces established between people are in need of some degree of integration and coordination. It is believed that this will lead to a better use of public space and reduce costs.*

*Some spaces may not need to be physical, but rely entirely on AR? For example, a remote office meeting might not require any furniture to meet, but rather the ability to interact and communicate through AR.*

*There is so much space for users to set up that it is a bit hard to know where to start and they may be less inclined to use it because they find it difficult.*

*Could you save some interesting designs so that next time I come I can experience someone else's space too?*

*Not sure if this is the right place for a residential function, it doesn't feel right anywhere in the vr process, the whole building is too permeable and it's difficult to create enough privacy, maybe a partition between the residential and the rest of the public building is needed to create some spatial transformation.*

*The starting point is a cash-grabbing complex, and I hope that my ground floor "Galeries Lafayette" will attract others to come in and have a look.*

*It's actually quite interesting to explore other people's spaces, especially if they're more customised (for example, jinlai's little flower house is more attractive than a module given directly.*

*I wanted a private, quiet space, and I liked the vegetation in it because it could be placed in any way I wanted. The wonderful mix of vegetation and architecture (which is not possible in the real world) easily influences my imagination and definition of space.*

*I want to create a narrative/community for the whole building.*

*I'd love to have some freedom to personalise the place and not need such a big space, maybe one or two floors would be enough.*

*The whole building is very relaxed, so the office space is slightly out of place for me (maybe the office space could feel like a cafe office instead), the private house is perfectly ok, like good friends, but I think it would be less likely to be a private space if a few user were meeting for the first time?*

*I like the interaction, it's very immersive, but maybe the four floors are quite spacious for 3 users, that's why there's no obvious interaction during the process.*

*The accessibility affects whether I will reach it. The roof is an area I really like, but it's a bit of a pain to get upstairs, slightly reducing its publicity.*

*In the choice of public space, the user is expected to have a stronger possibility of self-definition. How can the public space be defined through the interaction between people and AR, without the need for pre-defined modules by the designer, and ultimately achieve a good public space that meets the needs of as many people as possible?*

# 7.1 The AR Experiment

## 7.1.6 Design & Play principles

One of the wresults involved optimizing the passing flow function within the building. To ensure a smooth flow of people throughout the building, a strategic decision was made to create a flow area in the middle of the building. By positioning the traffic core at the center, the flow area became easily accessible and uninterrupted by other functions. This design choice aimed to enhance the overall accessibility and navigation within the building, minimizing congestion and facilitating efficient movement.

Another significant finding was the correlation between the floor levels and the allocation of private functions. Through careful analysis of participant feedback and observations, it was observed that higher floors experienced fewer instances of passing traffic. Leveraging this insight, the building structure was redesigned to allocate a greater proportion of private functions on the higher floors. This approach ensured a balance between the need for privacy in these functions and the overall flow of people within the building.

By implementing these specific design choices, the experiment-oriented results demonstrated improved functionality and user experience. The optimized flow area, coupled with the central positioning of the traffic core, enhanced accessibility and minimized disruptions. Similarly, the strategic allocation of private functions on higher floors effectively addressed privacy concerns without compromising the overall flow and accessibility of the building.

These findings highlight the importance of considering spatial factors and user behavior when optimizing and redesigning building structures for AR activities. The integration of these experiment-oriented results into the design process contributes to the development of practical guidelines and principles for creating AR buildings that offer seamless user experiences and optimal functionality.

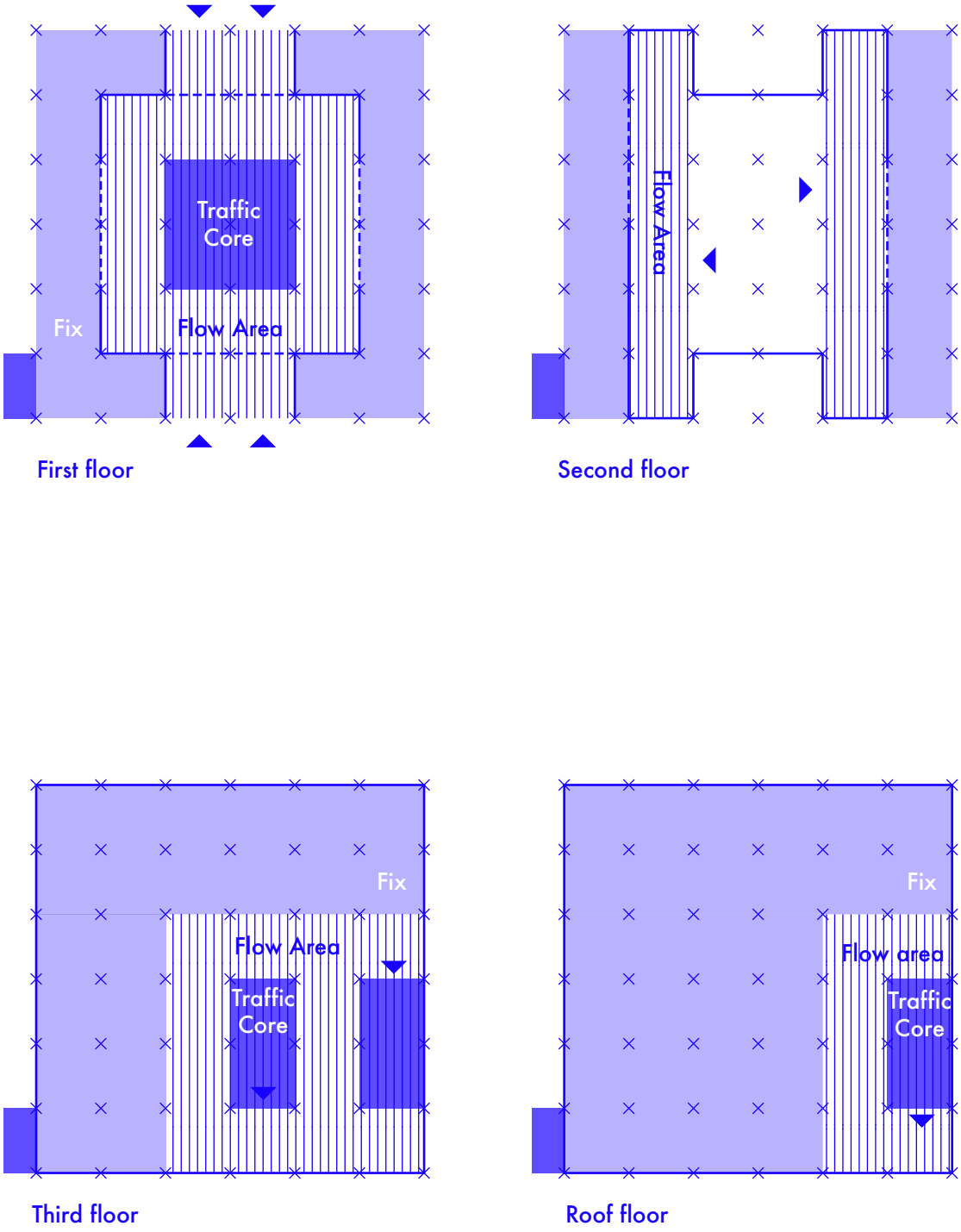



**Fig.7.8** Principles of design and use

Illustration by the author

# 7.1 The AR Experiment

## 7.1.7 Conclusions & Observations

Enhanced Curiosity and Engagement: AR can stimulate curiosity and engagement by allowing people to explore and interact with virtual elements in public spaces. It creates a sense of intrigue and encourages people to discover and learn about their surroundings.

Blurring of Physical and Virtual Boundaries: The feedback indicates that the boundary between physical and virtual spaces becomes less pronounced in AR environments. This opens up opportunities for seamless integration, where virtual elements can be seamlessly incorporated into physical public spaces, creating a more immersive and dynamic experience.

Social Interaction and Community Building: AR can foster social interaction and community building within public spaces. By providing opportunities for personalization and sharing of experiences, AR can facilitate the creation of narratives and communities within the virtual realm, promoting social connections and collaborative activities.

Personalization and Flexibility: AR enables users to personalize their experiences and spaces within public areas. It allows individuals to customize their virtual environments, expressing their preferences and creating unique spaces that align with their needs and interests.

Dynamic and Time-Based Transformations: AR has the potential to introduce dynamic and time-based transformations within public spaces. By incorporating changing elements, such as lighting variations or interactive features that respond to different times of the day, AR can enhance the experiential qualities of public spaces and create a more vibrant atmosphere.

Influence of Surrounding Environment: The surrounding physical environment plays a role in shaping the perception of AR-driven public spaces. Urban designers must consider the

| FLOOR | DISTRIBUTION | VIRTUAL/PHYSICAL | PUBLIC/PRIVATE | ELSE |
|---|---|---|---|---|
| 0 | | virtual>physical | public, no private space | |
| 1 | · People prefer to stay on the border<br>· Empty around traffic space | virtual>physical | public, little private space | |
| 2 | | Physical>virtual | public, more private space | most private |
| 3(ROOF) | | virtual>physical | public, no private space | most popular |

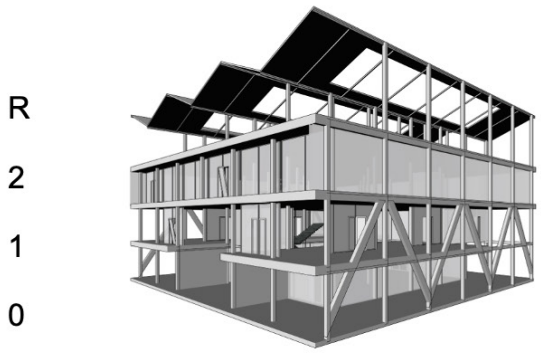



**Fig.7.9** Conclusions

Illustration by the author

contextual factors and design AR experiences that complement and enhance the existing urban fabric, ensuring a harmonious integration between the virtual and physical realms.

Balancing Privacy and Public Accessibility: The feedback highlights the need to strike a balance between privacy and public accessibility in AR-driven public spaces. Designers should explore ways to provide private and secluded areas within the virtual realm while still maintaining the inclusive and communal nature of public spaces.

By leveraging AR technology, urban designers can create public spaces that are more interactive, engaging, and adaptable to individual preferences. AR has the potential to transform public spaces into immersive environments that promote social interaction, personalization, and a stronger sense of community.

# 7.2 Implementations

## 7.2.1 Implementation on site

The implementation of the design prototype on the actual site serves several purposes in evaluating its effectiveness. Firstly, it allows for a practical assessment of how the proposed building elements interact with the existing site conditions. By physically placing the prototype on the site, the impact and integration of the design can be observed and analyzed. Additionally, digitally modeling the prototype within the context of the surrounding site provides a visual representation of its final effect, enabling a comprehensive evaluation of its compatibility and coherence with the environment. Through this implementation process, the reason and meaning of implementation become apparent as it allows for a tangible examination of the design's feasibility, functionality, and aesthetic harmony within its specific location. Ultimately, this on-site implementation offers valuable insights and data to inform the refinement and optimization of the design solution.

**Fig.7.10** Implementation scenarios

Illustration by the author

# 7.2 Implementations

## 7.2.2 Plan

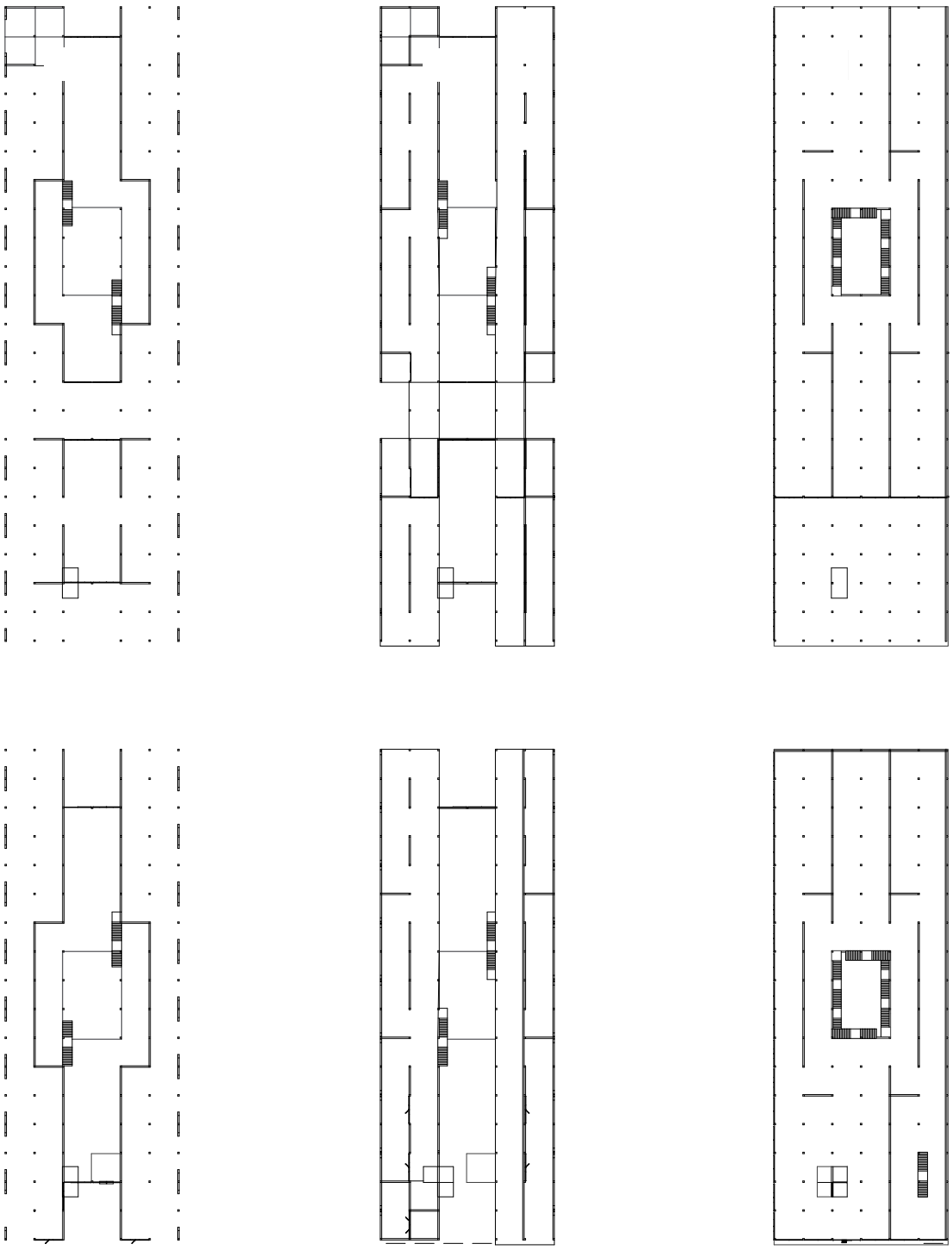
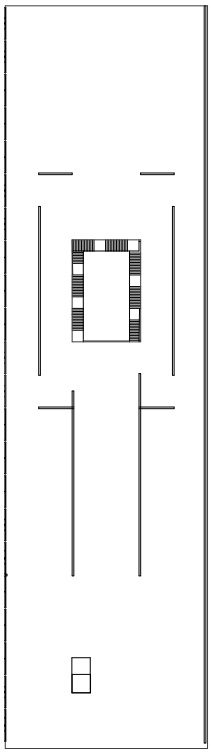
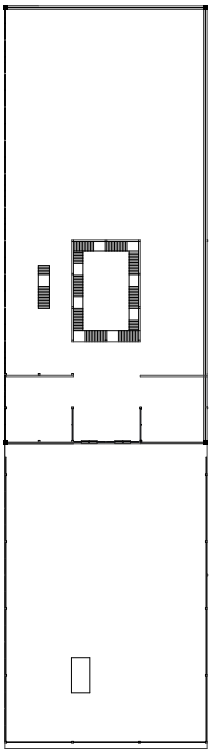
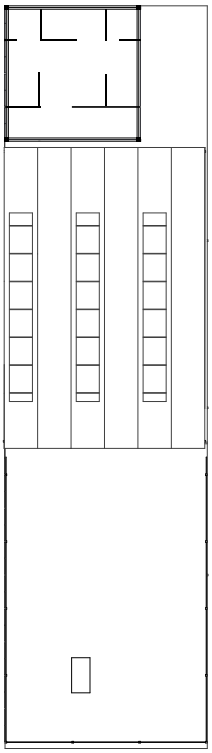
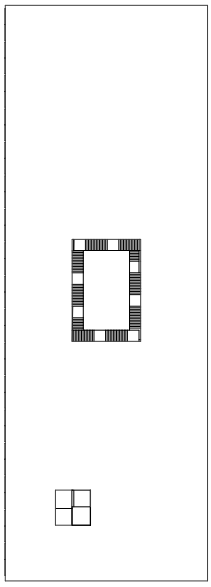


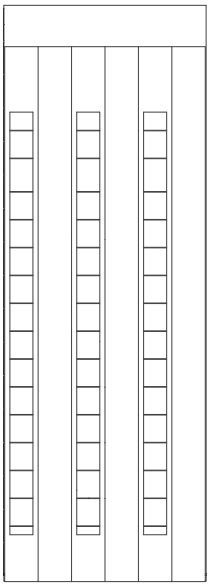
**Fig.7.11** Plans for implementations
The plan here illustrates the internal flow of the building to ensure access.
Illustration by the author

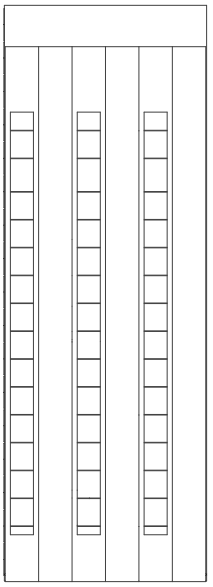








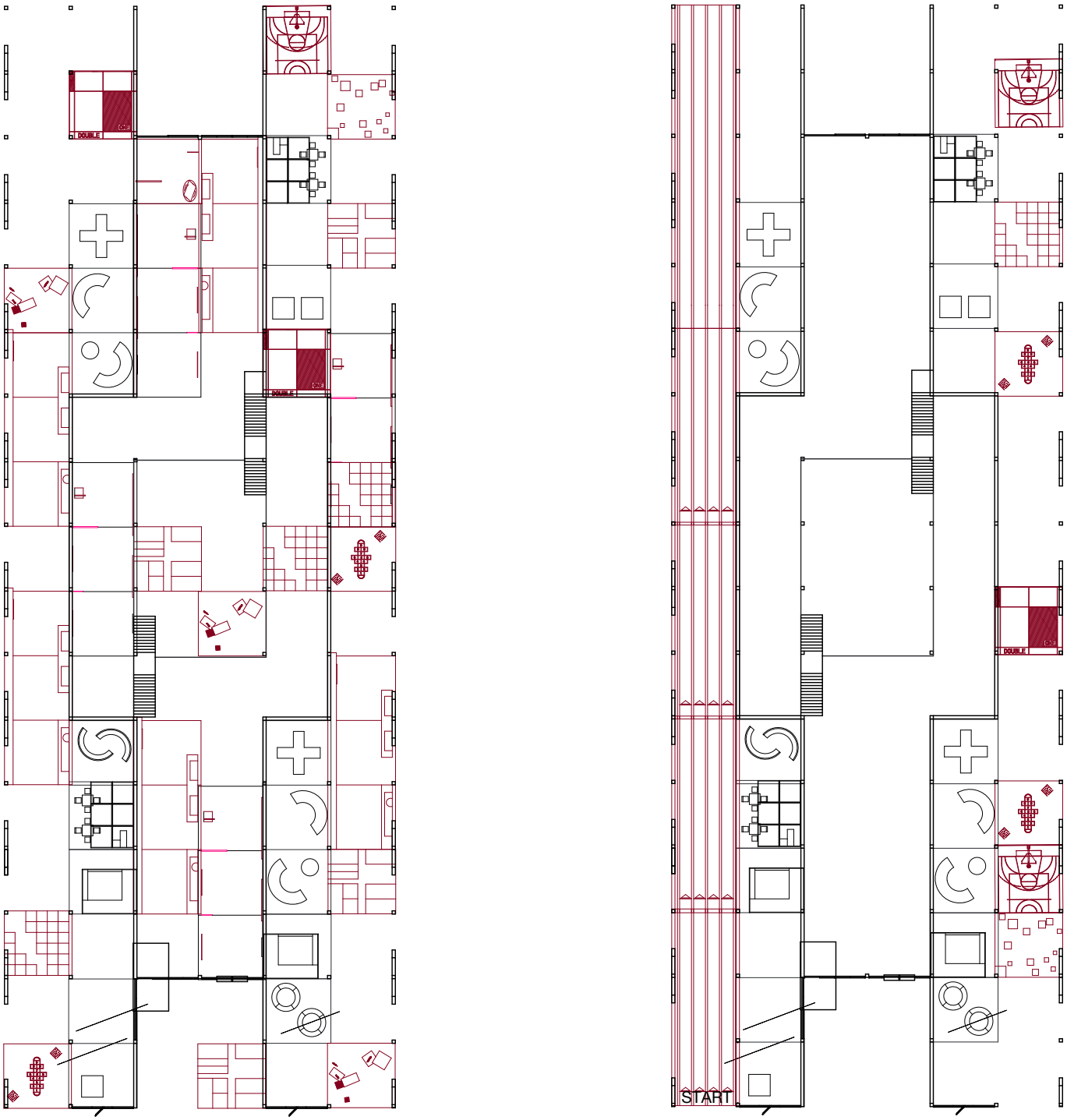




## 7.2.3 Different application scenario

Morning

Evening




The building's layout demonstrates its fluidity and adaptability, showcasing its multifunctional nature with distinct activities throughout the day. During daytime, the focus is on the flow of people and associated functions like exhibitions, book reading, retail shopping, open markets, and catering. In contrast, the nighttime activities shift towards seated gatherings, sports activities, and additional functions such as drinking, singing, dancing, and even movie screenings in the surrounding areas of the building.

**Fig.7.12** Plan for Day and night implementations

Illustration by the author


**Fig.7.13** Day and night implementations

Illustration by the author


**Fig.7.14** When you open a culture-themed AR layer

Illustration by the author

# ATE YOUR ROOF GARDEN HERE

GOGH's
IBITION

Van
Gogh
Museum
Amsterdam

n to BLAAK STATI

## 7.2.3 Different utilization scenario

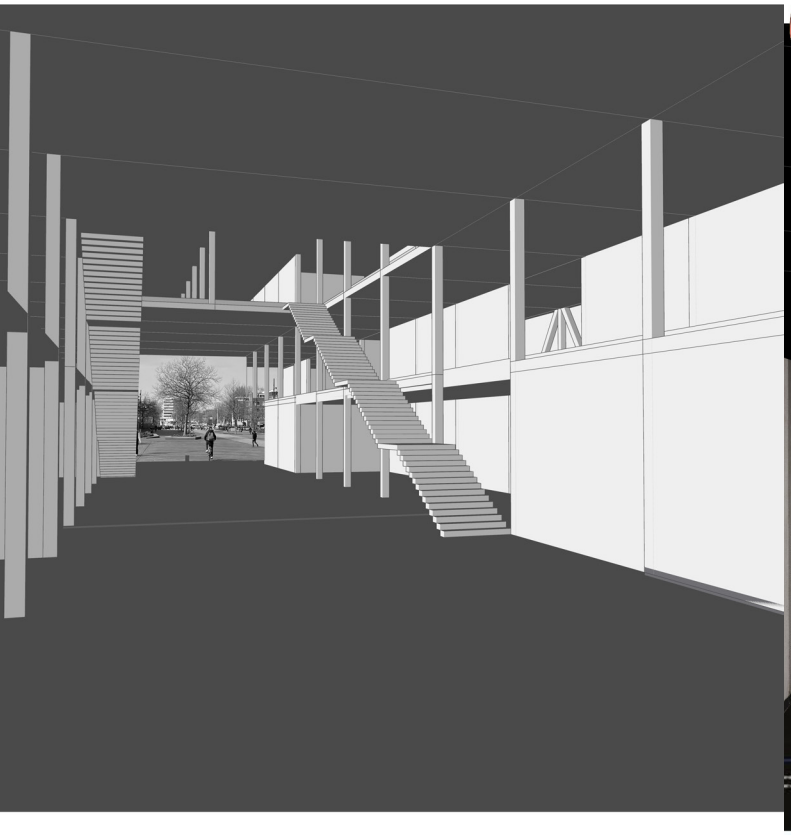



**Fig.7.15** Different AR scenarios

Illustration by the author

The utilization of AR technology empowers the creation of a broader spectrum of information and activity possibilities, enabling more efficient utilization of space. By leveraging AR, a wider range of interactive and immersive experiences can be designed and implemented, optimizing the use of available space and enhancing its functionality.


Pax
Israeliana
KDE x TikTok Experiencial Lab ©2020
New York City, NY
DIOR
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ANEL


**Fig.7.16** Different scenarios through glasses

Illustration by the author

# Conclusion
Conclusion
Conclusion
Conclusion

- DESIGN PRINCIPLE
- CONCLUSION


17:39
WELCOME TO YOUR
AR BUILDING
Experience public spaces in augmented reality
and design your own virtual layer here!

# 8.1 Design Principles

Spatial Dimension:

Flexible Design: Utilize AR technology to create neutral buildings that can adapt to various functions and activities, allowing for flexibility in the use of space.

Universal Accessibility: Apply universal design principles to ensure that the virtual and physical spaces are accessible to individuals of diverse abilities, providing equal opportunities for participation.

Dynamic Environments: Design virtual and physical spaces that can be easily reconfigured to accommodate different activities and user needs, promoting versatility and adaptability.

Social Dimension:

Enhanced Collaboration: Foster social integration and collaboration by designing spaces that encourage interaction and communication among users. AR technology can facilitate collaborative workstations, shared resources, and interactive displays, promoting engagement and cooperation.

Inclusivity: Consider the diverse needs and preferences of individuals when designing virtual and physical spaces, ensuring that they are inclusive and welcoming to all users.

Community Engagement: Involve the local community in the design process to gather insights and incorporate their feedback, ensuring that the spaces reflect their needs and aspirations.

Cultural Sensitivity: Take into account the cultural context of the urban environment to design spaces that respect and reflect the local culture, promoting a sense of belonging and identity.

By addressing these points in both the spatial and social dimensions, the project aims to create virtual and physical spaces that are not only flexible, accessible, and dynamic but also foster collaboration, inclusivity, and community engagement.

# 8.2 CONCLUSIONS

**Project Review**

In conclusion, this AR project has addressed the research question of using Augmented Reality to tackle spatial and social segregation in urban public spaces. By recognizing the challenges posed by the digital age and the erosion of public space's authenticity and purpose, the project has harnessed the transformative potential of AR technology to revitalize and reinvent the urban environment, creating inclusive, resilient, and engaging public spaces.

Architecture plays a pivotal role as the container in which activities take place, and it serves as the first step in bringing the concept of transforming urban space into reality. Through a comprehensive analysis of the site's constraints, historical context, activity mapping and relevant case-study, a design concept emerged that emphasizes neutrality, adaptability, sustainability and inclusivity. The physical building prototype was meticulously developed to accommodate both physical and virtual activities, serving as a harmonious and dynamic platform for the AR experience.

During the evaluation phase, AR experiments and on-site implementation were conducted to assess the effectiveness and feasibility of the design prototype, providing valuable insights for further refinement and optimization.

**Project Conclusion**

To answer the research question, "Using Augmented Reality as a solution to address spatial and social segregation, how can we design virtual and physical spaces for collaborative working while ensuring that urban spaces are inclusive, accessible, and dynamic?" this project demonstrates how AR technology bridges the gap between the virtual and physical realms, transforming public spaces into immersive, interactive, and socially inclusive environments at the architectural scale. By embracing the principles of flexibility, inclusivity, and sustainability, this project contributes significantly to the development of urban design in the digital age.

The AR project has provided valuable insights into the transformative potential of augmented reality technology at the

architectural scale in shaping public spaces. By focusing on the architectural space that accommodates public activities, the project has demonstrated the microcosm of urban space and its potential for inclusivity, interactivity, and engagement through AR.

However, it is important to acknowledge that there is still more research to be done at the urban scale. While this project has partially answered the research questions from an architectural perspective, there is a broader scope to explore the full potential of AR in urban development. Future studies could delve deeper into the integration of AR technology within the larger urban fabric, considering aspects such as urban planning, social dynamics, and community engagement.

**Looking ahead**

By expanding the research beyond the architectural scale, further exploration of AR's potential for urban development can uncover innovative approaches to address spatial and social segregation, enhance accessibility, and create dynamic and inclusive urban environments. This project serves as a foundation for future research and encourages continued exploration of AR's role in shaping the cities of tomorrow.

As cities continue to evolve, it is crucial to adopt innovative approaches that enhance the vibrancy, accessibility, and social connectivity of public spaces. The presented AR project serves as a stepping stone in redefining the relationship between people, buildings, and the urban environment. By embracing the opportunities offered by augmented reality, we can create dynamic, engaging, and harmonious urban spaces that enrich the lives of residents and visitors alike.

Reflection
Reflection
Reflection
Reflection

1. What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master programme (MSc AUBS)?

2. How did your research influence your design/recommendations and how did the design/recommendations influence your research?

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

5. How do you assess the value of the transferability of your project results? We also expect you to develop 2 reflection question yourself which relate to the content of your work.

6. How did the interdisciplinary nature of your AR design project challenge and shape your understanding of urbanism, and how did your supervisors contribute to your development throughout the project?

7. The critical reflection on the project's impact on urbanism

**1.What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master programme (MSc AUBS)?**
In my graduation project, I am exploring the impact of augmented reality (AR) on urban spaces, with a focus on addressing spatial and social segregation. This research topic aligns closely with my master track of Urbanism and my overall master program in Architecture, Urbanism and Building Science.

Within the Urbanism track, I have been able to delve deeper into the complexities of urban spaces, analyzing their social dynamics, and investigating strategies to create more inclusive and sustainable environments. By incorporating AR technology into the urban fabric, I aim to explore innovative design approaches that can mitigate issues such as the gentrification of public spaces, resource misallocation, and social isolation.

Furthermore, my master program in AUBS has provided me with a solid foundation in understanding the technical aspects of design and construction. It has allowed me to integrate architectural principles with advanced technological advancements, such as AR, to envision new possibilities for urban spaces. I tried to design a prototype for a multifunctional building that could be adapted to AR, with a solid and stable structure and an adaptable and appropriately scaled neutral form. Considering physical limitations of the environment and virtual activities which can adapt to AR.

By linking my graduation project topic with my master track and program, I can leverage the knowledge and expertise gained throughout my studies to propose practical and contextually relevant solutions. This holistic approach enables me to address the challenges of urbanization, while also capitalizing on the potential of AR to create more inclusive, dynamic, and adaptable urban environments. Moreover, the project involves different scales, from urban to architectural design which is a proper approach to understanding the city.

**2. How did your research influence your design/recommendations and how did the design/recommendations influence your research?**
My research into augmented reality (AR) and its potential impact on the urban environment has greatly influenced my design process. Through an extensive exploration of the practical use and potential of AR and the process of influencing the urban environment by technology, my research unveiled the transformative possibilities of integrating AR technology into the urban fabric.

Firstly my research into AR application scenarios has helped me to recognise the potential of AR's versatility, virtualisation, interactivity and digitality to address issues of spatial segregation and social exclusion. This understanding has greatly influenced my approach to design as I seek to create an inclusive and adaptable urban environment that
ties of AR that can layer informa
bridge divides and promote vita
the basis for the design strategi

In addition, I researched the i
identify potential AR interventio
gies. As an example, commerc
public space, while AR can la
ban space more inclusive. Adc
helped me to understand the a
isted, guiding me to choose the
the research helped me to bring

The designs I developed playe
my research. As I worked to tra
cal design strategies, I encount
siderations that prompted me t
my research methods. The desi
the feasibility and effectiveness
social isolation, which in turn en

Ultimately, the dynamic relation
design created a symbiotic syn
potential of AR technology to s
design process provided practic
cations that enriched my findin
develop more comprehensive a
dations that have the potential
environment and contribute to t
design.

By acknowledging the reciproc
and design/recommendations,
holistic understanding of the p
AR technology in transforming
cial integration.

**3. How do you assess the va
(your approach, your used me**
Firstly, my approach to the to
and interdisciplinary perspective
and sociological aspects, I was
ed nature of AR and its potent
dynamics. This approach allowe
derstanding of the subject matt
from various perspectives.

In terms of methods, I emplo
tive and quantitative approach
Through literature reviews, case
gained a deep understanding
ban issues, and human behavio

t uses the technological proper-
ation and increase interaction to
ality. The research has served as
es I have arrived at.

ssue of urban public space to
ons and problem-solving strate-
ial space occupies and defines
yer information and make ur-
ditional urban analysis research
reas where urban problems ex-
e pilot for my main design, and
g the design concept to life.

d an interactive role in shaping
anslate AR concepts into practi-
tered new challenges and con-
o further investigate and refine
ign process enabled me to test
of AR in alleviating spatial and
riched my research findings.

nship between my research and
ergy. The research revealed the
olve urban problems, while the
cal insights and real-world appli-
gs. This process enabled me to
nd informed design recommen-
to positively impact the urban
he discussion of inclusive urban

cal influence between research
I was able to develop a more
possibilities and implications of
urban spaces and fostering so-

**alue of your way of working**
**thods, used methodology)?**
pic involved a comprehensive
e. By considering both technical
able to explore the multifacet-
ial impact on spatial and social
d me to develop a nuanced un-
er and consider its implications

yed a combination of qualita-
es to gather data and insights.
e studies, and AR experiment, I
of existing AR applications, ur-
rs. Additionally, I had an AR ex-

periment to test the feasibility of my physical flow and feeling of neutral AR-public building prototype as well as the conflict and synergy of virtual activities and physical spaces working together. The feedbacks and conclusions from experiment also help to evaluate the design. The synergy between the methods leads to the final design result.

The methodology employed in this research consisted of five key components: foundational definitions, spatial order analysis, concept development, intervention implementation, and evaluation. Each component influenced and informed the others in a logical and iterative sequence. Foundational definitions provided a solid framework for understanding AR in urban contexts, while the exploration of spatial order guided the analysis of physical and virtual elements within urban spaces. The concept evolved and adapted based on research findings, leading to design interventions aimed at addressing spatial and social challenges. Evaluation methods assessed the effectiveness of these interventions, generating valuable insights. This systematic approach ensured the coherence and effectiveness of the research, enhancing our understanding of AR's potential in urban design and its ability to tackle spatial and social issues.

**4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?**

The research project on the integration of augmented reality (AR) in urban design has significant academic and societal value, with broad implications for urban development and design practices. Firstly, it offers a fresh perspective on leveraging AR technology to address urban issues, such as densification and inclusive public space design. By utilizing data-driven approaches, AR can facilitate more intensive spatial development and optimize the allocation of urban functions, leading to more efficient use of space and improved urban livability. This contributes to the formation of data-adapted urban systems and offers potential solutions for future urban patterns.

Secondly, the project explores the relationship between physical and virtual spaces in the context of the digital transition. While urban design traditionally focuses on physical space, the integration of AR prompts a rethinking of spatial forms that can accommodate both virtual and physical realms. This opens up possibilities for multifunctional development and meeting diverse needs in public and private spaces. As a relatively new technology, the impact of AR on urban patterns and spatial forms remains largely unexplored, making this research highly relevant for future urban studies and design practices.

Thirdly, the project highlights the practical value of seamlessly integrating data into everyday urban experiences. By demonstrating how AR can transform people's lives and interactions with their surroundings, it provides concrete insights into the

implications of behavioral and spatial dynamics. The experimental design process allows for the evaluation of outcomes and the assessment of potential benefits for cities. This research not only adds value to the field of urban design but also holds implications for ethical considerations in terms of privacy, data security, and the responsible use of technology in urban contexts.

As a conclusion, the academic and societal value of this graduation project lies in its exploration of AR's potential to address urban challenges, its contribution to the understanding of the relationship between physical and virtual spaces, and its practical implications for urban design and future research.

**5. How do you assess the value of the transferability of your project results?**

In assessing the value of the transferability of the project results, several factors come into play. Firstly, the building prototype developed within the project serves as a concrete example that showcases the integration of augmented reality in urban design. The design components and considerations incorporated into the prototype, including spatial arrangement, interactive features, and usability, can be transferred and adapted to other spaces and contexts. This prototype provides a tangible reference point for designers and stakeholders interested in implementing AR-adaptive buildings.

Moreover, the exploration of virtual/physical activity types within the research contributes to the transferability of the results. By identifying and analyzing various types of activities that can be facilitated through AR technology, such as interactive exhibitions, community engagement initiatives, or dynamic information displays, the project offers insights into the diverse possibilities of integrating AR in urban environments. These activity types can be adapted and applied in different spaces, presenting opportunities to enhance user experiences, promote social interaction, and foster a sense of place.

Additionally, the approach of setting design components, considering physical limitations, and exploring activity types not only demonstrates the practical application of AR in urban design but also provides transferable knowledge and inspiration for future projects. The findings and methodologies employed in this research can be utilized by designers and urban planners in different contexts to create AR-enhanced environments that address urban challenges and promote flexibility and inclusivity.

Furthermore, based on the designed architectural prototypes and application scenarios, it is possible to design an interactive interface for experiencing urban public spaces using AR glasses or a dedicated mobile application. This interface can be applied in any public space using the same scenario, allowing users to engage with the augmented reality features, access information about the surrounding
experiences. This adaptable int
the specific characteristics of d
ing a flexible and scalable solu
perience in various public space

In summary, the building prot
types, methodological approac
active interface contribute to th
results. They offer practical exa
and technological solutions tha
settings, enabling the integratio
design and creating more enga
es.

**6. How did the interdisciplina
project challenge and shape y
ism, and how did your super
velopment throughout the pro**

As a student of urbanism, my
cused on augmented reality, w
challenging topic. Throughout
associated with traditional desig
provided valuable guidance and

One challenge was the lack of e
in this emerging field. Augment
ward-looking, with few precede
I struggled with understanding
physical space, making it diffic
building effectively.

Another challenge was creating
commodate augmented reality
tainer" for AR presented diffic
rational methods to construct s
pervisor Marco helped me unde
jective decision-making plays a
ical factors and considering the
surroundings helped me clarify

Furthermore, I initially struggle
various virtual activities for augm
ing. Stefan, with his expertise in
introduced a matrix-based app
me to categorize activities bas
private nature, and fixed or m
aided in structuring my project a

Overall, these challenges and t
shaped my project in profound
helped me navigate the compl
urban design but also fostered a
problem-solving approach. I am

gs, and participate in interactive
erface can be customized to fit
ifferent urban contexts, provid-
tion for enhancing the user ex-
es.

otype, virtual/physical activity
ch, and the design of an inter-
he transferability of the project
mples, conceptual frameworks,
t can be leveraged in different
n of augmented reality in urban
ging and inclusive public spac-

**ary nature of your AR design**
**your understanding of urban-**
**visors contribute to your de-**
**oject?**
graduation design project fo-
which presented a unique and
the project, I faced limitations
gn thinking, but my supervisors
d support.

existing references and research
ed reality in urban design is for-
nts to draw upon. Additionally,
g the perception of virtual and
cult to visualize and design the

g a suitable environment to ac-
activities. Designing the "con-
culties, as there were no clear,
such a space. However, my su-
erstand that as a designer, sub-
crucial role. Analyzing the phys-
e architectural constraints of the
my thinking and approach.

ed to classify and organize the
mented reality within the build-
n virtual and augmented reality,
proach. This approach allowed
ed on their virtuality, public or
obile characteristics. It greatly
and moving it forward.

the guidance of my supervisors
d ways. Their support not only
lexities of augmented reality in
a multidimensional thinking and
n immensely grateful for the in-

valuable mentorship provided by my supervisors throughout this project.

**7.The critical reflection on the project's impact on urbanism**

Firstly, the integration of Augmented Reality (AR) as a solution for addressing spatial and social segregation has demonstrated its potential to transform urban spaces into more inclusive and accessible environments. By leveraging AR technology, the project has provided a new dimension to collaborative working, breaking down physical and social barriers that often hinder interaction and inclusion.

However, it is important to acknowledge the limitations and challenges that arise with the implementation of AR in urban design. While AR has shown promise in promoting inclusivity, its widespread adoption and accessibility still present obstacles that need to be addressed. Factors such as access to AR devices, connectivity, and digital literacy can create disparities, potentially perpetuating existing social inequalities rather than bridging them.

Besides, the project's impact on urbanism should be assessed in terms of long-term sustainability and scalability. While the designed AR-based collaborative spaces have demonstrated their effectiveness, their integration into existing urban infrastructures and systems requires careful consideration. Balancing the implementation of AR with the preservation of architectural heritage, urban aesthetics, and functional efficiency is crucial for ensuring a harmonious and sustainable urban environment.

What’s more, the project's impact on urbanism should be evaluated in relation to the broader urban context and its socio-economic implications. The successful implementation of AR-based solutions for collaborative working can potentially attract diverse stakeholders and spur economic growth. However, careful attention must be given to avoid gentrification, displacement, or exclusion of marginalized communities, ensuring that the benefits of AR technology are distributed equitably.

While the project's impact on urbanism through the integration of AR is promising, critical reflection emphasizes the need for a holistic approach that addresses issues of accessibility, sustainability, scalability, and socio-economic impact. By acknowledging these factors, future urban design initiatives can leverage AR technology to create inclusive, accessible, and dynamic urban environments that benefit all residents and communities.

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