



**EMBRACE URBAN GROWTH
AVOID URBAN SPRAWL**

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P5 report
June 2019

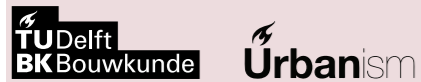
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Municipality of Amsterdam



Municipality of Almere

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Introduction

Introduction of the studio

Urban fabric studio studies the relations between tangible and intangible structures in different contexts. Its aim is to foster a sustainable and livable urban environment. This year the graduation studio focusses on the topic of automated mobility by exploring the possible impact of automated vehicles technology on the built environment within different scenarios. The studio trains student to draw the possibilities for the future, using scenario making as the main method.

A scenario is a narration, referred to strategies, projects, expectation and frames of values of actors, and hence normative, of a possible future that develops from an if-then conjecture doubly hypothetical on the potential and plausible consequences of possible actions, so as to define a desirable future as a guide for action. A scenario is effective when it manages to construct new horizons of sense.

A scenario concerns the context of the generation of hypothesis, while the forecast (as an explanation) concerns their justification; the scenario is hence, from a methodological point of view, structurally different from forecasting, and varies according to the contexts and customs. It is worth ones while making a distinction between the dimension of the process of the scenario (the mode of construction) and the scenario as product (script).

Project motivation

Automated Vehicles

Autonomous technology that will really transform our lives, because it will mean for the first time in history, mobility freedom will be available for everyone, everywhere. It will affect the daily life of residents and change the form of the city. AVs are verified to offer mobility benefits to people who are unable to drive at present, ease the congestion and save the financial loss. AVs imply changes to road infrastructure and the placement and development of homes and businesses. The world is already on the way to AV future, as urban planners, we should prepare for these changes and design for the sustainable vision.

Geographic motivation

The geographic research context of this report is Amsterdam region, the design city is Almere. On the one hand, Netherlands is considered to be the most well-prepared country for automated vehicles according to the Autonomous Vehicles Readiness Index (KPMG, 2018). As the economic and technologic driver for the country, Amsterdam is the most reasonable base for transportation innovation. On the other hand, responding to the population growth pressure, Amsterdam spread the housing to its surrounding cities, which makes the whole region the busiest commuting area and cause severe congestion problem. Suburban area is unsustainable in both traffic condition and land use pattern.

Glossary

Automated Vehicles (AVs)

"an autonomous vehicle is one in which vehicle operation occurs without direct human driver input to control key functions such as the steering, acceleration, and braking"

— Thrun, Sebastian, 2010

Smart growth

"a collection of land use and development principles that aim to enhance our quality of life, preserve the natural environment, and save money over time. Smart growth principles ensure that growth is fiscally, environmentally and socially responsible and recognizes the connections between development and quality of life. Smart growth enhances and completes communities by placing priority on infill, redevelopment and densification strategies"

— Smart Growth BC, 2007

Chapter 1. CONTEXT

1.1 THE IGNORED CHALLENGE : URBAN SPRAWL

1.2 THE FUTURE PRESSURE : URBAN GROWTH

1.3 AUTOMATED VEHICLE: REPAIR OR EXPAND SPRAWL

1.1 THE IGNORED CHALLENGE : URBAN SPRAWL

Definition of urban sprawl

Urban sprawl is commonly used to describe physically expanding urban areas. The European Environment Agency (EEA) has described sprawl as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas. Sprawl is the leading edge of urban growth and implies little planning control of land subdivision. Development is patchy, scattered and strung out, with a tendency for discontinuity. It leap-frogs over areas, leaving agricultural enclaves. Sprawling cities are the opposite of compact cities – full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth.

Why sprawl matters?

Sprawl threatens the very culture of Europe, as it creates environmental, social and economic impacts for both the cities and countryside of Europe. Moreover, it seriously undermines efforts to meet the global challenge of climate change.

Urban sprawl is synonymous with unplanned incremental urban development, characterised by a low density mix of land uses on the urban fringe. In Europe every year more than 1000 km² of land are taken for housing, industry, transport or recreational purposes¹. Such long-term changes are difficult or costly to reverse, and nearly always involve trade-offs between various social, economic and environmental needs.

The consequences of urban sprawl may have both positive and negative impacts; however, negative impacts are usually more highlighted because the sprawl is often uncontrolled or uncoordinated. The positive impacts include higher economic production, opportunities for the unemployed and better services and lifestyles. There are also severe negative impacts and generally be admitted override the positive sides. Such as inflated infrastructure and public service costs, energy inefficiency, disparity in wealth, impacts on wildlife and ecosystem, loss of farmland, increase in temperature, loss of farmland, poor air quality, impacts on water quality and quantity, impacts on public and social health. Besides the environmental damage, during the sprawl the suburban is used to be the complement area to the inner city. With the suburban growth, the development model may reduce social interaction, weakening the bonds that underpin a sustainable city (Brueckner, 2000).

1 : <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013D1386>

Why are cities sprawling?

In most instances, the causes of urban sprawl and suburban growth are highly interlinked. Historically, the growth of cities has been driven by increasing urban population result in coordinated compact growth or uncoordinated sprawled growth (Bhatta,2010). The urban sprawl can happen in the both situations, whether it is good or bad depends on its pattern, process, and consequence. There are also some of the causes that are especially responsible for urban sprawl and lead to suburban growth. One of the most indispensable trigger is the growing amount of population and changes of desirable living pattern. As the nation's population expands, cities must grow spatially to accommodate more people. In addition, rising incomes realised new lifestyles (home with a garden or large living space) in suburban environments, outside the inner city, as well as relatively high increases in the price of already urbanized land. At the same time, urban sprawl and suburban growth has accelerate in response to improved transportation system and enhanced personal mobility. The extending regional railway and highway has made it possible either to live farther away from city center, while retaining all the advantages of a city location, or enabled people to live in one and work in another.

Links to EU policies

In essence, through the realisation of the 'internal market', Europe's new prosperity and economic development has put pressure on cities. The role and contribution of cities to Europe's economic growth, jobs and competitiveness, while also delivering social and environmental goals, has been addressed extensively by the EU institutions together with the regional and local authorities (European Commission, 2005). Sustainable urban development appears prominently in many European policy commitments, not least EU regional policy.

The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. In order to give more long-term direction it sets out a vision beyond that, of where it wants the Union to be by 2050². It includes an objective that land is managed sustainably and promotes the objective of no net land take by 2050.

"In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society."

It identifies three key objectives:

1. to protect, conserve and enhance the Union's natural capital
2. to turn the Union into a resource-efficient, green, and competitive low-carbon economy
3. to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing

2 : <http://ec.europa.eu/environment/action-programme/>

HISTORICAL DEVELOPMENT OF AMA

before 1900:

At the end of the thirteenth century, a dam was constructed there where the River Amstel flowed into the Zuider Zee. The port of Amsterdam grew up around this dam. Thanks to trade and fishing, Amsterdam developed and expanded, naturally enriched by the majestic and characteristic ring of canals.

1900-1959: Urbanization

Between 1900 and 1959 the urbanization was in full swing, people went to the city in the hope of finding work and a better life. Urbanization creates enormous social, economic and environmental changes, at the meantime predominantly rural culture was being rapidly replaced by predominantly urban culture. To accommodate the large amount of residents, the city grew in the unfolding pattern.

1960-1985: Suburbanisation

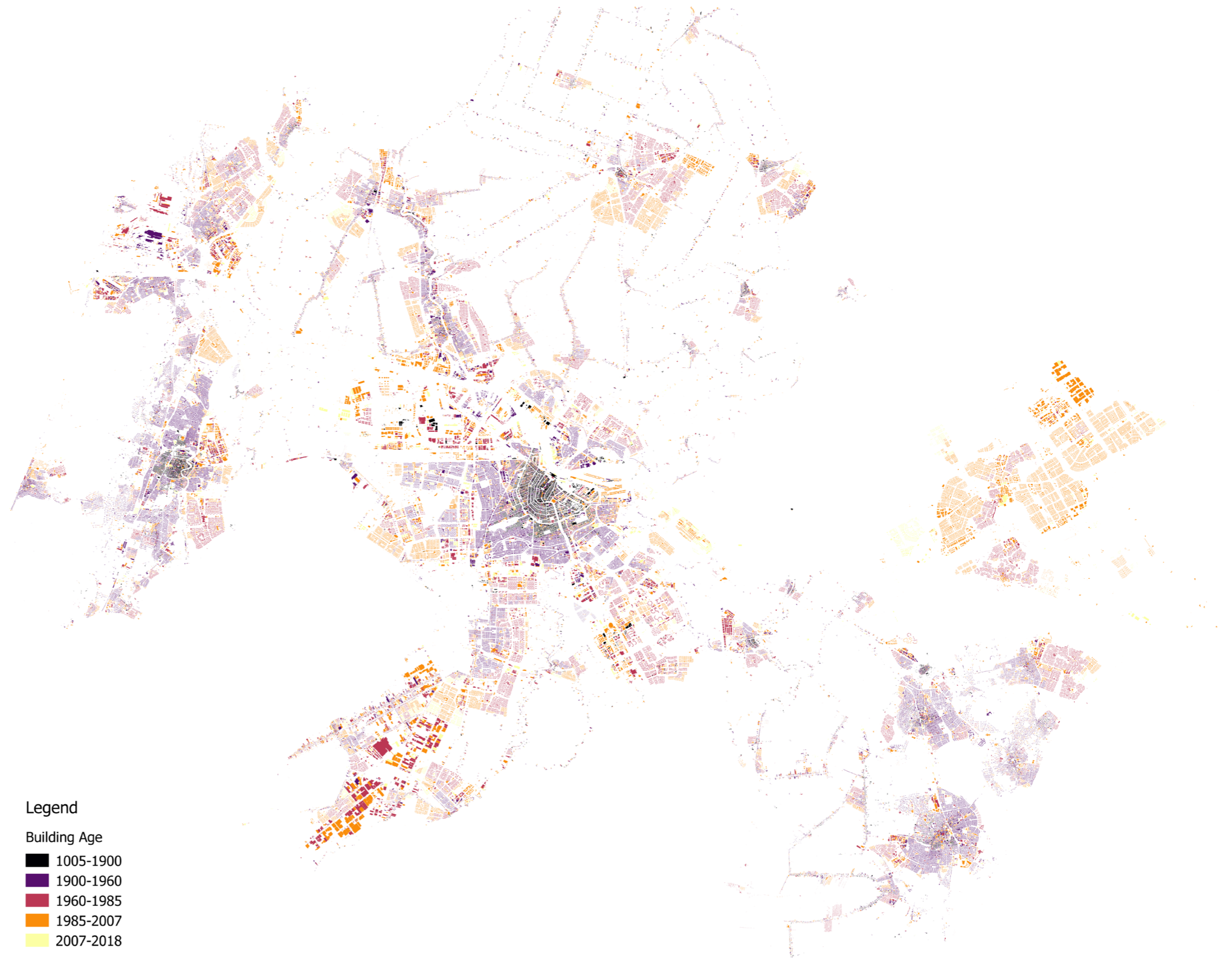
In 1960 another period started. Between 1960 and 1985 the population of Amsterdam dropped. Partly due to the rise of the car and the preference for detached houses with garden, the deconcentration policy became a success: many families exchanged the big city for surrounding municipalities.

1986-2007: Urban renewal

From the mid-1980s the population increased steadily and the foreign branch rose further. The city had become more attractive due to urban renewal. It is true that families still moved to the region, but also a growing number of students and young workers who settled in the city resulted in the changes in population structure.

2008-2018: Unprecedented strong growth

Since 2008, the natural population growth is almost 11,000 inhabitants per year¹. In addition, foreign migration has increased considerably since 2008. According to the prognosis, there will be 998,000 inhabitants of Amsterdam in 2050. The ongoing urban growth puts more and more pressure on the future development of Amsterdam.

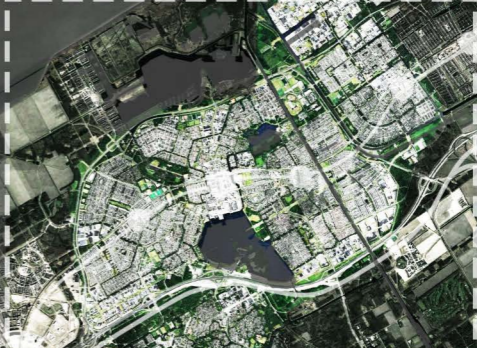


URBAN SPRAWL PATTERN OF AMA

Linear Strip Pattern



Scattered Pattern



Compact Pattern



Poly-nucleated



Urban Sprawl Pattern

There are different definitions of sprawl, however, they all share the same common thought that urban sprawl is the expansion of the urban area outside its borders into the suburbs. In most cases the development is single purpose and car dependent, agricultural and natural lands get lost and patches, enclaves, are created. Therefore researchers have created classifications of the different types of sprawl. As stated, the type of sprawl found in North America and Europe differs. In North America development is not contiguous but spread out, whereas in Europe the density is higher but the form is more evenly equally scattered across the region, thus leaving more open spaces (Batty et al, 2003, p. 4). Galster et al. (2001) have classified sprawl into the following five types, which are classified in terms of degree of compactness, dispersion or 'scatteration'. The first four type can be easily discovered in AMA.

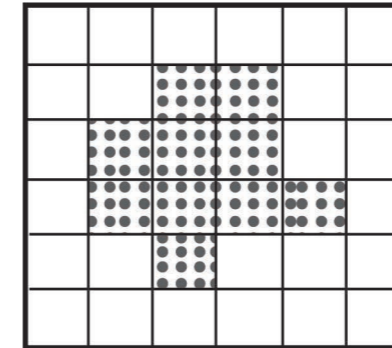
(1) Compact contiguous development: sprawl forms gradually around the urban area, not creating patches, and mainly has a high density.

(2) The scattered sprawl development: uncoordinated discontinuous development away from the historical central core, creating open and vacant land between new built-up areas.

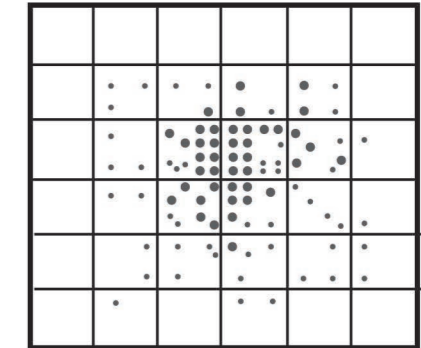
(3) Poly-nucleated nodal development: several smaller towns are agglomerated, the sprawl is discontinuous, much lower density than the traditional settlement, physically separated from the urban city of which it sprawled. Creating new 'larger' agglomeration of towns separately from each other (Batty et al., 2003, p. 4).

(4) Strip or linear development: the urban expansion along infrastructural works or rivers, the expansion is continuous but scattered, leaving agricultural and natural land open.

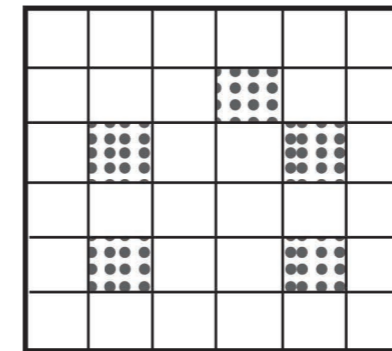
(5) Leapfrogging development: is the development that leapfrogs over existing barriers



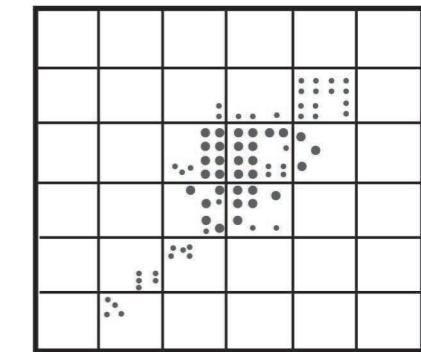
Compact sprawl pattern



Scattered sprawl pattern



Poly-nucleated sprawl pattern



Linear sprawl pattern

SUSTAINABILITY ANALYSIS OF ALMERE

Sustainability

During the long process of urban sprawl and suburban growth, there is an enormous change in land cover. Land is essential because our food and raw materials originate from them and is a habitat for flora and fauna. Similar to other resources it is a scarce commodity. Any disturbance to this resource by way of change in land-use, e.g. conversion of forestland or agricultural land into built-up, is irreversible, which alert the urban planners treat the sprawl more seriously. The use of land unsuitable for development may be unsustainable for the natural environment as well as to the humans.

In 1972, the sustainable development was a key theme of the United Nations Conference on the Human Environment in Stockholm. The concept of sustainability was coined explicitly to suggest that it was possible to achieve economic growth and industrialisation without environmental damage (increase in temperature, loss of farmland, poor air quality, impacts on water quality and quantity). Sustainable development is defined as, 'development that meets the needs of the present without compromising the ability of the future generations to meet their own needs' (WCED 1987). Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations. With the complex changes in urban system and development goals, sustainable development does not focus solely on environmental issues. The United Nations 2005 World Summit Outcome Document refers to the 'interdependent and mutually reinforcing pillars' of sustainable development as economic development, social development, and environmental protection (United Nations 2005b).

However, there is a lack of research on sustainability in the context of urban sprawl. During the urban sprawl process, suburban area is positioned as the administrative function instead of the city as a whole. The development

of suburban area or even the periphery city highly rely on the central city. Under these circumstances, sustainability can be used to assess the development dependency between suburban and city in terms of economic, social and environmental issues.

As described in the part of the analysis of connectivity and accessibility, urban transportation networks such as urban rapid transit systems have essential impacts on travel opportunities, and land use change. Traffic model has a strong influence on urban spatial structures as well as socio-economic activities. Analyzing and understanding the (un)sustainability of current economic, social and environmental development in condition of transportation can contribute to design a sustainable urban and peri-urban areas.

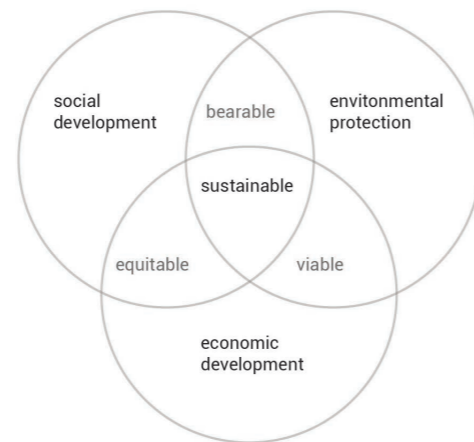


Figure: Schematic mode of sustainability (after ICUN 2006)

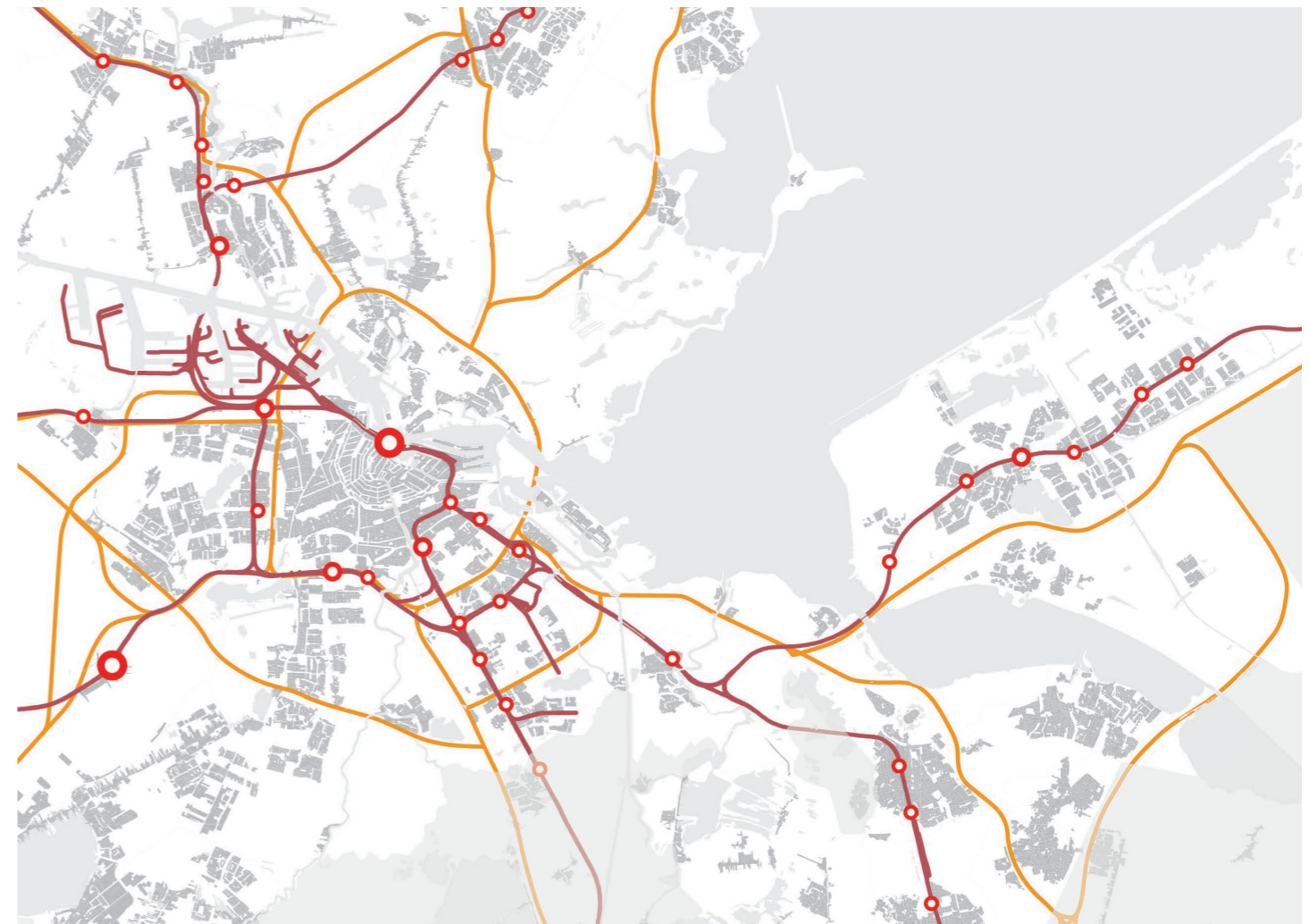


Figure: Amsterdam metropolitan area transportation analysis

Legend

— railway — main vehicle traffic line ● main station

Infrastructural connectivity

Commuting between Amsterdam and Almere stands still one of the busiest daily journeys in Netherlands. It can be explained by understanding the city role of Almere. Almere used to be the agriculture land, in order to share the housing demand and population growth of Amsterdam, it was transformed to the urbanized area from 1970s. The spatial distance and travel distance between Amsterdam and Almere. The spatial distance is about 22km and the travel distance is about 34km. There are two kinds of infrastructural connections between

Almere and downtown area, which is motorways (A6 and A27) and railway (Flevolijn). People can travel by automobile, train and bus. There are five regional bus lines linking Almere with Amsterdam.

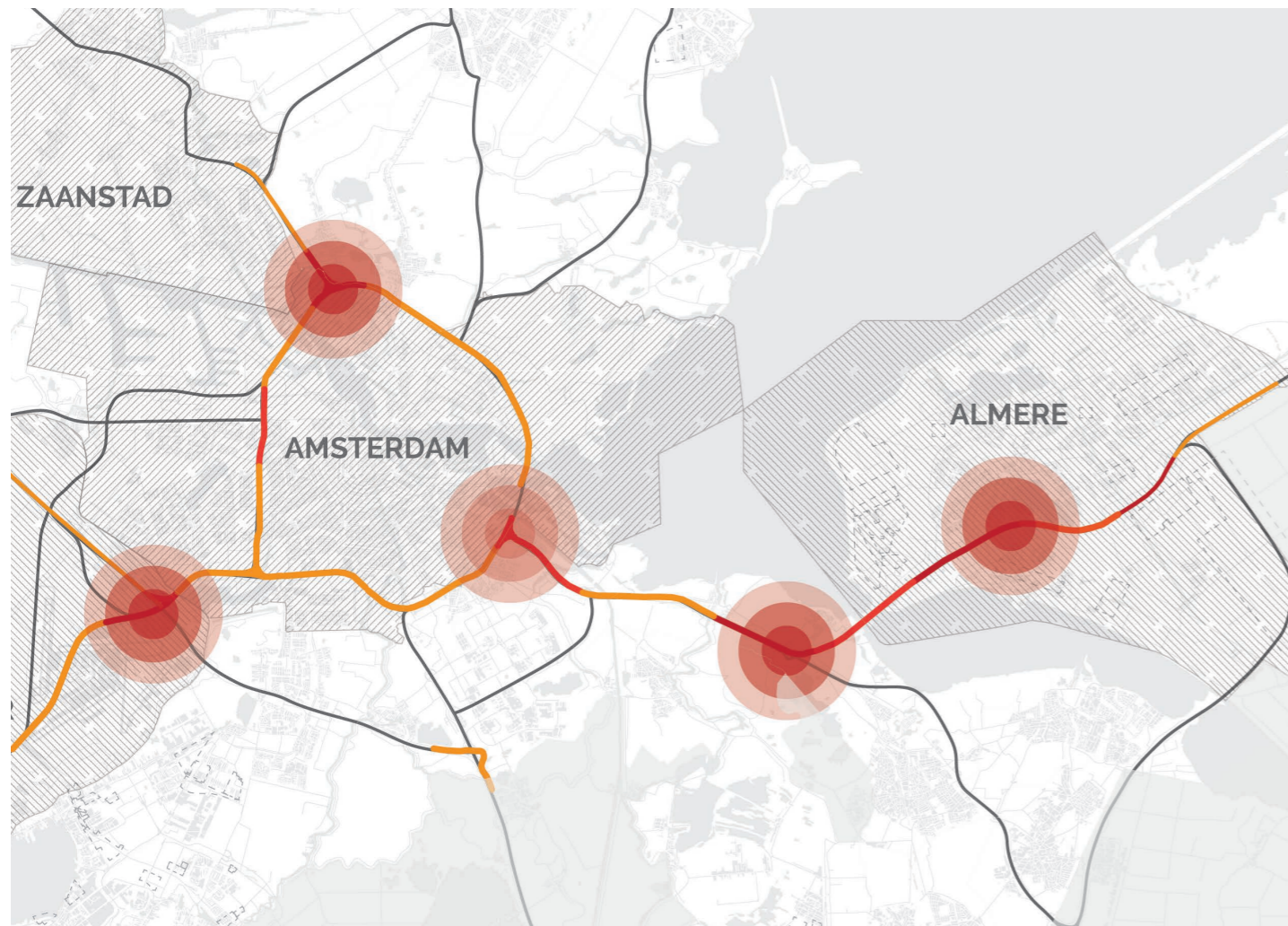


Figure: Amsterdam metropolitan area congestion analysis



Traffic congestion

Despite provided different kinds of travel models, physically, Almere relies entirely on a single rail and road connection. The daily commuting amount from Almere to Amsterdam is almost 20,000, which cause the serious congestion problem entering the city ring of Amsterdam . Planning schemes, aimed at increasing the total population of Almere to 350,000 by 2030. The population growth puts huge pressure on traffic system and may bring more serious congestion. Nowadays, the road is often congested with Almere residents spending

one of the longest car trips in Netherlands with a travel distance of 36km (Gemeente Amsterdam, 2017). To enter the Amsterdam city, the average traffic time spent in congestion is 1.22 times of the usual time which is 45min (morning peak 1.35 times and evening peak 1.52 times).

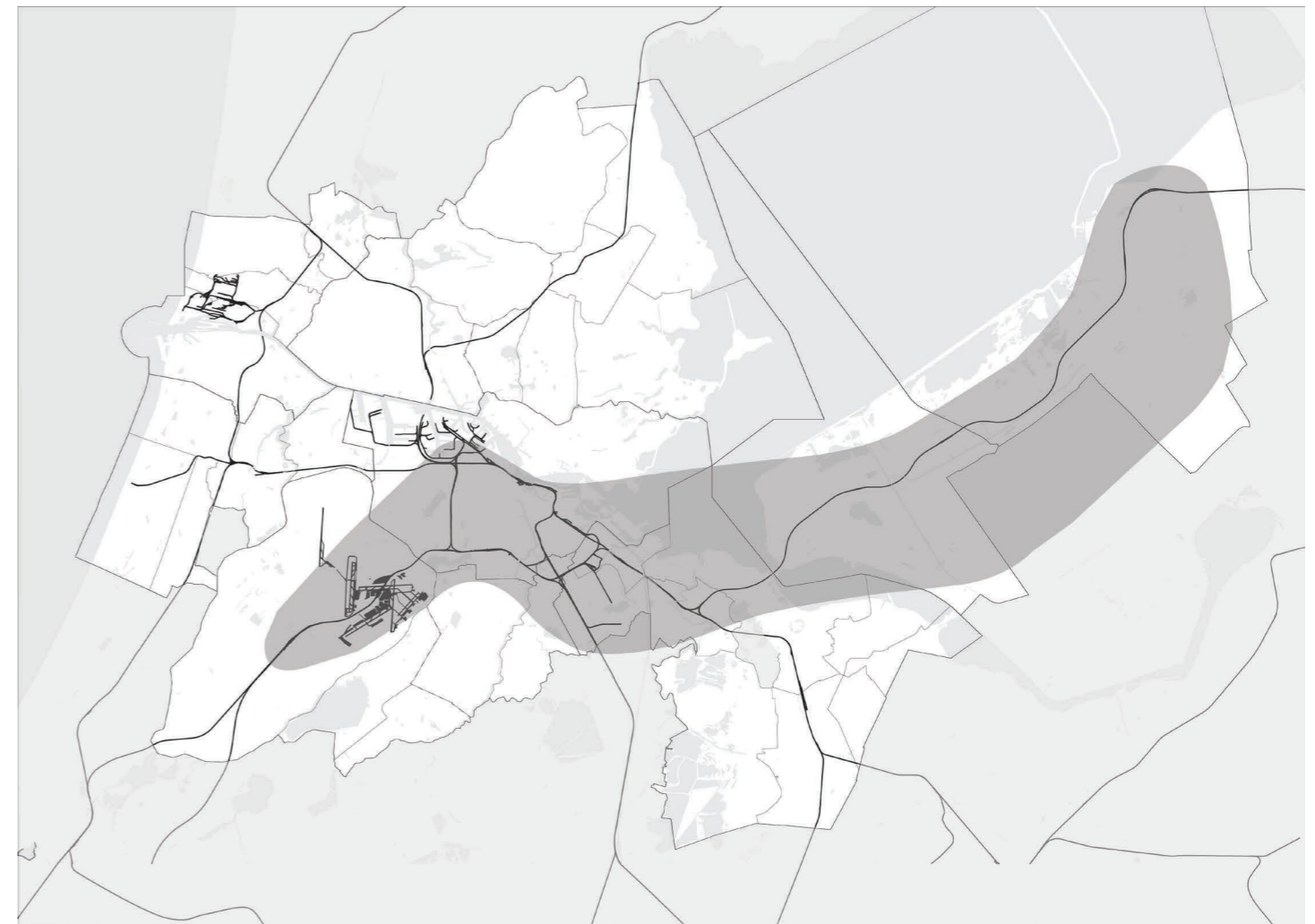


Figure: Regional structure for OV-SAAL

Governmental interventions for traffic

First option uses the existing Holland Bridge in its expanded road and rail capacity together with High Occupancy Vehicles lanes (HOV) connecting the new development sites and the rapidly developing Almere Port area in a new east west axis. OV-SAAL¹ guarantees a capacity expansion from 6 to 12 trains per hour improving connections to Amsterdam and Amsterdam Zuidas. Secondly, it integrates better to Almere's transport logic of feeder route systems. In transport terms, the first and last mile refer to the movement

of people to/ from a transport hub. It is an important planning term in sustainable urban development as it indicates how easily people can access public transportation from their home or workplace rather than relying on a car for the entire journey.

1. Openbaar Vervoer Schiphol-Amsterdam-Almere-Lelystad. Source:<https://www.prorail.nl/projecten/almere/ov-saal>



Amsterdam
Figure: Land-use comparison between Amsterdam and Almere



Almere

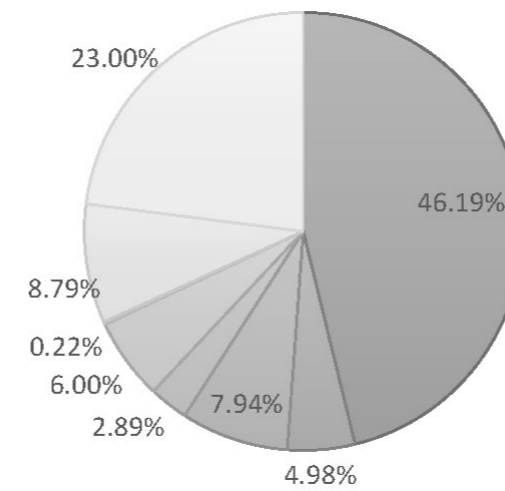


Figure: Function proportion Amsterdam

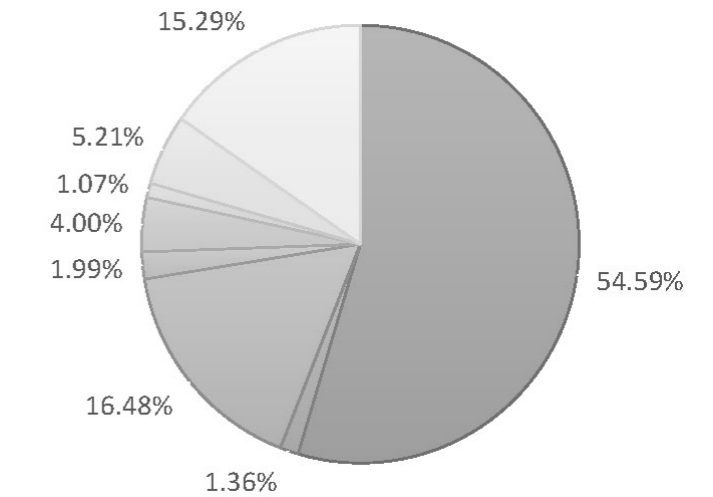


Figure: Function proportion Almere

- residential function
- garthering function
- factory
- educational function
- business function
- healthcare function
- commercial function
- others

Economic dependency

Almere is an important “dormitory town” near Amsterdam, although it once had been designed as independent town and still is presenting itself as such. The Ministry of Housing, Spatial Planning and the Environment (VROM) considers Almere above all the location where the biggest house-building program of the Netherlands should be realised until 2030 (population capacity to 350,000). To accommodate the large amount of residents, Almere has been mainly built for residential function. The city is positioned to bear the single

development task, which leads to the single pattern of land use and the type of residents. The monotonous residential pattern causes the identical travel behaviour thereby puts pressure on the transportation system at a specific time.

At the same time, single zoning also decreases the quality of life. Single zoning for residential areas forces women to stay at home and be excluded from the economy, forces people to leave their homes and children

and work in isolated workplaces, which add tension and unnecessary stress.

Due to the imbalanced development pattern, residents of Almere depend to a relatively large extent on jobs outside their own city. The employment rate in Almere is dependent on employment growth elsewhere and the city attraction for new residents and business. The unemployment rate of Almere has been above average in recent years in AMA, and the expectation will fall further.



Figure: Commuting demand and shuttle analysis

Legend

- demand in high level
- demand in low level
- demand in medium level
- \longleftrightarrow shuttle of Amsterdam

One-way commuting and air pollution

Not only Almere is highly relying on the labor market outside the city and show the obviously out-going commuting pattern, the whole metropolitan area shows the unbalanced commute traffic and also attracts the commuters from outside region.

Amsterdam, together with its surrounding municipalities, is an economic driver in the region and country. It is especially obvious in the MRA there were 174 thousand more jobs at companies and institutions than there were

employed persons in 2015. In other words, the MRA has a net work function and an inbound shuttle that is larger than the outgoing shuttle. With the number of 22,000 commuters, the route between Almere and Amsterdam keeps being the busiest in the Netherlands and shows the severe pattern of one-way travel direction. This type of travel behavior also causes the high NO₂ emissions in the center where the level of car ownership is low.

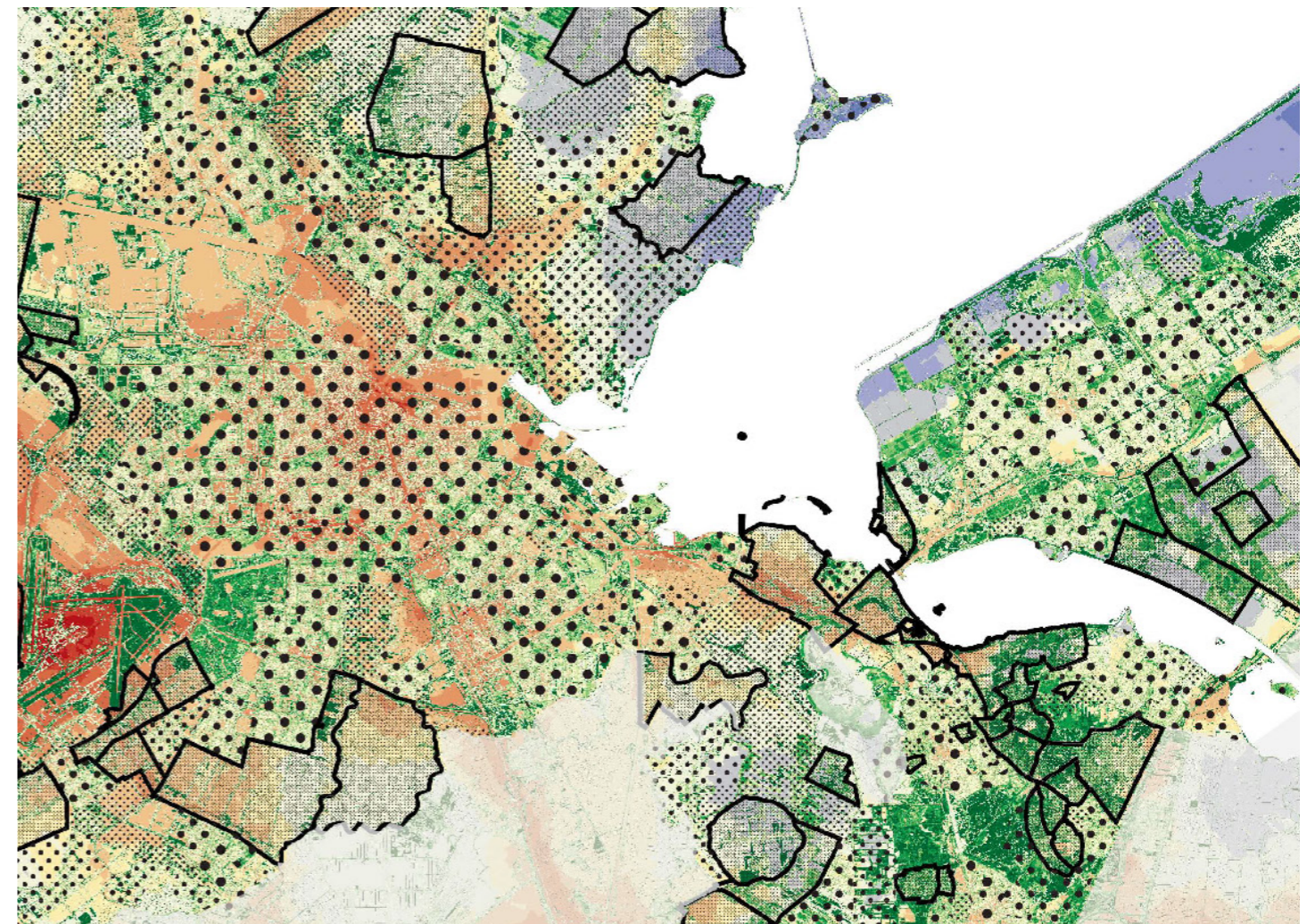


Figure: The relationship between car ownership and NO₂ pollution

Legend

- low NO₂ → high NO₂
- < 0.92 cars/household/neighborhood
 - 0.92-1.12 cars/household/neighborhood
 - 1.12-1.27 cars/household/neighborhood
 - 1.27-1.49 cars/household/neighborhood
 - > 1.49 cars/household/neighborhood



“The city is too big now! There are a lot of shops, but a lot of them are empty, why is that?”

Dutch elderly man, pensioner,
Almere's resident since 1996

“At first, I said it myself: ‘Almere? I don’t want to live there!’ and now it’s quite OK. It is slowly improving... The city is not finished yet.”

Men, 43, from Haarlem

“I live in Rotterdam and I think Almere is a dorm city. Nobody in the Netherlands really likes it. Usually families come here to find a job in Amsterdam and Utrecht.”

Man, 35, living in Rotterdam

Grote Markt

1.2 THE FUTURE PRESSURE : URBAN GROWTH

The Amsterdam Metropolitan Area is a popular place to live and work. The demand for housing is and remains large. More residents and more jobs means more homes. This places a great deal of pressure on municipalities to take action and build sufficient affordable housing in the short term. But speed should not be at the expense of quality. Government should pay attention to build the right homes in the right places and ensure a high-quality living environment and good accessibility.

In the period 2017-2040, according to the latest forecast, AMA municipality must add no less than 230,000 homes to meet the demand. This means that government has to realize an average of 10,000 homes per year. That's 3,200 homes per year more than predicted in the 2008 forecast.

To achieve the housing demand, natural land transformation is still the main method to provide new urban base. Certainly, because it is more difficult to

develop on inner-city locations such as old factory sites, than on outside locations. In the coming years, many cities will be built (dark red on the map). New housing construction is also planned outside the existing cores in villages and towns (explanation). This housing is in the province of Noord-Holland both inside and outside existing urban area. In Flevoland, this distinction is not made (in purple the new urban areas are indicated). The large-scale housing locations of the MRA are found in Almere, Amsterdam and Haarlemmermeer West.

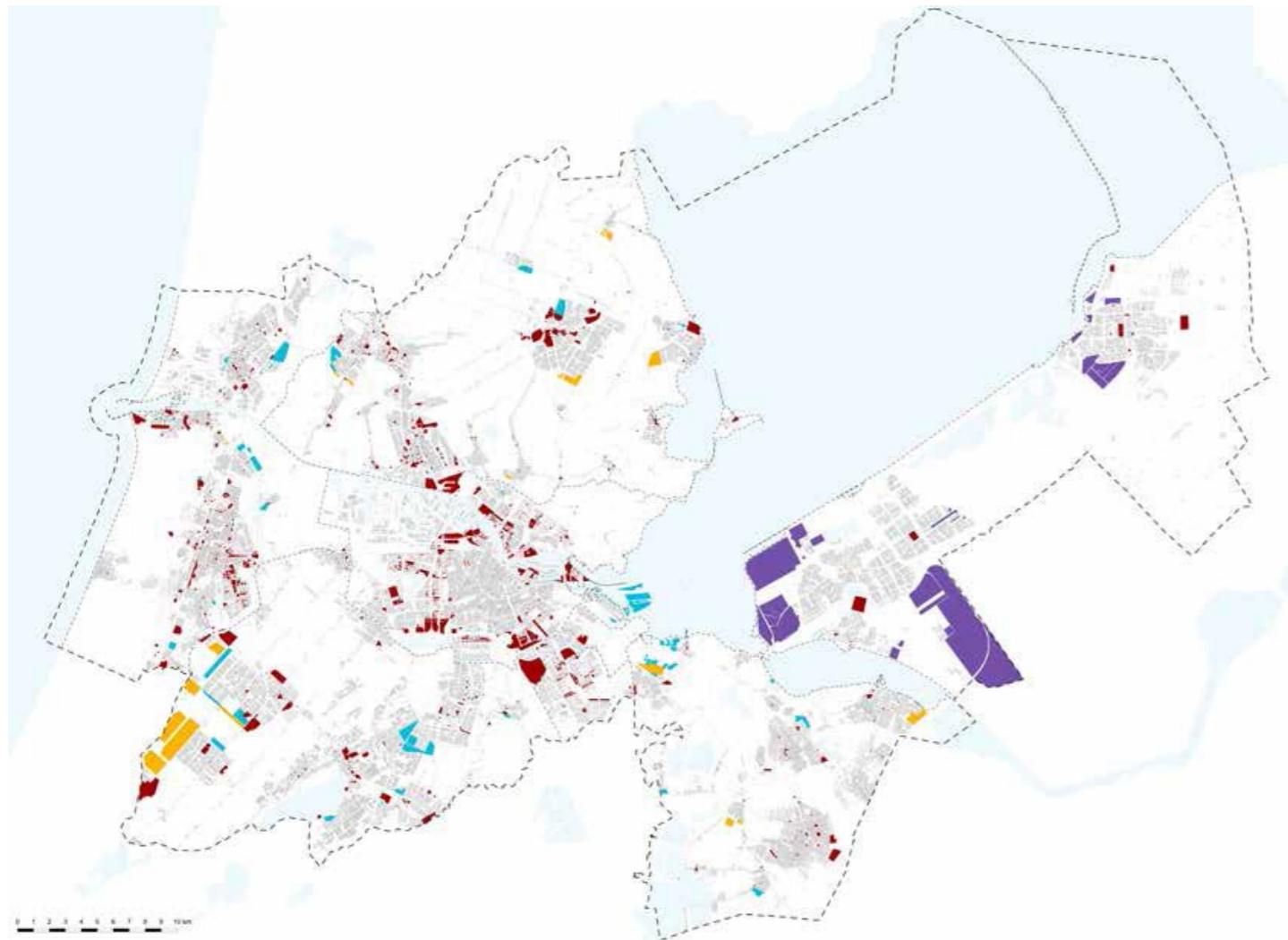


Figure: AMA vision of planning status
(source: In gesprek over onze woningbouwopgave tot 2040 - metropool regioamsterdam)

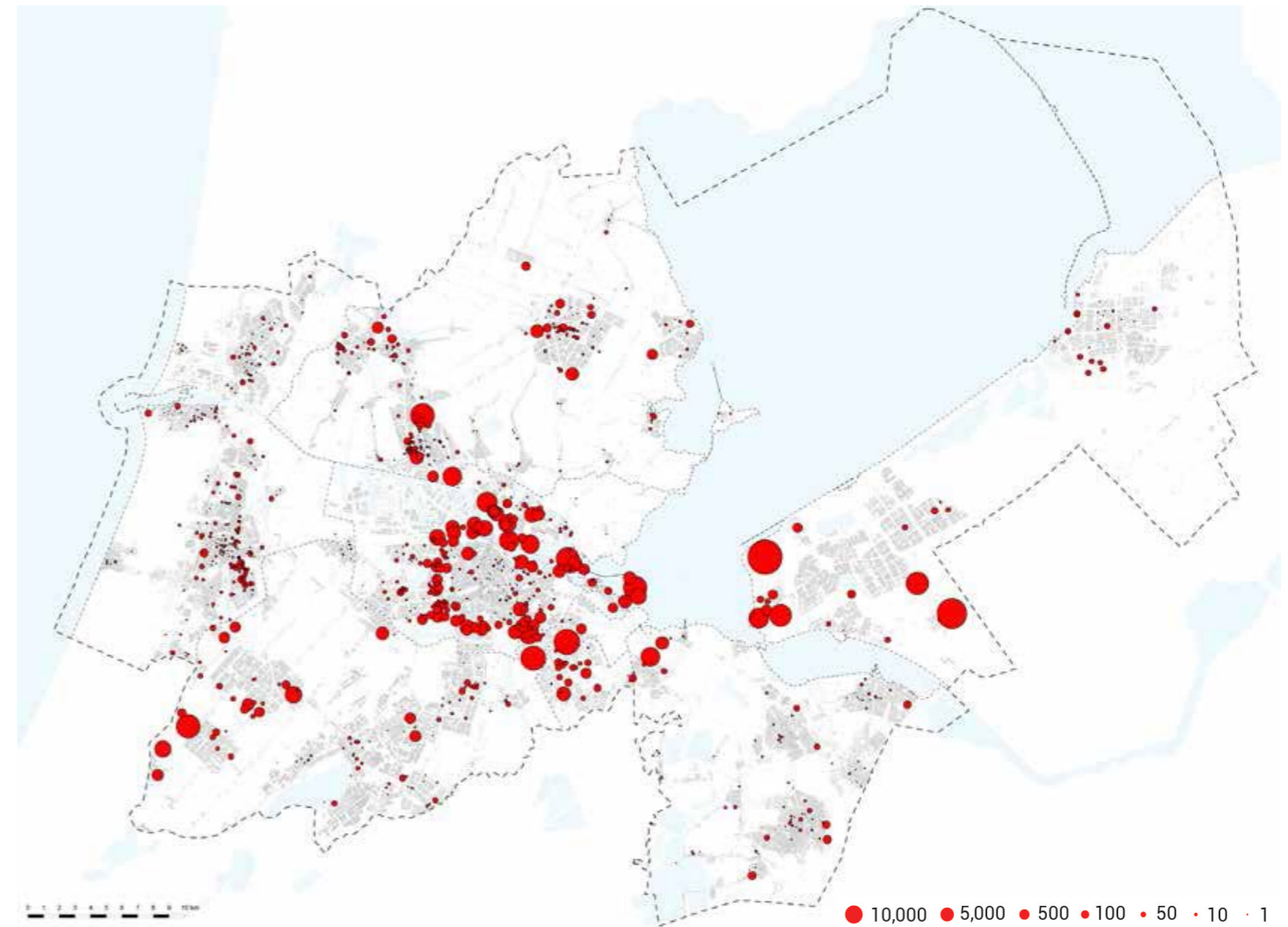
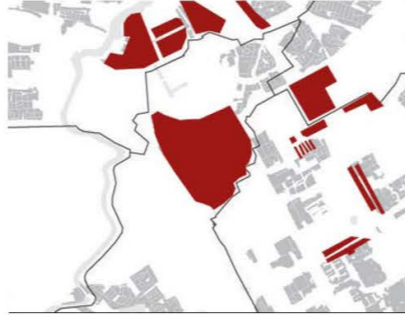

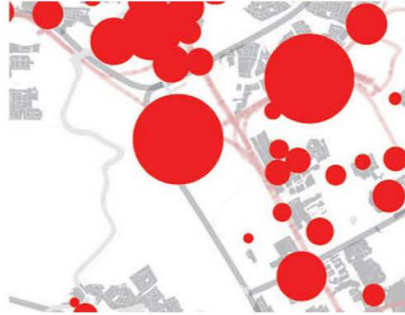
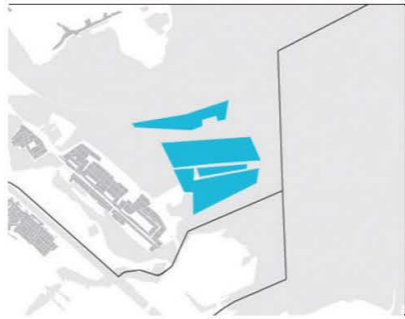

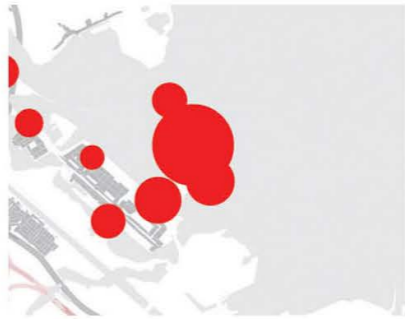



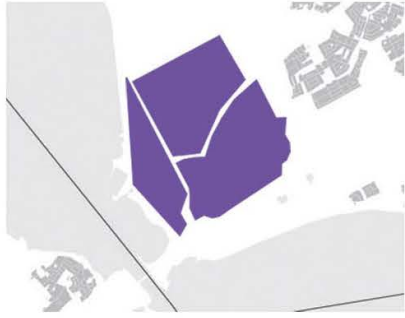




Figure: AMA vision of planning capacity
(source: In gesprek over onze woningbouwopgave tot 2040 - metropool regioamsterdam)

PLANNING TYPE ANALYSIS

	Planning status	Current situation	Planning capacity	Housing amount
type one: new inner-city				7293 houses
type two: develop villages				7430 houses
type three: develop towns				6600 houses
type four: new urban area				8666 houses

Note: The housing amount is calculated by author. The basic data is selected from the report of "Plan capaciteit Noord-Holland 2017 : Overzicht nieuwbouwplannen per regio en gemeente"

PLANNING THE FUTURE OF ALMERE: SPRAWL OR COMPACT

Type one: Sprawl in organic development

Current growth scenario for Almere projects the population for 70,000 new people. The planning vision for Almere 2040 is to develop "organic" city in the edge area. The government decides to transform the brown field and green space to new urbanised land. The "organic urban development" is a strategy departing from that of the overarching master plan (top-down planning), allow freedom for private commissioning and constitutes the next step in resident participation. It pertains not just to residents' own parcels of land, but to the layout of the entire district. They are free to decide on the shape, size and programming of the land to be built on, provided that a 'buffer zone' remains around the property that is free of construction. This expansion, in imagination, represents the surprisingly low-density rural lifestyle.



 Municipal density: 1,574 per sq km
 Community density: 4,452 per sq km
 Average household size: 2.53

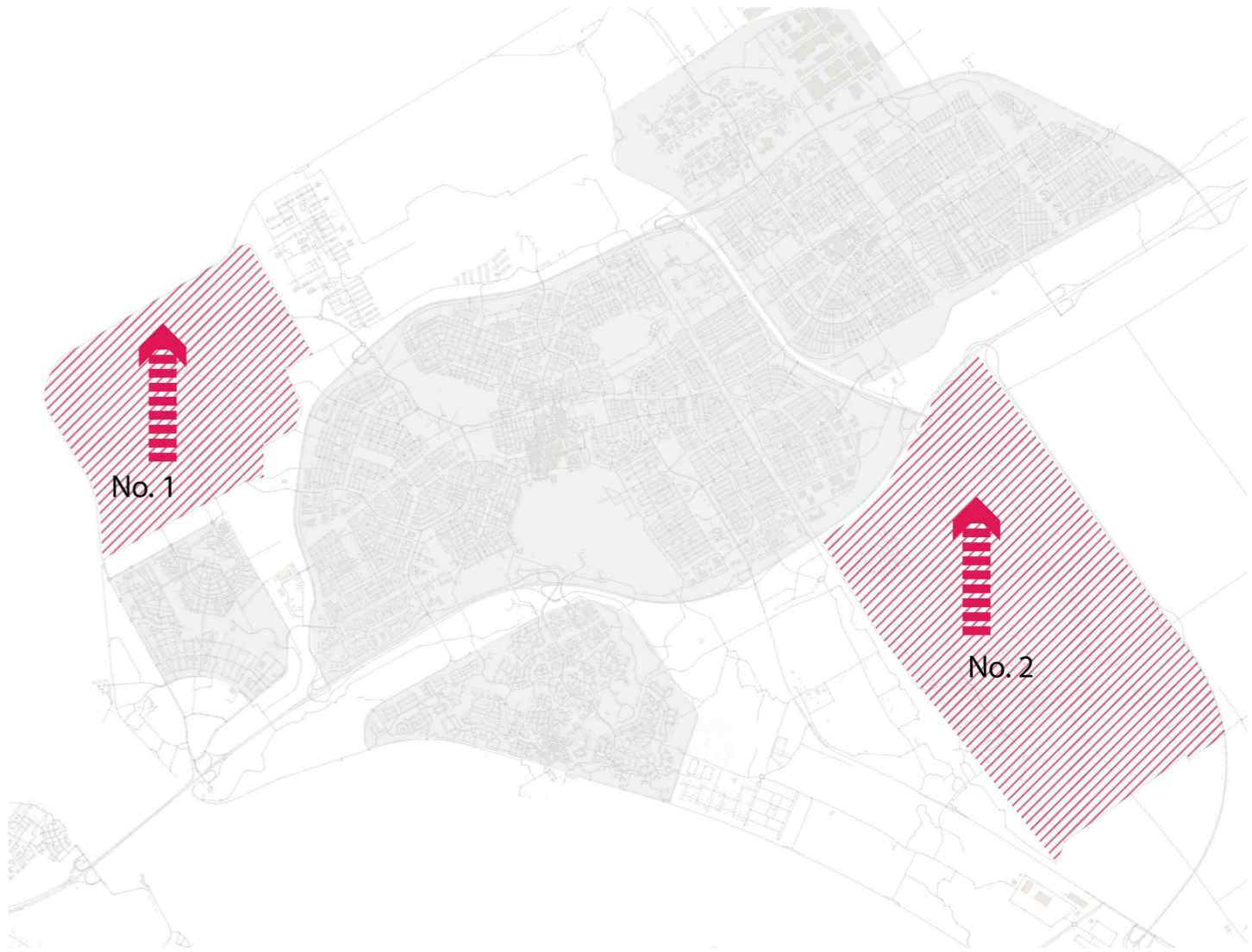


Figure : Current situation of land No.1 and No.2

To measure the urban growth capability of the sprawl plan, the project assume the keep the same urban density in the new built area. By caculating the average community density (the population density on living community and city center) and area of new land, the possible population growth is 102,261. It approves that with the sprawl plan the urban growth task can be achieved.

Task : 70,000 new resident
 + 35% population growth

remain current Almere density : 4,452 per sq km



	Space of new land	Density	Possible increase of population
No.1	6.34 sq km	4,452 per sq km	28,225
No.2	16.63 sq km	4,452 per sq km	74,036
Total	22.97 sq km	4,452 per sq km	102,261

Type two: Compact city development

Since the space utilization rate of Almere is dramatically low, there is high possibility that the city can be redeveloped and used in a more efficient way. To research the possible growth capability, the city is divided into four parts, which is one center area and three edged community. The current density of the four testing area is calculated. There are two kinds of proposals. The first is making the city 1.3 times denser. Based on current area of land and the design density, the potential population growth is 61,545, which is just 9,000 less than growth task. The second proposal is to make the Almere 1.5 times denser. Calculated in the same way, the possible growth is 102,577, which is about the same amount as growth in sprawl planning.

The comparison between the sprawl plan and compact plan approved that Almere is capable to achieve the urban growth task without taking over the natural land. The project will further work on exploring redevelop opportunity in center area (No.1 land) to test if the population can be achieved.

Task: 70,000 new resident
+ 35% population growth

future density : 1.35 times denser

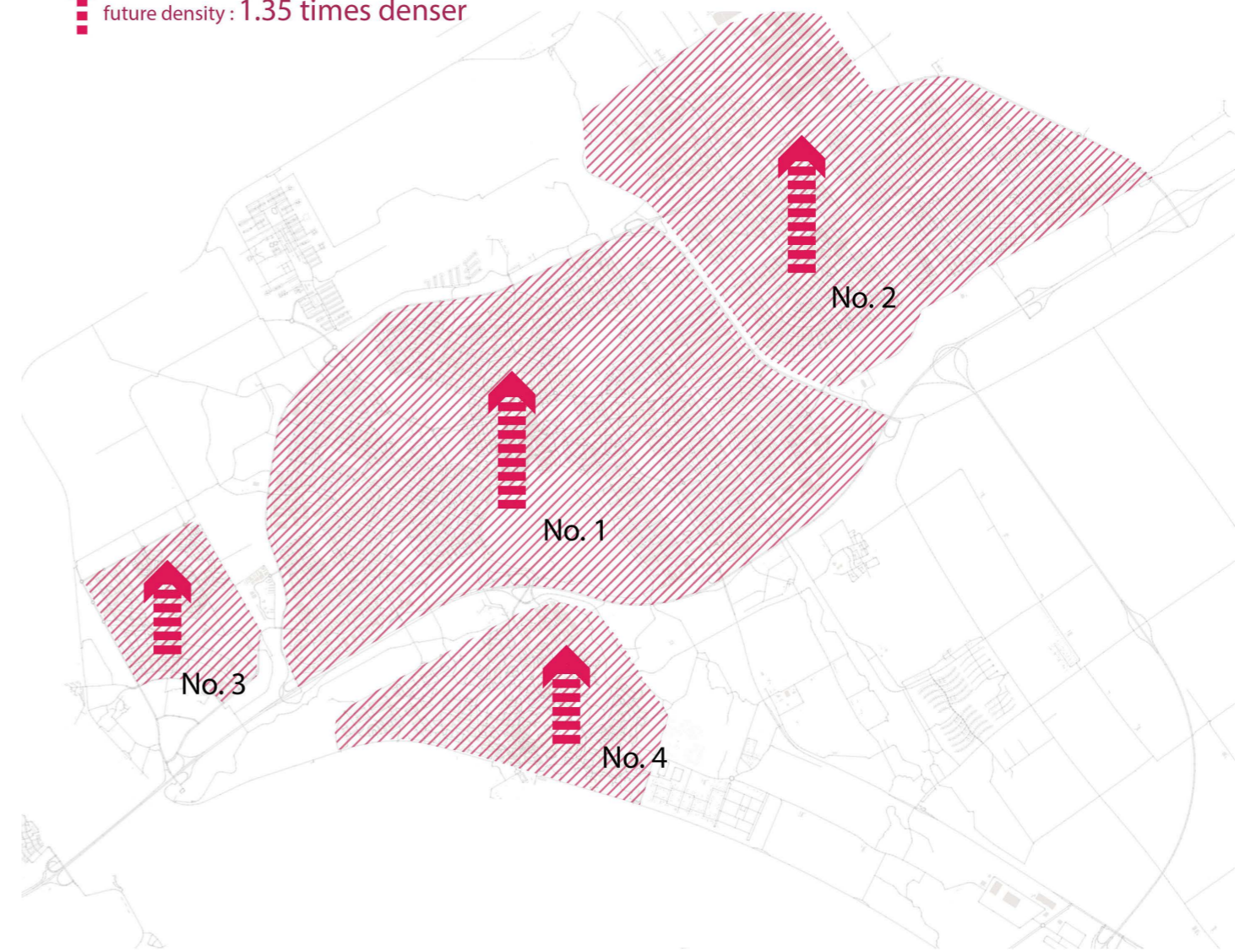


Figure : examples for land in low utilization rate

- (1) green land in low quality
- (2) infrastructures in low utilization rate
- (3) large amount of space occupied by parking
- (4) brown field

	Space of land	Design Density	Possible increase of population
No.1 (Almere center)	21.595 sq km	7,226 per sq km	40,459
No.2	12.128 sq km	6,220 per sq km	19,560
No.3	2.508 sq km	6,011 per sq km	3,908
No.4	6.631 sq km	4,581 per sq km	7,876
Total	42.862 sq km		71,803

1.3 AUTOMATED VEHICLE: repair or expand urban sprawl

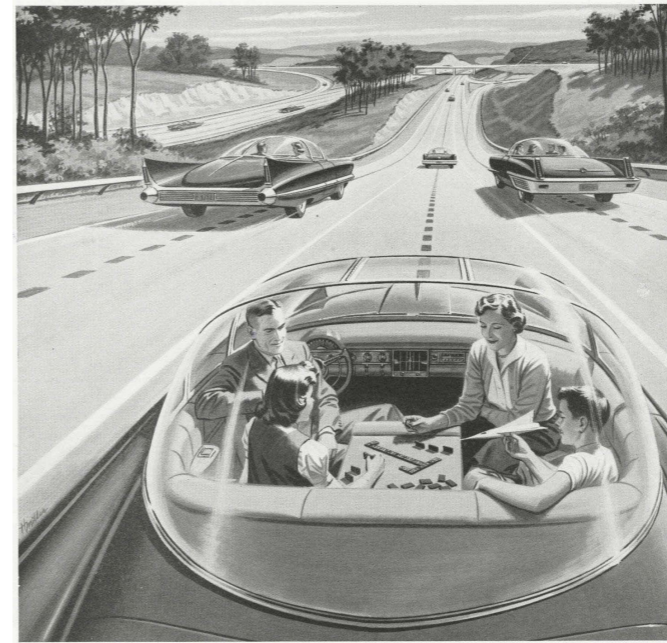
Introduction

Autonomous vehicle technology is a rapidly developing technology that promises to revolutionize the form and function of our urban spaces. An autonomous vehicle is one in which vehicle operation occurs without direct human driver input to control key functions such as the steering, acceleration, and braking. Autonomous vehicles are going to change our cities and regions, and those changes will come sooner rather than later. Most prognosticators agree that it will be decades before AVs are the dominant form of transportation.

AVs have the potential to save lives by preventing accidents caused by driver error (including distracted driving), and they could allow for more efficient vehicle movement gained by closer vehicle spacing. They could provide "first and last mile" and "last 50 feet" connectivity to transit increasing mobility options for people with disabilities, seniors, and children. And they are expected to free up vast amounts of land currently used for parking, gas stations, and other autooriented

land/buildings (including brick-and mortar retail) for conversion to other uses.

However, AVs are not guaranteed to produce uniformly positive interactions between humans and the built environment. With the liberation of travel ability, people can go further, this may accelerate urban sprawl. They may end up increasing congestion if people shift from transit to personal autonomous vehicles. If people rely on AVs for door-to-door transportation, they may walk less. This may initiate a cycle of reduced local requirements for sidewalks and crosswalks that further discourages the choice to walk, creating negative health and social impacts. There will certainly be impacts on workers in the transportation field, as people who drive buses, trucks, and cars for a living stand to lose their jobs. And there are bigger-picture concerns with regard to privacy, data security, and personal safety if technology companies drive AV-related policies.



ELECTRICITY MAY BE THE DRIVER. One day your car may speed along an electric super-highway, its speed and steering automatically controlled by electronic devices embedded in the road. Travel will be more enjoyable. Highways will be made safe—by electricity! No traffic jams... no collisions... no driver fatigue.

Figure: Advertisement for "America's Electric Light and Power Companies," Saturday Evening Post, 1950s. Credit : The Everett Collection.



Figure: A prototype self-driving car by Google. PHOTO: REUTERS

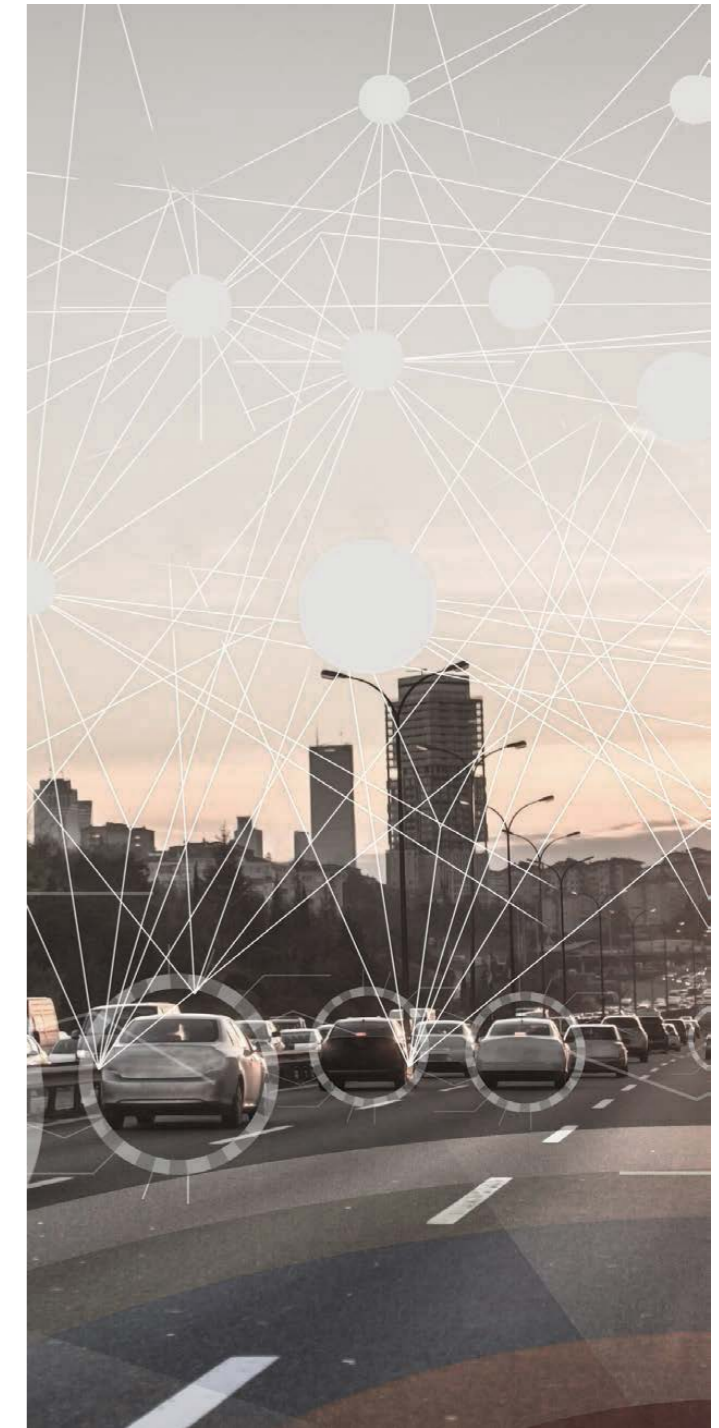


Figure: Automated street imagination

Potential benefits of AVs

- fewer traffic deaths and injuries
- increase mobility for people with disabilities, seniors, and children
- more efficient vehicle movement
- first/last mile connectivity
- less land area needed for parking, gas station

SPRAWL REPAIR

Potential negative impacts of AVs

- negative health impacts
- increase congestion
- job losses
- privacy and security concerns
- effects on other transportation modes
- encourage long commutes and vehicle travel

SPRAWL EXPANSION

Chapter 2. THEORY

2.1 THEORY OF URBAN SPRAWL

2.2 ANTI-SPRAWL STRATEGY : COMPACT CITY

Abstract - In Europe there is a growing concern about the development of future urban form, especially deconcentrating of urban land use in the form of urban sprawl. Urban sprawl is synonymous with unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe. Historically, urban sprawl was caused by population growth and transformation from rural population to urban population. In recent decades, the relationship between cause and effect has become more complex. The article focus on three aspects: technical theories focus on the urban mobility system, economic theories focus on the urban markets, and social theories focus on the society and urban space. The consequence of urban sprawl may have both positive and negative impacts; however, negative impacts are usually more highlighted because the sprawl is often uncontrolled or uncoordinated. To control the urban sprawl trend, Netherlands has been working on the compact city policy in decades. The strategies such as urban intensification, higher urban density, and mixed use development have had a positive impact on the compact design. The compact city policy need to be placed as the main future planning policy and need to be improved and applied to control urban sprawl and contribute to sustainable urban development.

Key words – urban sprawl, compact city, urban growth, transportation system, urban densification, spatial quality, spatial planning

2.1 THEORY OF URBAN SPRAWL

Introduction

The urban sprawl is the outcome of various factors including demographic issues, economic driver, physical geography, living preference etc. There is general agreement that urban sprawl is the combined effect of growing affluence, changing lifestyles and the vast advance in personal mobility made possible by the private automobile (Dieleman and Wegener, 2004). The extending regional railway and highway has made it possible either to live farther away from city center, while retaining all the advantages of a city location, or enabled people to live in one and work in another. In order to understand urban sprawl, it is therefore important to review theoretical insights on the interaction between transport and urban form.

Theories on the two-way interaction between urban land use and transport address the locational and mobility responses of households, firms and travellers to changes in the urban land use and transport system at the urban-regional level (Dieleman and Wegener, 2004).

Technology is always powerful to change the way people move and live and finally change the urban structure. Historically, the city was compact in the period of horse-powered transportation mode which caused traffic and health problems. With the emergence of internal-combustion vehicles people are able to travel farther with the same time costs. This has made every corner of the periphery area almost equally suitable as a place to live or work. People move to suburban area, which is the embryonic form of modern metropolitan areas. However, exactly how the development of transportation system influences the land use factors such as location decisions of labour market, investment companies and households is not clear to many urban planners.

The major theoretical approaches to explain the interrelationship of land use and transport in metropolitan areas include technical theories (urban mobility systems), economic theories (cities as markets), and social theories (society and urban space).

Technical theories (urban mobility systems)

In the 1950s, first efforts were made in the USA to study the interrelationship between transport and the spatial development of cities. Hansen (1959) illustrated that locations with good accessibility had a higher density than remote locations. The recognition became popular among American urban planners and was further developed to be the 'land-use transport feedback cycle'. The relationships implied by this diagram can be briefly summarized:

- The distribution of land use, such as residential, investment or industrial function determines the locations of human activities such as living, working or education.
- The distribution of human activities requires physical trips provided by transportation system to overcome the distance between the destinations.
- The distribution of infrastructure in the transportation system creates opportunities for accessible extend area.
- The distribution of accessibility in space cooperate with location decisions and results in changes of the land use pattern.

The theories based on the observation of human mobility, such as travel distance and time costs. The places is physically connected does not mean it is accessible. This diagram lead to a better understanding of interrelationship between individual mobility and travel behaviour. Talking about the possibilities of travel, people also consider about the finical and time costs. If it is beyond expectation, the travel vitality will dramatically decrease. On the other way, if the travel costs decrease the result will be spatial distribution of human activities and longer travel distance.

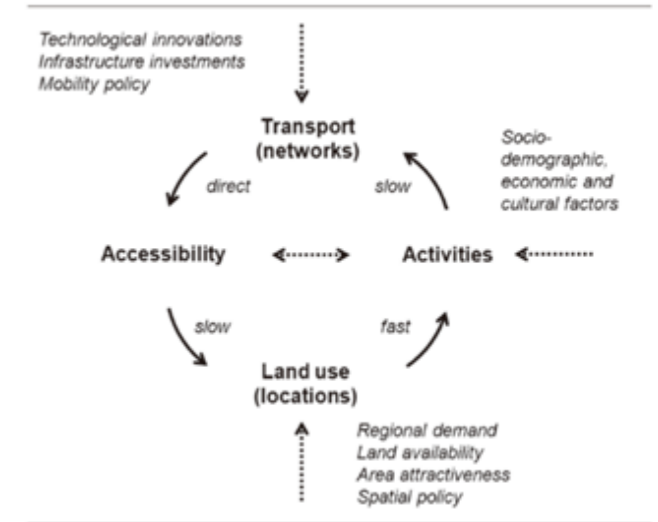


Figure: Transport and land use feedback cycle

2.2 ANTI-SPRAWL STRATEGY : COMPACT CITY

Economic Theories (Cities as Markets)

Analysis shows that residential sprawl and the development of economic activities, in turn linked to the development of transport networks, are intrinsic causes of expanding cities. New transportation investment, in particular motorway construction, can be a powerful stimulant for new development and sprawl, including shopping centres and residential areas (EEA report, 2006). This is largely a consequence of increasing travel and freight transport demand, as well as relatively high economic costs of urbanised land. It forces developers to seek lower prices in the more peripheral areas. Agricultural land therefore becomes a highly attractive target for investors and developers. This kind of land transformation leads to both spatial polarization and spatial dispersal within urban regions. The investments require extensive, low-density sites with good access to the regional and local road network, and this explains why new residential area or manufacturing firms prefer suburban locations and generate leapfrog pattern along the transportation infrastructure. New suburban development without adequate public transportation typically increases the demand for private car use. In contrast the construction of new light rail systems has a tendency to increase housing densities around access points (Handy, 2005). As explained previously, households make choices between residential areas taking into account the price of housing and the price of commuting between the work place and home. When travel costs fall below a certain threshold and income reaches a certain level the rate of sprawl quickens, and unsurprisingly sprawl is more common in regions where incomes are high and commuting costs are low (Wu, 2006).

Social Theories (Society and Urban Space)

Historically, the growth of cities was fundamentally linked to increasing population and the transformation from rural population to urban population. However, in recent decades, urban sprawl is no longer closely related to population growth. We have to admit the urban population growth will still put pressure on how to accommodate large amount of new residents. Other demographic factors may increasingly have impacts on urban sprawl, such as the changes of demographic structure, living desire, and family pattern. Families with small children are most likely to move to suburban areas and to rural areas outside the city. In contrast the elderly and single are least likely to move out of cities. As the trend towards an increasingly ageing population and smaller households continues, it may be anticipated that some slowing down of the movement from cities to suburbs will occur in the coming decades (Couch & Karecha, 2005).

On the other hand, there are many negative aspects of the inner city cores, including poor environment, social problems and safety issues, create powerful drivers of urban sprawl. City cores are perceived by many as more polluted, noisy and unsafe than the suburbs. The built-up environment is also considered unattractive because of poor urban planning, with areas lacking green open space and sports facilities. Unemployment, poverty, single parent households, drug abuse and minorities with integration problems are also often identified with inner-city areas. These negative environmental factors drive many families with small children out of the city.

Introduction

To live with the limits of urban space, the Charter of Leipzig (European Urban Knowledge Network, 2007) and the publication Cities of Tomorrow (European Commission, 2011) emphasize the importance of compact urban developments as an important sustainable strategy for the future development of European cities. The Seventh Environment Action Programme (7th EAP) includes an objective that land is managed sustainably and promotes the objective of no net land take by 2050. The attempt to regulate urban form usually comes under such terms as compact city policy and the promotion of multifunctional land use. In this concept, the focus shifted from urban expansion to revitalising and densifying existing urban areas. The aim was to curb suburbanisation and limit new urban development at the urban fringe.

There are three concepts addressed in this chapter provides a clearly understanding of the process which result in a more compact urban environment.



Figure: New York. Downtown density: 25,800 per sq km



Figure: Paris. Downtown density: 20,200 per sq km

Urban intensification

Existing towns and cities can only become more compact through a process of intensification. Lock suggests that intensification is a process which 'ensure that we make the fullest use of land that is already urbanised, before taking green fields' (1995, p.173), and Naess has described it as the process of encouraging development to where 'technical encroachments on nature have previously taken place' (1993, p.309). Roseth describes intensification in terms of urban 'consolidation', which he defines as 'the increase of population and/or dwellings within a defined urban area' (1991, p.30). Through different terms of definition, we can draw the conclusion that urban intensification can be achieved through different kinds of spatial process, however, the goal is to improve the utilization rate of urbanised land and space.

Spatially, intensification can be either intensification of built form itself or of activities within the town or city. It can be new development, on either previously undeveloped or derelict land, or redevelopment of existing buildings at higher densities. It can also take the form of alterations to the existing fabric; for example, sub-division, conversions, additions and extensions.

Higher urban density

By living in closer proximity to each other, cities can accommodate far more of the world's population, use less energy, concentrate goods and services and move from one place to another more efficiently. The benefits of higher-density development can be explained from four aspects.

Firstly, it has been approved by researchers, such as Miller & Shalaby (2000:23-24, 42) and Cervero (1998: ch. 3), that as dwelling unit density increases above a certain threshold, automobile usage and total distance travelled by car per household decrease in favour of transit, walking, and cycling.

Secondly, increased intensity of human activity and 24-hour use of public spaces can promote safer urban environments through "eyes on the street" and more economically dynamic retail environments.

Thirdly, the higher density of new development, the lower amount of rural land converted to urban use and the greater opportunities to preserve agricultural land and environmentally sensitive areas.

Fourthly, more people accommodated in one urban block has been shown to reduce capital costs for infrastructure which means the cost of constructing distribution systems such as pipes and wires will be lower with shorter cover distance.

Mixed use development

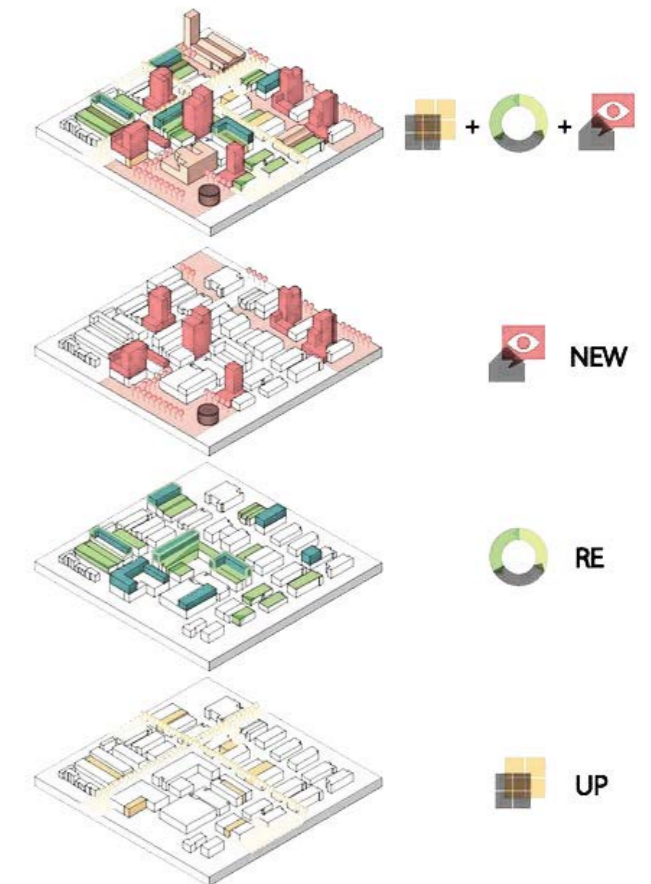
Mixed-use development is a type of urban development that blends residential, commercial, cultural, institutional, or entertainment uses, where those functions are physically and functionally integrated, and that provides pedestrian connections. Community is the historically typical pattern of mixed use development. Mixed-use, closely-knit neighbourhoods ordered around streets and squares are the archetypal human settlement. Popular inner neighbourhoods, smaller cities, market towns and historic villages are often slowly evolving communities where the church, the pub, the village street and its shops, the green, the square, the cemetery and the bus stop make up a pattern of public spaces that help people organise their lives in a socially and spatially-connected way.

With industrialisation as well as the invention of the skyscraper, the mixed use development can be practiced in different scale, from the single building to city region. These three principles are geared towards providing a guiding framework and ensuring that patterns of mixing which will be economic while maintaining conditions of health, safety and general amenity of the urban environment are developed.

Firstly, land-uses in the mixed pattern should be compatible, complementary and harmonious to provide a high degree of maximisation to the urban space economy and convenience to the residents of the city.

Secondly, the horizontal and vertical dispositions and land-use combinations of various categories that are functional and practicable to develop within the urban setting, should be carefully adapted and applied.

Thirdly, sites to be planned for mixed land-uses should be adequate to contain the multiplicity of uses intended and to accommodate ancillary requirements for circulation, parking and storage.



Chapter 3. METHODOLOGY

3.1 PROBLEM FIELD

3.2 PROBLEM STATEMENT

3.3 RESEARCH QUESTION

3.4 AIM

3.5 METHODOLOGY

3.6 EXPECTED OUTCOME

3.7 CONCEPTUAL FRAMEWORK

Introduction

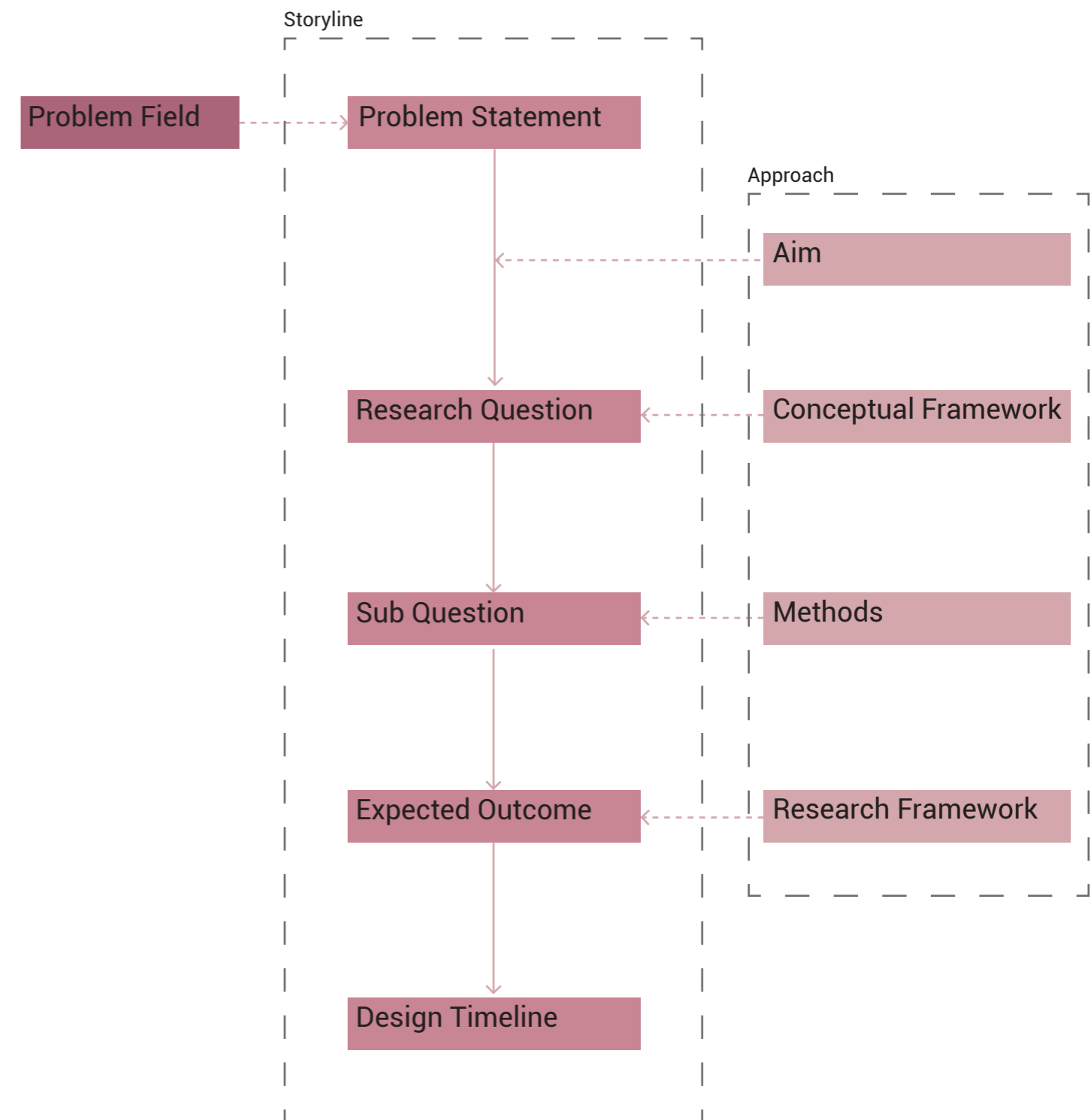
In Europe there is a growing concern about the development of future urban form, especially deconcentrating of urban land use in the form of urban sprawl. Urban sprawl is synonymous with unplanned incremental urban development, characterized by a low-density mix of land uses on the urban fringe. Historically, urban sprawl was caused by population growth and transformation from rural population to urban population. In recent decades, the relationship between cause and effect has become more complex. It becomes the outcome influenced by the mobility system, urban markets, and social structure, etc (which is explained in theory chapter).

The consequence of urban sprawl may have both positive and negative impacts; however, negative impacts are usually more highlighted because the sprawl is often uncontrolled or uncoordinated. In Europe every year more than 1000 km² of land are taken for housing, industry, transport or recreational purposes. Such long-term changes are difficult or costly to reverse, and nearly always involve trade-offs between various social, economic and environmental needs. To live with the limits of urban space, the Seventh Environment Action Programme (7th EAP) includes an objective that land is managed sustainably and promotes the objective of no net land take by 2050. To avoid urban sprawl, many interpretations has been practiced mainly concluded as smart growth, compact city, suburban retrofit, urban redevelopment, etc.

To face the urban sprawl challenge, besides urban planning strategy, technology innovation can also be

the answer. Automated vehicle is about to hit the road which will really transform our lives. Because it means for the first time in history, mobility freedom will be available for everyone, everywhere. It will affect the daily life of residents and change the form of the city. AVs are verified to offer mobility benefits to people who are unable to drive at present, ease the congestion, save the financial loss, and release street space. AVs imply changes to road infrastructure and the placement and development of homes and businesses. However, it may also bring negative effects such as excessive dependence on automated mobility and accelerate urban sprawl. The world is already on the way to AV future, as urban planners, we should prepare for these challenges and design for the sustainable vision.

The design site of the project is Almere. The proposal of the project can be concluded from two aspects, on the one side to redesign the street space will the influence of automated vehicles, on another side to practice smart growth strategy in Almere city to improve urban density and control urban sprawl. It is also inspiring to combine street design and urban design to test if smart growth strategy can be used to enhance the positive effect and eliminate the negative effect caused by automated vehicles.



Problem field

Just over a century ago, the mass production and rising affordability of the private automobile contributed to massive changes in transportation networks, individual travel behaviors, and the built environment (Chapin, Stevens, and Crute 2017). The private automobile provided greater mobility, allowing drivers and their passengers to escape dense, complicated, and polluted urban centers. In the following decades, federal, state, and local governments supported this increased mobility through massive investments in road networks, state highways, and ultimately a massive interstate system that allows for high-speed travel over long distances. This increased mobility brought about long-term changes in the built environment as well. At the metropolitan level, reduced travel times and costs contributed to the urban sprawl.

The consequences may have both positive and negative impacts. The positive impacts include higher economic production, opportunities for the unemployed and better services and lifestyles. There are also severe negative impacts and generally be admitted override the positive sides. Such as inflated infrastructure and public service costs, energy inefficiency, disparity in wealth, impacts on wildlife and ecosystem, loss of farmland, increase in temperature, loss of farmland, poor air quality, impacts on water quality and quantity, impacts on public and social health. Besides the environmental damage, during the sprawl the suburban is used to be the complement area to the inner city. With the suburban growth, the development model may reduce social interaction, weakening the bonds that underpin a sustainable city (Brueckner, 2000).

In AMA, there are different kinds of sprawl pattern. Almere is a new town built as the dormitory town which has a negative public image as a suburban low-rise populated solely by small families where there is nothing to do. The city lacks its own identity and vitality. And the city is highly dependent on Amsterdam on economy and social activity. The commuting between Amsterdam and Almere is one of the busiest commuting routes in the Netherlands. The pattern of one-way commuting causes the serious traffic congestion on A6 and the second ring of Amsterdam, and air pollution in center of Amsterdam. The future of Almere should be planned to improve social identity and economic vitality without sprawl.



Problem statement

Urban sprawl is synonymous with unplanned incremental urban development, which causes the inefficient usage of land and soil resource, traffic congestion, air pollution, etc. The negative impacts of urban sprawl have direct effects on the quality of life and sustainability of future development. With the pressure of population growth, as the economic driver, the planning vision of Almere still shows the sprawl trend. To embrace the urban growth and avoid urban sprawl, efforts need to be made to live within the limits of urbanized land. To a large extent, automated vehicles will change both transportation system and travel behavior which can either promote or ease sprawl speed. With the liberation of transportation ability, city is likely to expand further. However, the impact of automated vehicles can contribute to redevelopment both on street and urban block. The urban transformation in the era of automated vehicles need to be guided and controlled to generate to sustainable urban development.

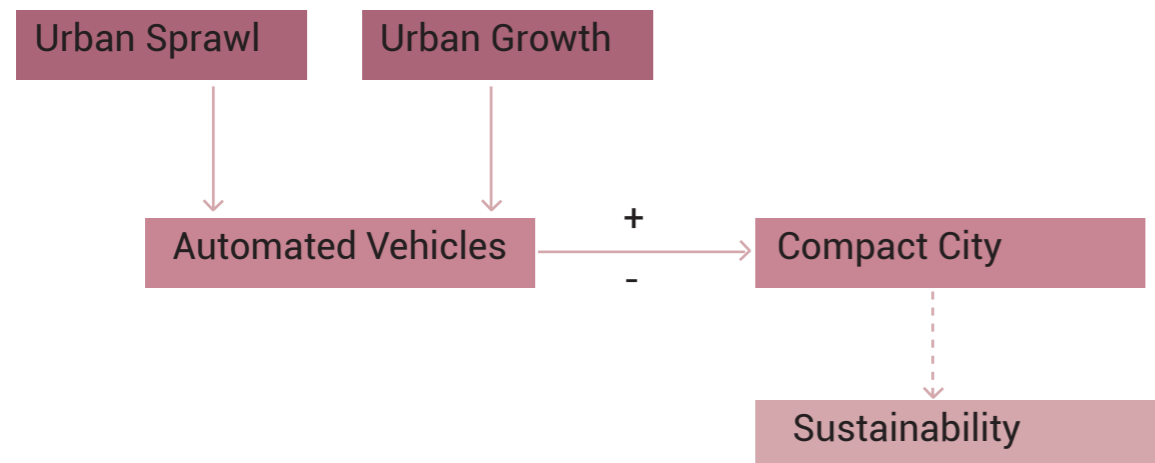
Aim

The final goal of the project is to embrace urban growth and avoid urban sprawl. The project aims to design a compact Almere in the era of automated vehicles and contribute to improve living quality and which can be described from three aspects as below:

Research aim – explore the theory and strategy of compact city. Since automated vehicles may bring the positive effects and negative effects, compact city can be applied to reinforce the positive and eliminate the negative.

Analysis aim – combine data and space. During the whole process, the project will explore the different ways to practice the combination (data and space) in understanding the current situation, imaging the future challenge, and testing urban design.

Design aim – design the compact Almere. On street level, the project will explore the impact of automated vehicles on the built environment and redesign the street space. On city level, the project will focus on the redesign of urban block to improve the space utilization rate.



Research question

How to design a **compact Almere** in the era of **automated vehicles** and contribute to **urban sustainability**?

proposal

trigger

aim

Current problem: urban sprawl

1. How to evaluate the current urban sustainability of Almere, in the context of sprawling Amsterdam?

Future pressure: urban growth

2. How to measure the urban growth pressure of Almere through statistical and spatial analysis?

Trigger: automated vehicles

Proposal: compact city

3. How will automated vehicles impact the transportation system and urban block pattern in Almere?

5. What is compact city and how can it impact the development of automated mobility system?

4. How can automated vehicles contribute to redevelopment opportunity in street and city scale?

6. How can automated vehicles be applied to improve the land use efficiency and contribute to urban sustainability?

Methodology

Current problem: urban sprawl

1. How to evaluate the current urban sustainability of Almere, in the context of sprawling Amsterdam?

Method: literature review, mapping

Content: Since the initial motivation of this project is urban sprawl problem, I have to fully understand the causes and consequence of urban sprawl. This part can be done through literature review. Once the theory base of urban sprawl is completed, it can be used as the guidebook to better understand the historical development and current city role of Almere in the context of Amsterdam expansion.

Besides the theory research, spatial understanding is needed. This part can be achieved by group mapping. The group atlas collect information from AMA and present in three aspects: infrastructure and mobility, socio-economic and environmental condition, and physical environment. It provides the initial fully understanding of AMA and helps to stimulate the further research direction. The project traffic sustainability

Future pressure: urban growth

2. How to measure the urban growth pressure of Almere through statistical and spatial analysis?

Method: data analysis, mapping

Content: To understand the future growth pressure, efforts need to be done both from data analysis and spatial measurement.

- Population amount: number of residents live in Almere including historical data of gender, age, nationality, physical condition, career, marriage, income, etc.

- Population density: there are two kinds of density in the project. Municipal density, which is operated based on full-scale including natural land, water area, etc. Community density, which is operated based on community range merely focus on built environment.

- Population growth: number of residents will increase in the future. The project compares the population prediction report from Almere government, AMA municipality, and the future scenario of Netherlands to come up with the most likely population growth curve.

Trigger: automated vehicles

3. How will automated vehicles impact the transportation system and urban block pattern in Almere?

Method: literature review, scenario building, mapping

Content: The implementation of automated vehicles is the futuristic trend, which means the impact is the uncertain factor. To achieve the realistic planning as much as possible, literature review and scenario building is both needed. The literature review is done on the possible impacts of automated vehicles on automobile dependency, street design, parking pattern, travel behavior, etc, as the ideal element. When applied on the real city system, the problems such as national policy, ownership, accessibility, insurance should be considered. Despite the political issue and social acceptance, the scenario of this project is built on the issue of ownership (public/ private) and accessibility (limited/ unlimited).

However, the literature review and scenario building can provide the general knowledge not specific for Almere. Mapping is needed to understand transportation system and street hierarchy of Almere, then possible impacts can be draw. The spatial changes need to be tested and modified.

4. How can automated vehicles contribute to redevelop opportunity in street and city scale?

Method: literature review, scenario building, mapping, field trip

Content: The impact of automated vehicles will be fully analysed in four scenarios. This sub question is in the context of "best" scenarios (public ownership & limited accessibility). In this scenario, the impact of automated vehicles is controlled by government, and can be applied in limited urbanised area to avoid uncontrollable route sprawl.

The spatial redevelop opportunity will be explored in different scales, inspired from literature study, field trip and tested by mapping, to suit the specific Almere condition. Using automated vehicles as the trigger to define redevelop site and space, then the design strategy and activity strategy need to be further defined with the functional planning of Almere. This need to be combined with the proposal of compact Almere design.

Proposal: compact city

5. What is compact city and how can it impact the development of automated mobility system?

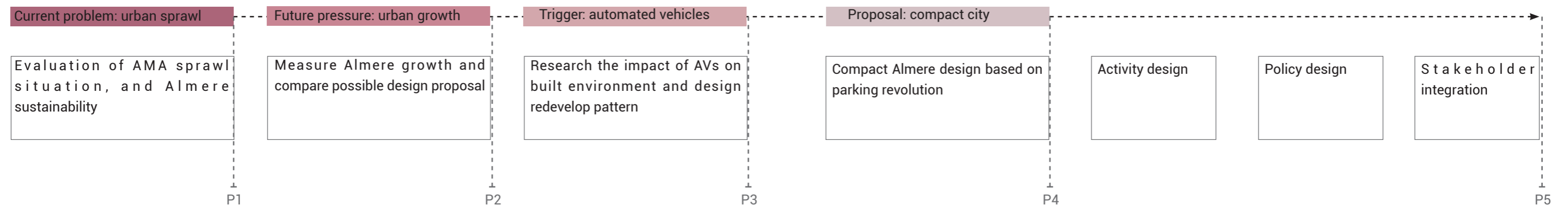
Method: literature review, mapping, design, field trip

Content: This sub question is committed to research on the compact Almere design, which is the extension from scenario building (sub question No.3). The develop principle and design strategy for compact city need to be fully understand and researched. The work process is roughly divided into the following steps. Firstly, the project will conclude from the emperical experience to sumary the compact design methods. Secondly, Almere mapping will be done to analyze the street system, transportation system and urban pattern. Thirdly, the research will combine the design site and space (from sub question No.5), from micro to macro, explore how can the automated vehicles contribute to the compact urban space. After which, from macro to micro, reflect the urban design on the street scale and revise the automated mobility system.

6. How can automated vehicles be applied to improve the land use efficiency and contribute to urban sustainability?

Method: mapping, design, policy design

Content: This sub question represents several aspects to further define the effective urban planning. In terms of design, it includes the final adjustments and experience summary. In terms of policy, the stakeholder analysis will be included. Considering about the function position of the design, the duration of implementation, policy development and the involvement of stakeholders, the whole design projects will be arranged in the timeline from short-term, medium-term to long-term proposal.



Expected output

As explained previously, the project will focus on street design and urban design.

Design strategy – anti-sprawl strategy. Based on the current compact city strategy, the anti-sprawl strategy aims to explore redevelopment opportunities and improve space utilization efficiency, in the era of automated vehicles.

Street design – automated mobility. The project will come up with new hierarchy and design for street based on automated transportation system. Traffic activity, social activity and leisure activity will also be included.

Urban design – compact city. On city level, there will be the urban design focus on redevelopment of urban block to improve urban density and space utilization rate. Urban sustainability will be improved from three aspects: traffic sustainability, social sustainability, and living sustainability.

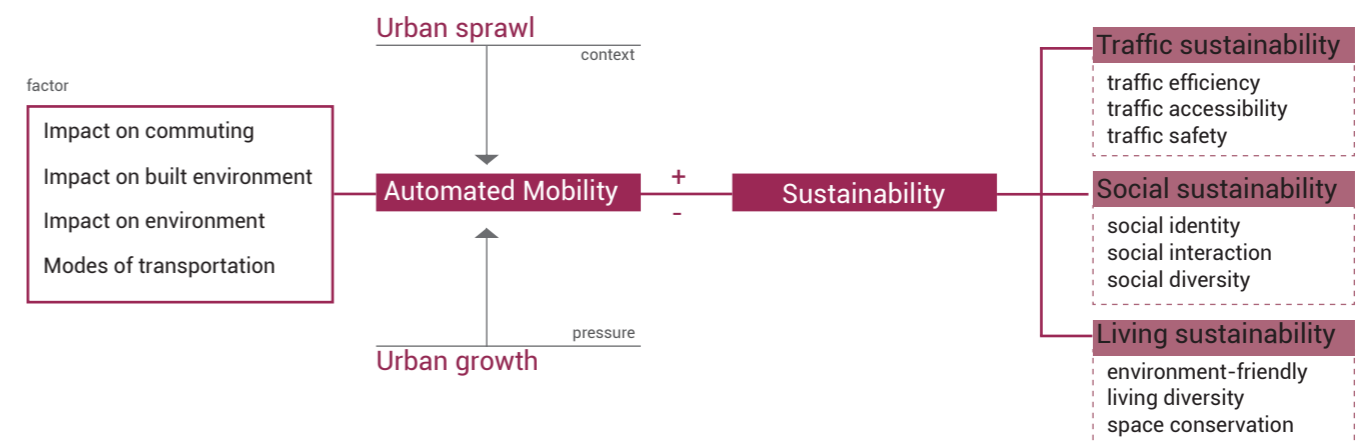
Conceptual framework

The project will improve the urban sustainability from three aspects.

Traffic sustainability – With automated vehicles, the street space will be released. There will be less vehicles on the street, so the traffic space will decrease. Traffic will be more efficient. The vehicles are system control, traffic accident caused by human mistake will decrease. Since the road will be safer, traffic will be more accessible for disabled people, the elderly and children.

Social sustainability – Street can be activated with the help of automated vehicles. Street space can be reused for social activity and entertainment activity. The linear space along street can be integrated and redeveloped as park and green belt, etc. There will be more opportunities for social interaction, thereby generate the sense of belonging.

Living sustainability – followed smart growth strategy, the project will focus on urbanized land and redevelopment design. On large extend, the design strategy will concentrate on mix land use and compact building design. The urban density and space utilization rate will increase so as the service efficiency.



Conclusion

The project aims to control urban sprawl and embrace urban growth by applying automated vehicles on street level and smart growth strategy on city level. Compact city strategy will be used to reinforce the positive effects and eliminate negative effects of automated vehicles. The final design outcome can be street redevelopment and urban block redevelopment to achieve compact city and contribute to urban sustainability (traffic sustainability, social sustainability, and living sustainability).

Several kinds of methods will be practiced during the whole project, such as literature review, mapping, group work, field trip, data analysis, scenario building, policy design, and urban design.

However, the possible development level of automated vehicles should also be taken into consideration. The further research can be developed towards using qualitative analysis to explore the acceptance for automated vehicles and possible amount. Combining the quantitative analysis and qualitative analysis, the uncertainty and decision-making for design proposal can be limited, tested and verified.

Limitations related with ethical aspects for automated vehicles are difficult to overcome. For instance, software plays a crucial role for the control of self-driving cars, the security for big data is always the key discussion topic. The concern may influence the public acceptance of automated vehicles and promotion process. Apart from this, the transparency, quality assurance process, and reliability are possible factors influence the development of automated vehicles, but these are difficult to evaluate.

Chapter 4. AUTOMATED VEHICLES

4.1 INTRODUCTION

4.2 DECREASE OF CAR OWNERSHIP

4.3 AUTONOMOUS PARKING

4.4 FREE UP PARKING SPACE

4.5 CONCLUSION

Introduction

This chapter will lay out some of the major opportunities and challenges that will shape AVs' impacts on cities and the appropriate policy responses to them. Then detail the effects AVs are expected to have upon the built environment. This report identifies several major opportunities AV technology provides to improve the form and function of our communities and to better the lives of those living in them. These opportunities include the reconstruction of land use functions related to urban transportation, less parking space need, and street transformation.

This rapidly advancing technology offers the promise of increased safety for users and greater efficiency in systems operation. AVs also allow riders to be productive and entertained during their travel times, provide mobility to populations that are unable to drive (children and the elderly), and will almost certainly contribute to changes in vehicle ownership patterns. They offer the potential to launch a wide range of new mobility options that serve targeted populations ranging from urban communities to isolated lower-income populations.

Alongside this potential, AVs (and artificial intelligence in general) offer possible challenges. They could lead to changes in historical housing settlement patterns, causing sprawl to spread farther into exurban areas. In a rapidly aging society with growing social and economic disparities, they may exacerbate spatial and cultural separation.

In a word, it is for sure that AVs will make huge difference for the future urban form. It is our mission to fully understand the potential impacts and prepare for transforming to a sustainable future.

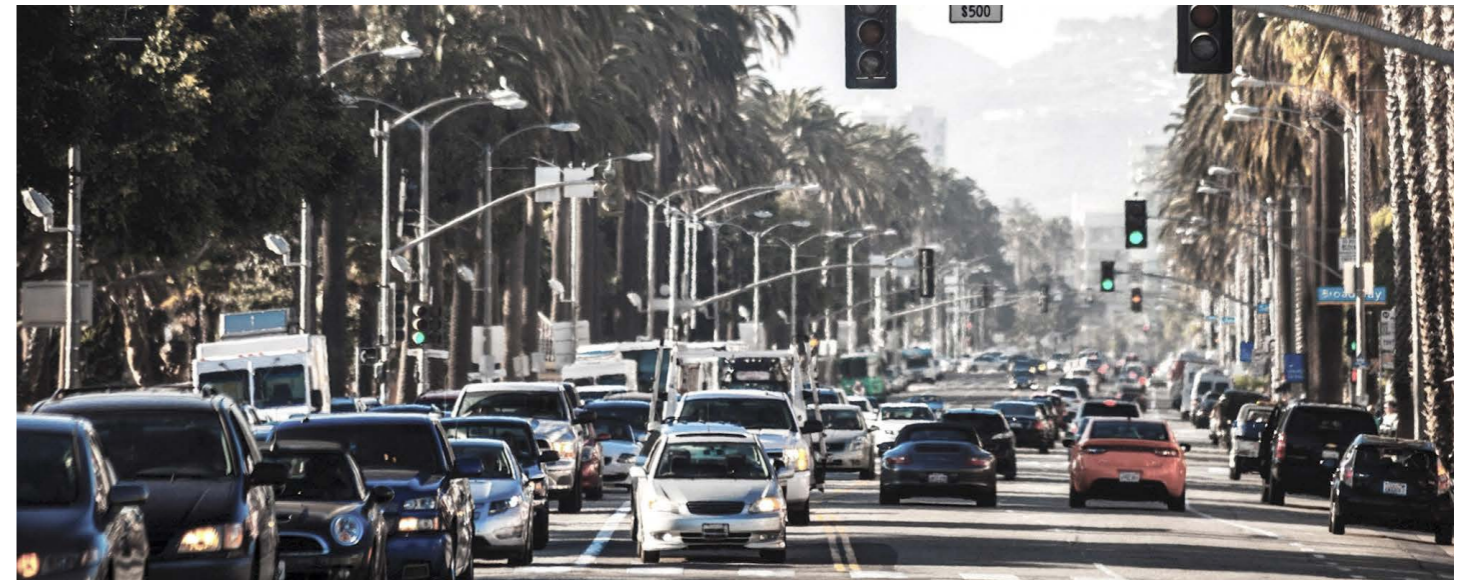


Figure : current street with conventional vehicles
(source: <https://www.arcadis.com/en/global/arcadis-blog/nate-cherry/future-city-la-part-i-mobility/>)



Figure : future street impression with automated vehicles
(source: <https://www.aurecongroup.com/expertise/urban-mobility-integrated-transport>)

Future world with AV --- Urban Sprawl

The size of urban city is highly related to transportation innovation. Historically, from horse-powered transport to internal-combustion (such as automobile , train, and airplane), urban system can be totally reshaped with increasing travel ability. With automated vehicles, cities may sprawl even further. It can be explained in two aspects, efficient traffic and longer travel time.

Existing planning policies are based on our current transport systems. Green-belts, for example, are designed to reduce urban sprawl by restricting development within a buffer zone around an urban area. However, with automated vehicles, traffic will be much more efficient, which means people can travel further with same travel time. Another possible impact is longer travel time. AVs will make people free from car driving and the useless time spent in traffic jam can be valuable such as study, enjoy music, relax, and play games.

Driverless cars will make it much more easier to live outside the green belt while still working inside. So these loops of green are in danger of becoming a thin layer with ever-spreading suburbanisation.

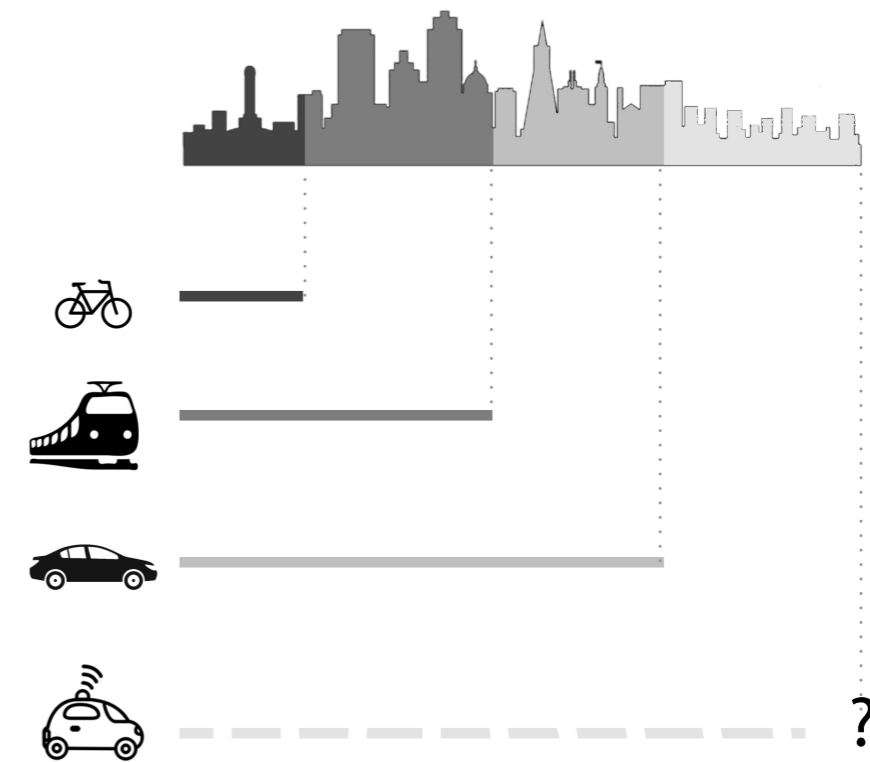
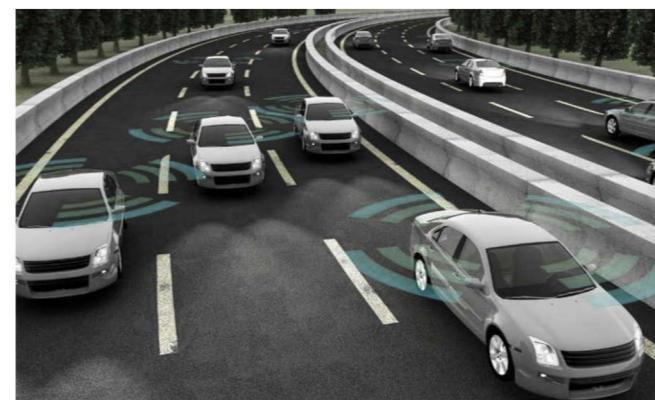


Figure : Urban size with different travel modes



Efficient traffic



Travel time increasing



Future world with AV --- Compact city

The shift to AV technology will change the physical layout of urban and suburban areas and may lead to a compact future.

Widespread adoption of AV technology will likely have a substantial impact on street design, with the potential for narrower pavement widths and more efficient vehicular rights-of-way. Autonomous vehicles are expected to be smaller with the ability to drive more precisely (Fagnant and Kockelman 2014; Litman 2018). AVs are expected to remove the need to design roads and lanes to account for human error. AVs' ability to move more precisely than human-operated vehicles will enable roads to be designed with narrower lanes.

Existing parking lots and requirements will see the most obvious changes from a shift to AV. There will be no need for municipalities to require a minimum number of parking spaces if the population does not depend on privately owned automobiles for mobility, opening up a realm of possibilities for use of land that is currently occupied by surface parking.

Potential impacts of AVs combined with other technology trends may also transform land use related with conventional vehicles such as gas station.

There is a great deal of concern that AVs may encourage sprawl, but there is also some optimism that they may provide potential opportunities for "sprawl repair." New urban/suburban districts may be more efficient for transit, energy production/distribution and stormwater management.



(1) mass transit street space



(2) massive parking space



(3) land use for conventional vehicles

Figure : urban elements can be transformed with AV technology



(1) vision of AVs on street
(source: New transportation hub and development in amsterdam. UNStudio)

Figure : future vision of aotumated vehicles in city



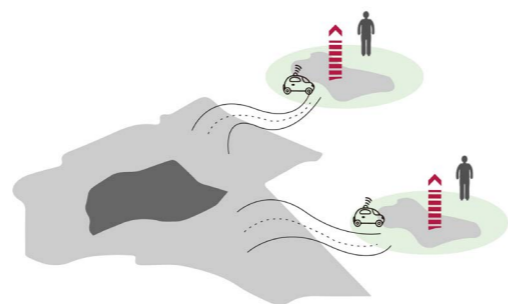
(2) vision of AVs on plaza

Scenario building

All in all, there is a great deal of concern that AVs may encourage sprawl, but there is also some optimism that they may provide potential opportunities to repair sprawl. In order to achieve a more scientific research, scenario building is needed to fully understand the possible automated era to move forward to the "best scenario." Forward-thinking cities and regions with the impact of automated vehicles could create avoid the negative spatial impacts and guide the sustainable development of cities.

As analysis shows, there are both disadvantages and advantages of possible compact future and sprawl future in AV era. Considering about the Europe policy (no net land take by 2050), the project aims to research how can automated vehicles can contribute to the compact future and urban sustainability.

URBAN SPRAWL



decrease in
biodiversity



increase in
infrastructure investments



increase in
automobile dependency

Figure : Possible impact of urban sprawl in AV era

URBAN SPRAWL



contribute to
environmental sustainability

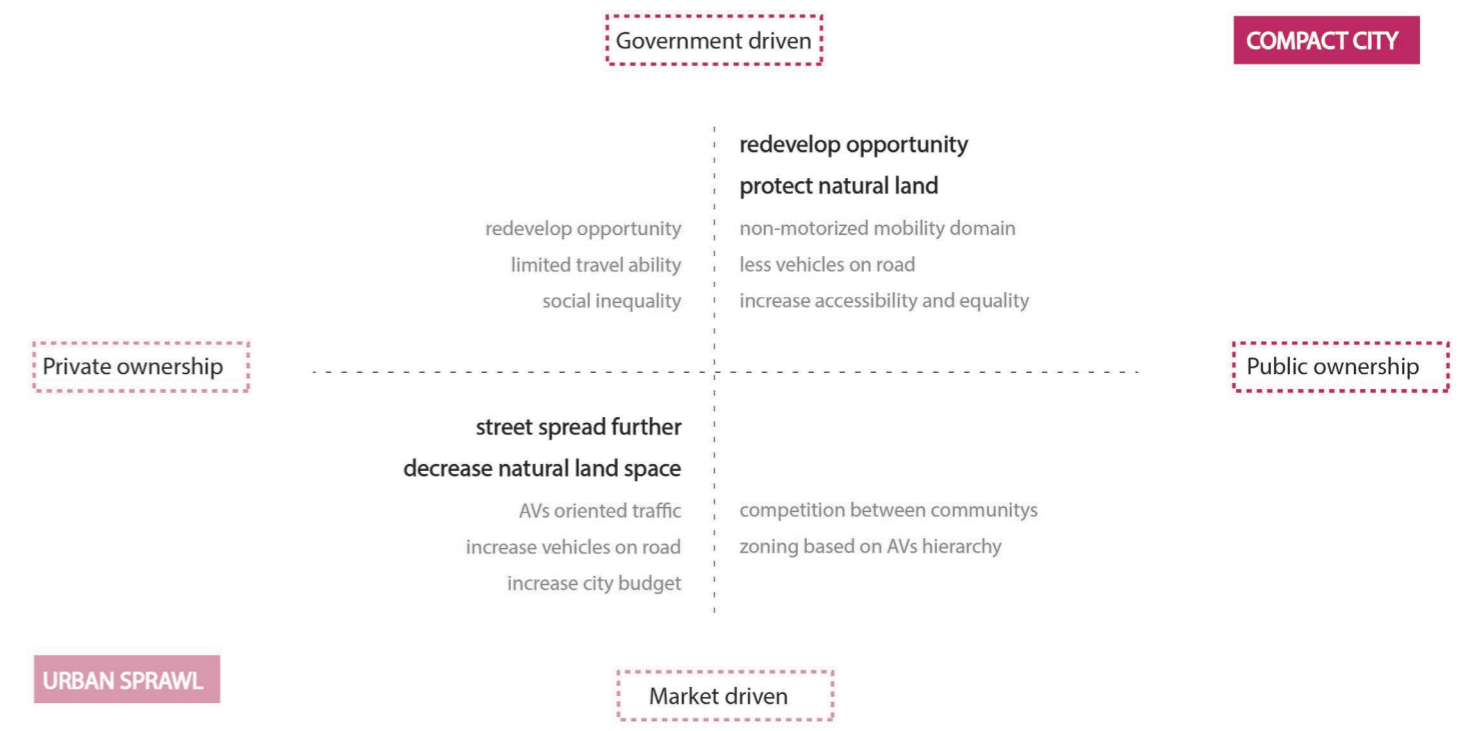


contribute to
non-motorized mobility



contribute to
public space quality

Figure : Possible impact of compact city in AV era



Decrease of car ownership

Owning, maintaining or even simply driving a car has already become almost prohibitively expensive and inconvenient especially for younger generations. Meanwhile, older generations are also realizing that their cars are stationary, parked for more than 90% of the time. With so many urban households only using their cars a few times a year, the costs of maintaining the vehicle, per trip, shoot up. There are huge financial savings to be made in switching from being a car owner to a shared car renter/user, sharing the costs with fellow users.

Mobility as a Service (MaaS) is a new mobility business model, relying on a digital platform that integrates various forms of transport services into a single on-demand service. Such a service would mark the shift from privately-owned vehicles, from the idea of owning a means of transport. Instead, transport would be

consumed, as needed, as a service. Ideally, this would lead to fewer cars on the road, meaning less congestion and with a much a smaller demand for parking, freeing up space in cities for new development.

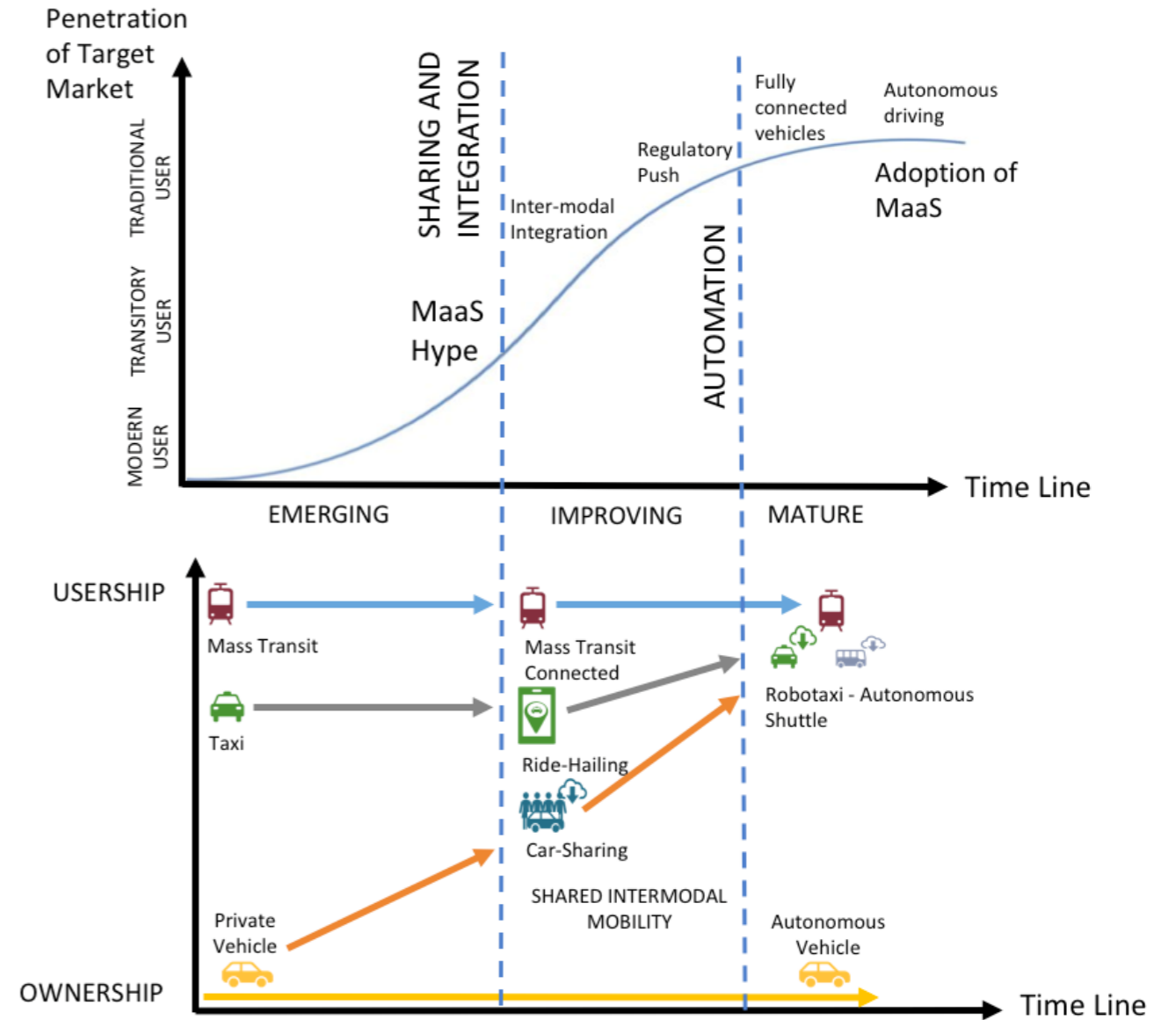
But even in a market with a high rate of MaaS uptake, owning a private car could still remain a popular choice, particularly in underserved areas such as urban suburbs and rural areas. However, with expensive autonomous vehicles coming into the game, fewer people will be able to afford to have private ones. For this reason, many people giving up their own old private cars will probably switch to shared mobility services.



The only available option today



Tomorrow's freedom of mobility



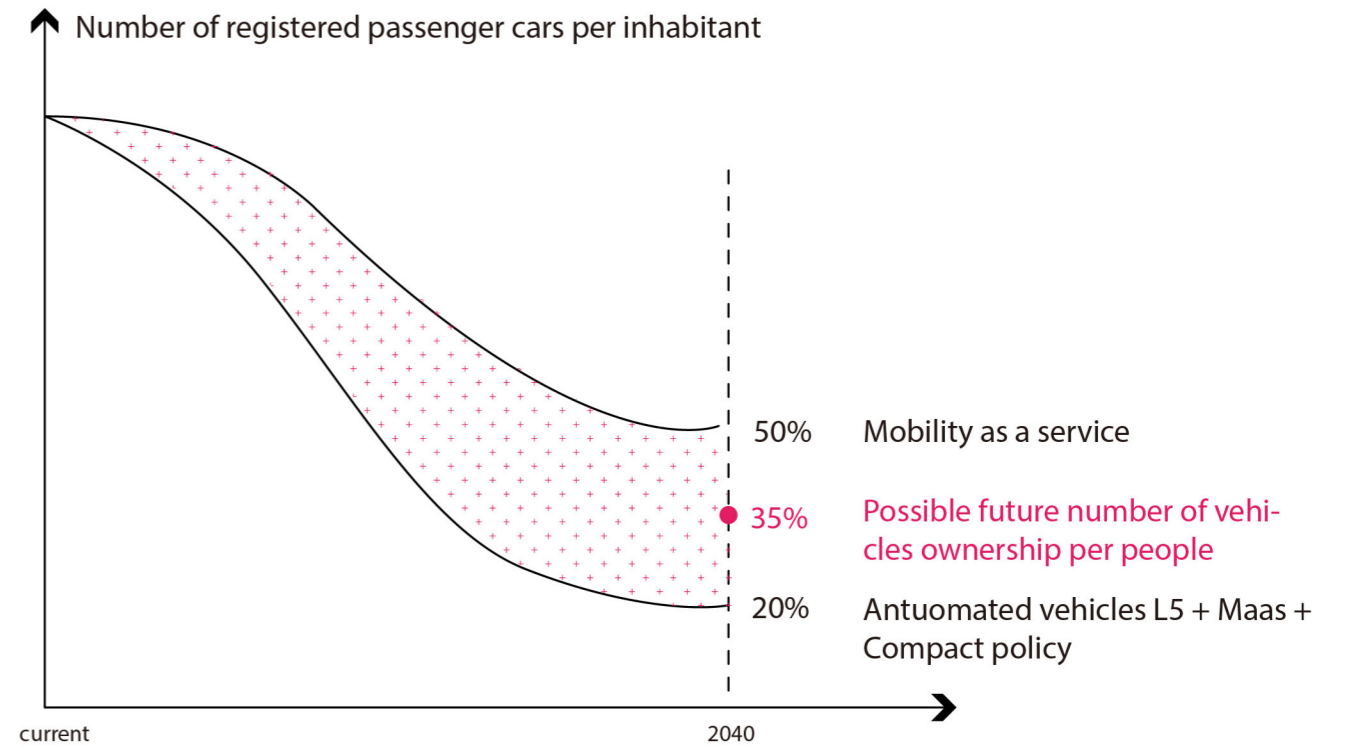
Source: Serra, A., Verstappen, J., Devaux, V., & Bax, L. (2018). FROM CAR OWNING TO RIDE-SHARING: HOW MAAS COULD CHANGE THE WAY WE TRAVEL. (Bax & Company).

The mobility as a service is a business model has been functioning in reduce vehicle ownership. With the application of autonomous vehicles, people can be released from driving. Since people who cannot drive would be able to join the sharing travel. At the meantime, people can enjoy a more valuable time during travel in AVs, and by digital system, AVs can travel more efficient than human drivers. All these factors have been proved by researchers that applying AVs in MaaS model would bring a huge drop in vehicle ownership almost up to 80%. (RethinkX,2017)

With research and exploration, the project came up with the possible range of vehicle ownership in 2040. MaaS would transform half the private ownership into usership. Taking autonomous vehicles into consideration, the number would keep dropping down to more or less 20%. To make the project more scientific convincing and transferable, the future AV ownership would be possibly decreased to 35% than the current number.

"With AVs in MaaS model, fewer cars travel more miles, the number of passenger vehicles on American roads will drop from 247 million to 44 million, opening up vast tracts of land for other, more productive uses."

— RethinkX, 2017



source: A RethinkX Sector Disruption Report (2017)



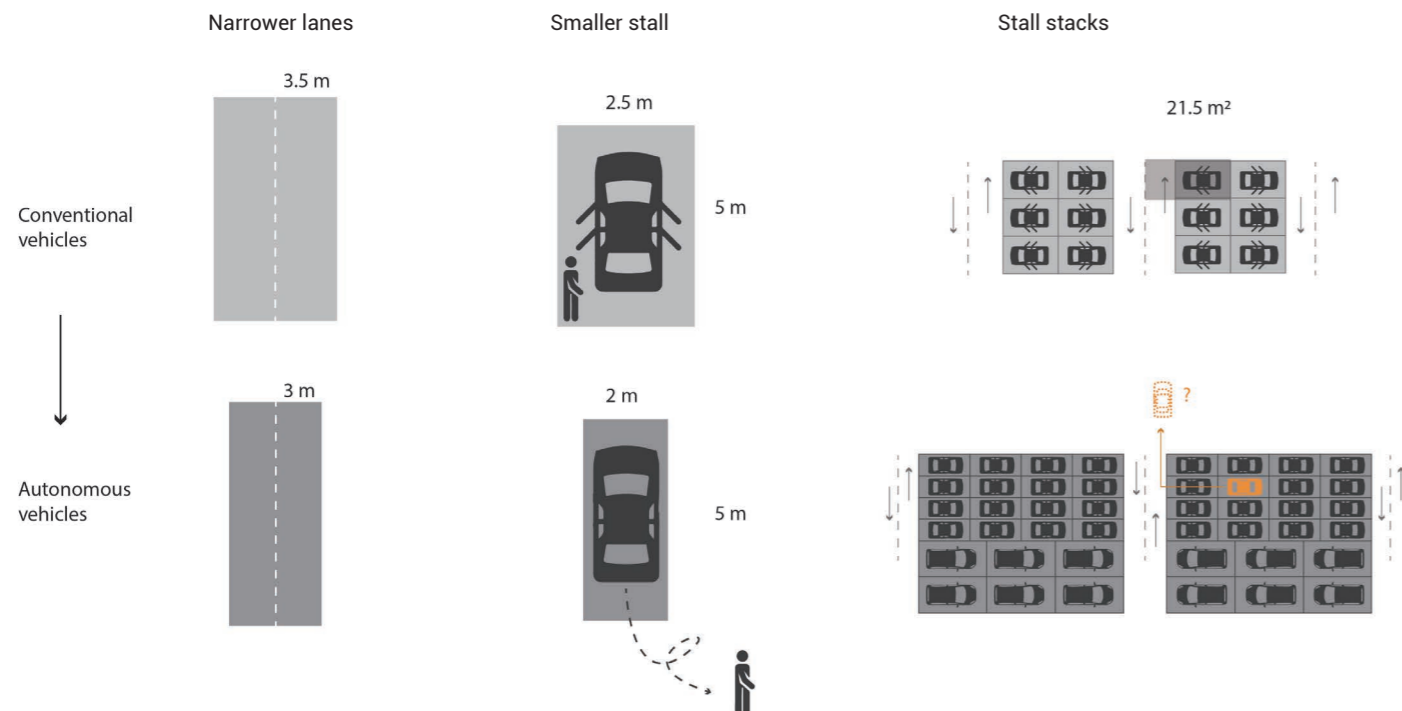
Current car ownership * 35% = Future AV ownership

Autonomous parking

- Smaller parking stall

The autonomous parking system has a great impact on parking space efficiency. When people park cars, they need space to open the doors and walk away, but driverless cars do not need such space. What needs to be mentioned is the vehicle designer are working on smaller AVs, but it is hard to assume the exact size. To make the project more transferable, AV parking stall would have a narrower width but stay in same length. In real word, the AV parking space can be even less. Existing layouts divide the parking lots into several islands and roads. The islands are used to store vehicles while the roadways separate the islands and allow vehicles to be manipulated while looking for the ideal location. To ensure that no vehicle gets blocked, islands had less than two rows of vehicles in traditional parking

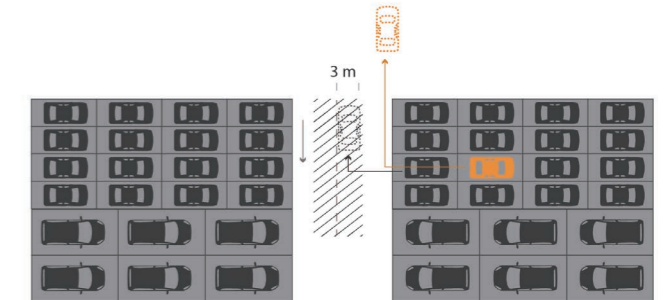
lot design, which causes the waste of space. With AV technology, however, the islands can have more than two rows and the roadways can be narrower. Driver-less AVs drop off their passengers at the parking entrance (or at a designated drop-off zone) and drive themselves to a spot chosen by the autonomous parking operator. When AVs reach the parking spot, they would be able to park themselves in stacks. In this automated parking system, the average space per vehicle is estimated to decrease by an average of 62% and a maximum of 87% (Nourinejad, 2017).



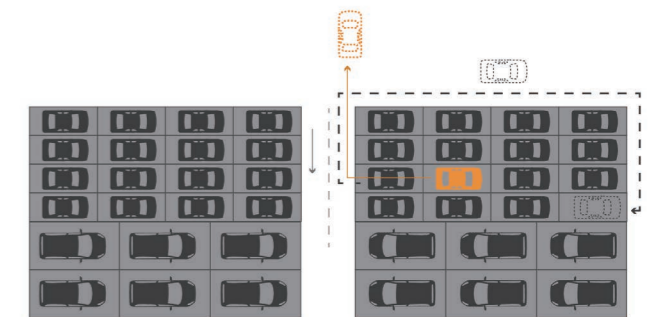
- Autonomous parking system

An essential strategy to increase car-park space efficiency (in addition to removal of elevators, etc.) is to stack the AVs in several rows, one behind the other. While this type of layout reduces parking space, it can cause blockage if a certain vehicle is barricaded by other vehicles and cannot leave the facility. To release barricaded vehicles, some researchers came up with the parking operator that the AVs can automatically relocate to create a clear pathway for the blocked vehicles.

To explore the possible size for AV stall, the project came up with two extreme autonomous parking system. One is designed to have a temporary stand lane with 3 meters. When the block AV needs to get out, the previous AV would first move to the standing lane to clear the way out. In this situation, the average AV parking space is 16 square meters. Another is designed without the standing lane. AVs can cruise around the island to park in another available spot to have a clear pathway for blocked vehicles. The average parking space is about 12.5 square meters.



Type 1. With temporary standing lane
- 16 m² per AV parking stall



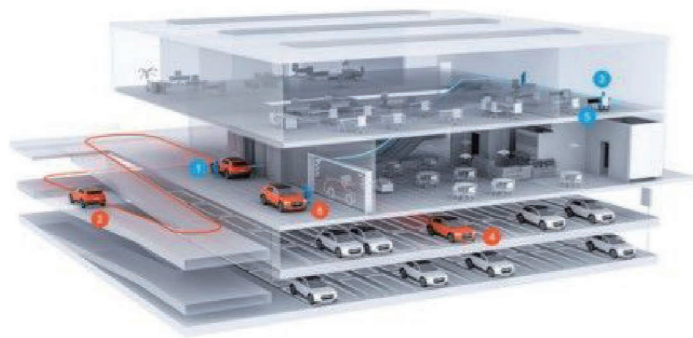
Type 2. Cruising the island without temporary standing lane
- 12.5 m² per AV parking stall



Source: <http://www.arrowstreet.com/portfolio/autonomous-vehicles/>

"Driverless vehicles storage is packed in hyper-efficient rows on the top level. Garage designed for autonomous for self-parking vehicles can substantially increase their efficiency and use 60% less space."

— Assembly Row, Somerville, MA



"The garage is expected to reduce parking square footage by 26%, with a mix of conventional and driverless cars. When the garage is used exclusively for driverless cars, parking square footage can be reduced by up to 60%."

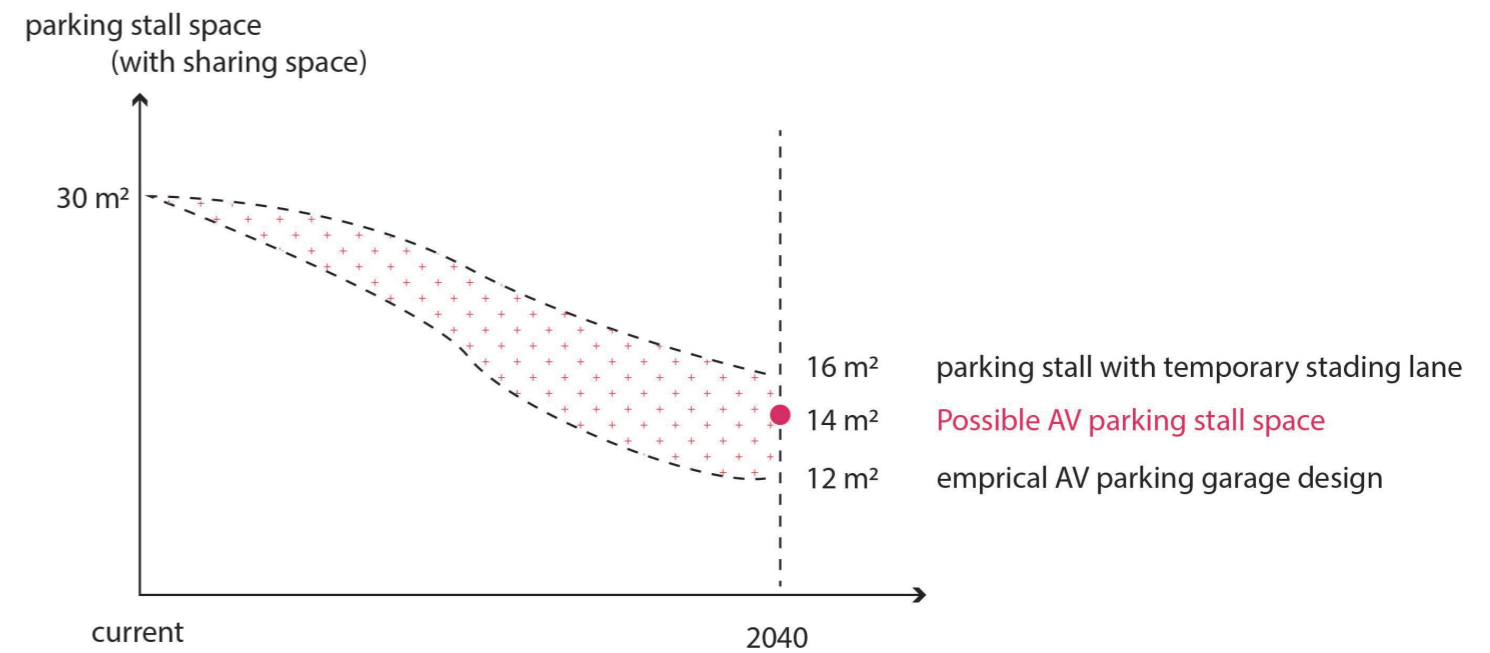
— Assembly Row, Somerville, MA

Source: Driverless future. A POLICY ROADMAP FOR CITY LEADERS

- Size prediction for AV parking stall

The project also looks into empirical evidence for future AV parking garage design. With the high parking efficiency, the possible parking space can be reduced by 60%. Taking the standard parking space as 30 square meters, the possible AV parking space can be as less as 12 square meters. Combining the research and original

exploration for AV parking stall, the project came up with the possible space range between 16 square meters and 12 square meters. The project took transferability into consideration, the possible AV parking stall is 14 square meters.



14 m² per AV parking stall

Free up urban space

Based on the decrease of vehicle ownership and save of parking space, it is for sure that automated vehicles will give us the exciting chance to free up the urban space and generate to new urban development. There is a big chance that we can take this chance to deal with the current urban risks.

- Ecology disaster

The decrease of vehicle ownership and reuse of parking space (if transform into green space) could dramatically reduce the Urban Heat Island Effect (UHIE) within cities, which in turn can reduce the need for air conditioning inside the vehicles and the CO2 emissions accompanying it, again reducing the overall heat produced. A reduction in the UHIE also means a more pleasant environment for pedestrians and cyclists, with safer, narrower streets promoting urban walkability.

- Urban health / Urban growth

If driverless cars free up space and we took the opportunity, we could see a new focus on beautiful and high quality public space. The parking lot can be transformed into valuable public function to provide psychological relaxation and stress alleviation, stimulate social cohesion, support physical activity. The new construction can be added such as housing project which can release the pressure of urban growth.



- Free up parking lots

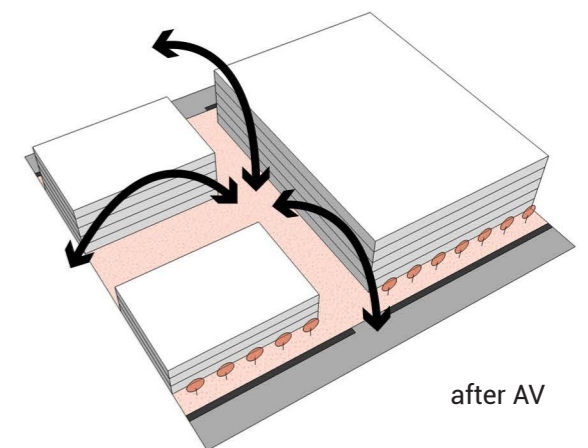
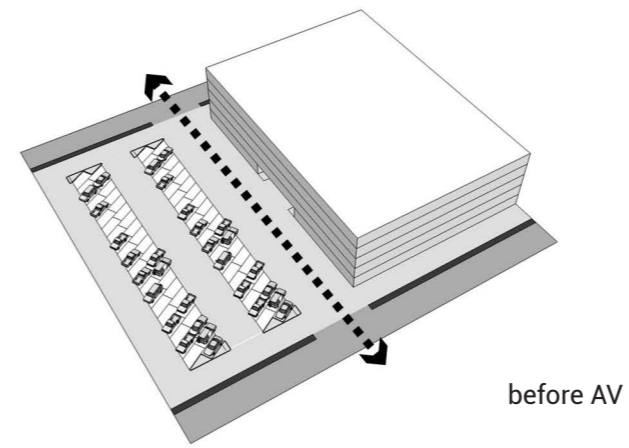
Existing parking lots and requirements will see the most obvious changes from a shift to AV. There will be no need for municipalities to require a minimum number of parking spaces if the population does not depend on privately owned automobiles for mobility, opening up a realm of possibilities for use of land that is currently occupied by surface parking. The new location and design style for future parking facilities will not be discussed in this report, however, it is for sure the parking will not occupy the highly valuable urban land in the era of automated vehicles.

However, cities must plan for this transition. Pilot projects dedicated to reducing or reallocating parking can help cities test strategies for location- and congestion-based parking pricing, district-wide parking cap and trade, and design standards and incentives to make parking lots and structures more easily converted to offices and other spaces.

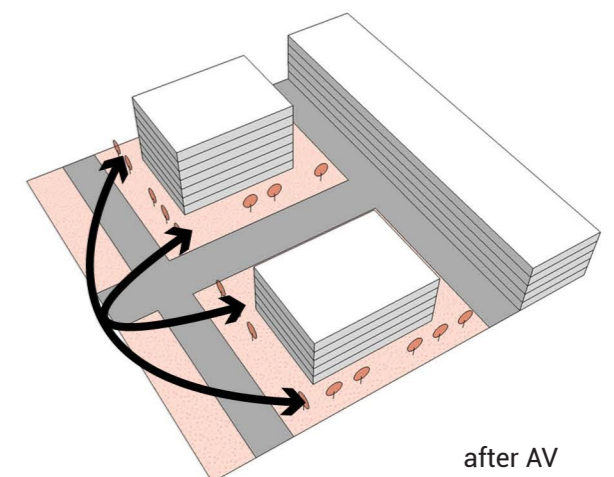
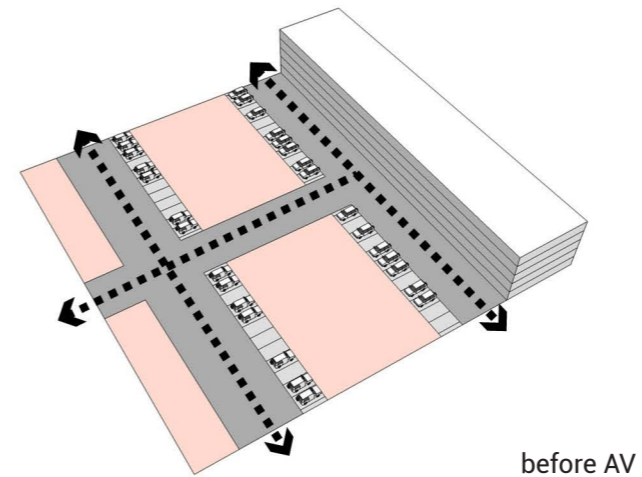
AVs are expected to greatly reduce parking demand over time, rendering large amounts of land devoted to parking and the standards that created them obsolete. In addition, the redevelopment of current parking space can change the pattern of community block and center block. Regulatory approaches include:

- Eliminate or significantly reduce minimum parking requirements. Cities across the country are eliminating parking minimums, typically in downtowns or other business districts.
- Adjust parking dimensional standards to the reduced area that AVs will require to park. Ultimately, the location and design of AV parking structures will likely not need to take humans into consideration, resulting in much reduced space requirements.
- Parking space is an essential element in current urban design, and the redevelopment will bring about the changes for urban block pattern.

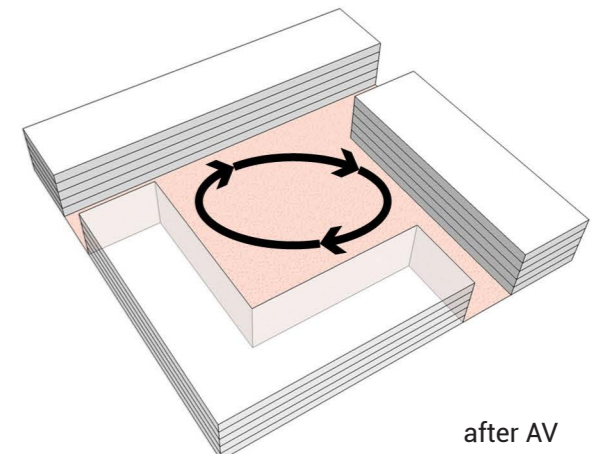
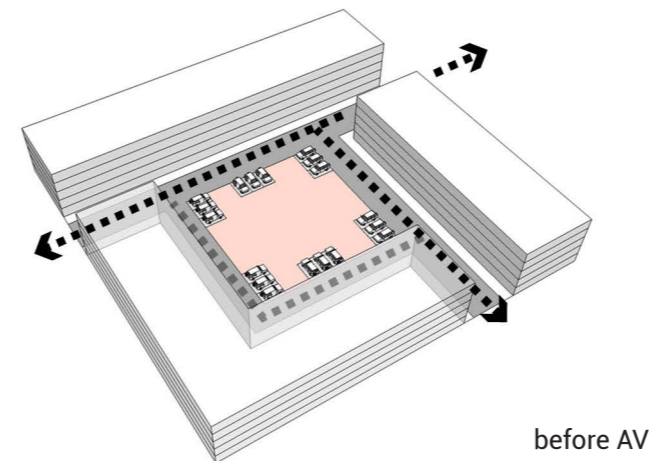
Parking lot and parking garage



Parking along street



Parking in living block



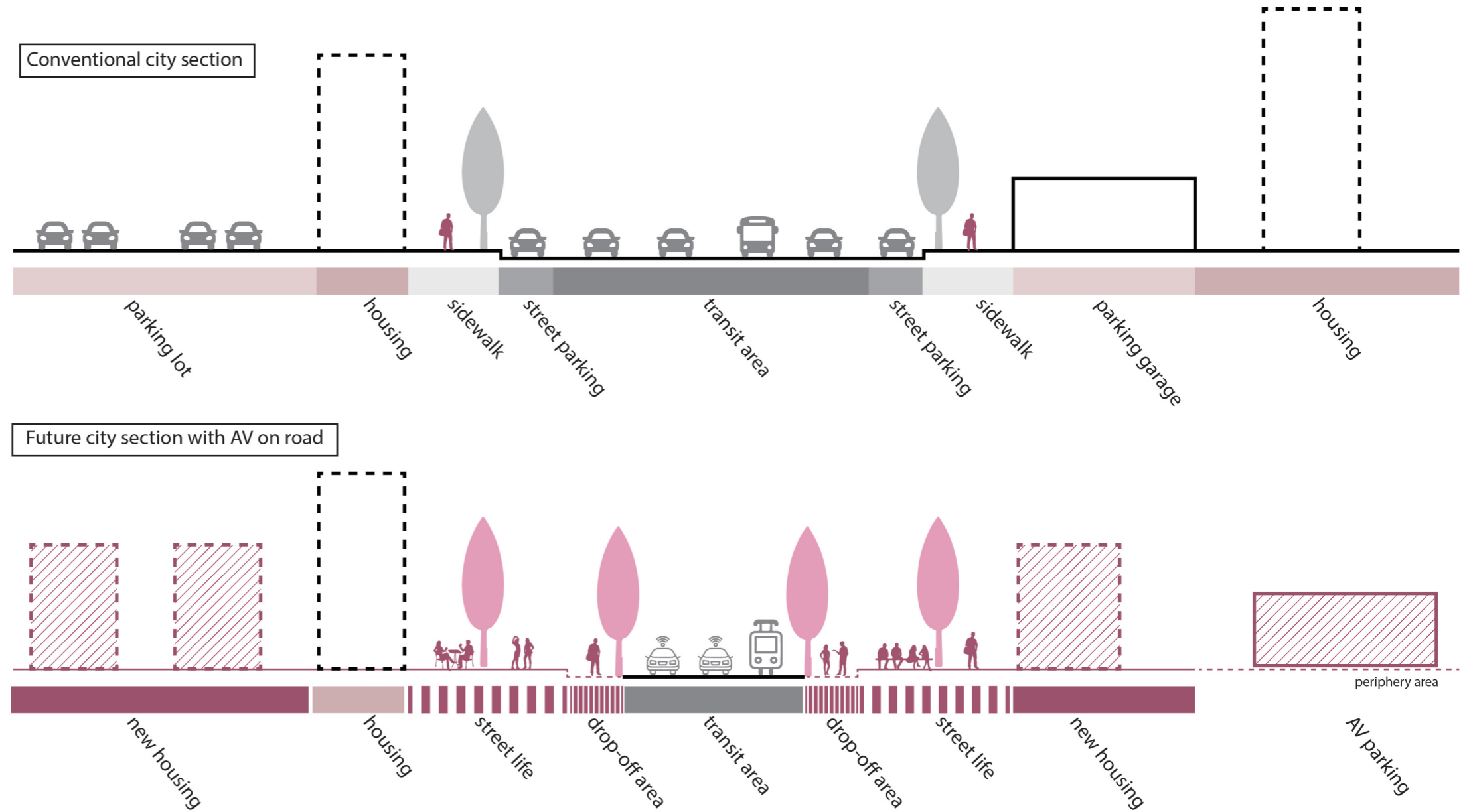
←-----→ vehicle movement

↔ human movement

- Free up street parking

Widespread adoption of AV technology will have a substantial impact to free up street space, with the potential for narrower pavement widths and more efficient vehicular rights-of-way. Slimmed-down pavement and rights-of-way will be made possible by a number of factors. First, autonomous vehicles are expected to be smaller with the ability to drive more precisely. AVs are expected to remove the need to design roads and lanes to account for human error. AVs' ability to move more precisely than human-operated vehicles will enable roads to be designed with narrower lanes, which will leave more space for bicycle and pedestrian facilities, active streetscapes, or green spaces.

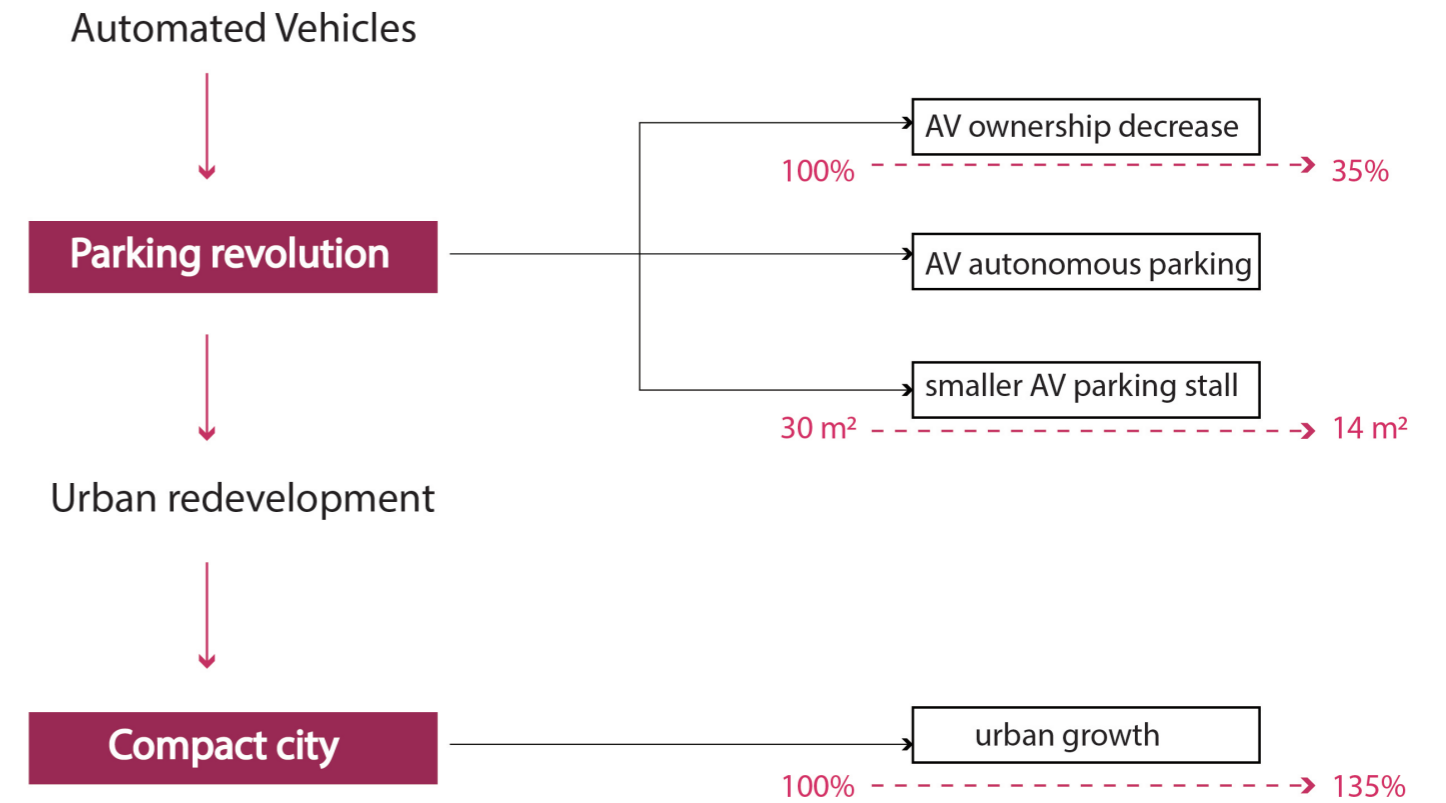
Second, AVs offer the potential for increased throughput. AVs are expected to improve the efficiency of automobile travel by reducing congestion caused by crashes, enabling vehicles to travel closer together, and improving traffic flow through intersections due to the emergence of free-flow intersections. When combined, these factors could significantly improve the vehicular throughput of existing roadways.



Conclusion

In the era of automated vehicles, the structure of street system and urban block will be changed. The impact can contribute to urban sprawl (market driven & private ownership) or compact city (government driven & public ownership). Planners need to be thinking about AVs because of the significant impacts they will have on our communities. There are potential positive benefits as well as potential negative impacts, but none of these are assured. The secondary impacts are even more of an unknown. Planners have an important role to play in helping communities maximize the benefits and minimize the negative impacts of the technology.

The most apparent impact that automated vehicles may bring is parking transformation and street transition. The parking lot will no longer occupy the valuable land in city which allows the urban redevelopment for more functional urban project to improve space utilization. Sensors will allow autonomous vehicles to travel closer together than human-controlled vehicles, reducing the necessary pavement width and freeing up space for wider sidewalks, bike lanes, and other amenities. The next chapter will identify the possible redevelop area in Almere center to contribute to the compact development.





PARKING REVOLUTION

Chapter 5. COMPACT ALMERE

5.1 ALMERE STREET ANALYSIS

5.2 SWOT ANALYSIS

5.3 Compact Almere: redevelop opportunity

5.4 Compact Almere Figure Analysis

5.1 ALMERE STREET ANALYSIS

Street analysis

In this regional scale map, we can see that the city of Almere is still not well connected. The city is still growing and the street network of this city is not working well so that people could get lost orientation easily. Above map shows different network of road as per their characteristics, at present in Almere there are different types of road-streets which we can define as per their width, traffic flow and function at edge of roads.

This city is crossed only by one highway (A6) through the city centre. This highway has a congestion problem during office hour because of lack connection for people who work in Amsterdam. Inside the city of Almere, this highway has 3 big junction that connect to the main roads which serves the connections from highway to city and links with second levels of transport routes. The main road in the north part of the city acts as

Almere ring-road that covers urbanization in the north side of Almere. In the first step of analysis, we can see that the highway and the main road surround the city centre of Almere urbanization. The internal roads, that directly connect to the highway and main roads, reaches every part of city with different functions and links with smaller and internal streets. This road mostly connects to the smaller local street of the residential area that sprawls around the city of Almere. In the two step of analysis we can see that this local street connects to the neighbourhood street in the residential area. Because the availability of space in Almere is still high, the housing type of Almere mostly use cluster system so that needs a well connection. Because the lack connection in term of distance in Almere, people still depend on car to go to their destination. The public transport inside and outside Almere is still improving so that people do not use it frequently.



Street view of Almere main road



Street view of Almere internal road



Street view of Almere local street



Street view of Almere neighborhood road



Figure : Public transportation system analysis
Legend - - - railway - - - motorway



Figure : Street transportation function analysis
Legend — main road — internal road — local street

5.2 SWOT ANALYSIS

Strengths

1. Plenty of green and also blue space within Almere. Almere was planned to be green since the creation of the city. There is the strong relationship between the inhabitants and the green areas.
2. Land ownership is high in Almere compared to the rest of the Netherlands. The majority of land in Netherlands is owned by the State.
3. Possibility of improvement to the district's connections through the green and vacant spaces within the city. The building legislation allows freedom and flexibility in design and construction.
4. Physically closed to Amsterdam and Utrecht. And the cost of housing and living is relatively low compared to Amsterdam and Utrecht.
5. Distribution of basic facilities along the district is cohesive, such as schools, medical centers, police stations, and commercial areas.
6. Existence of "Neighborhood hopping". Local residents are interested in being in community activities.

Opportunity

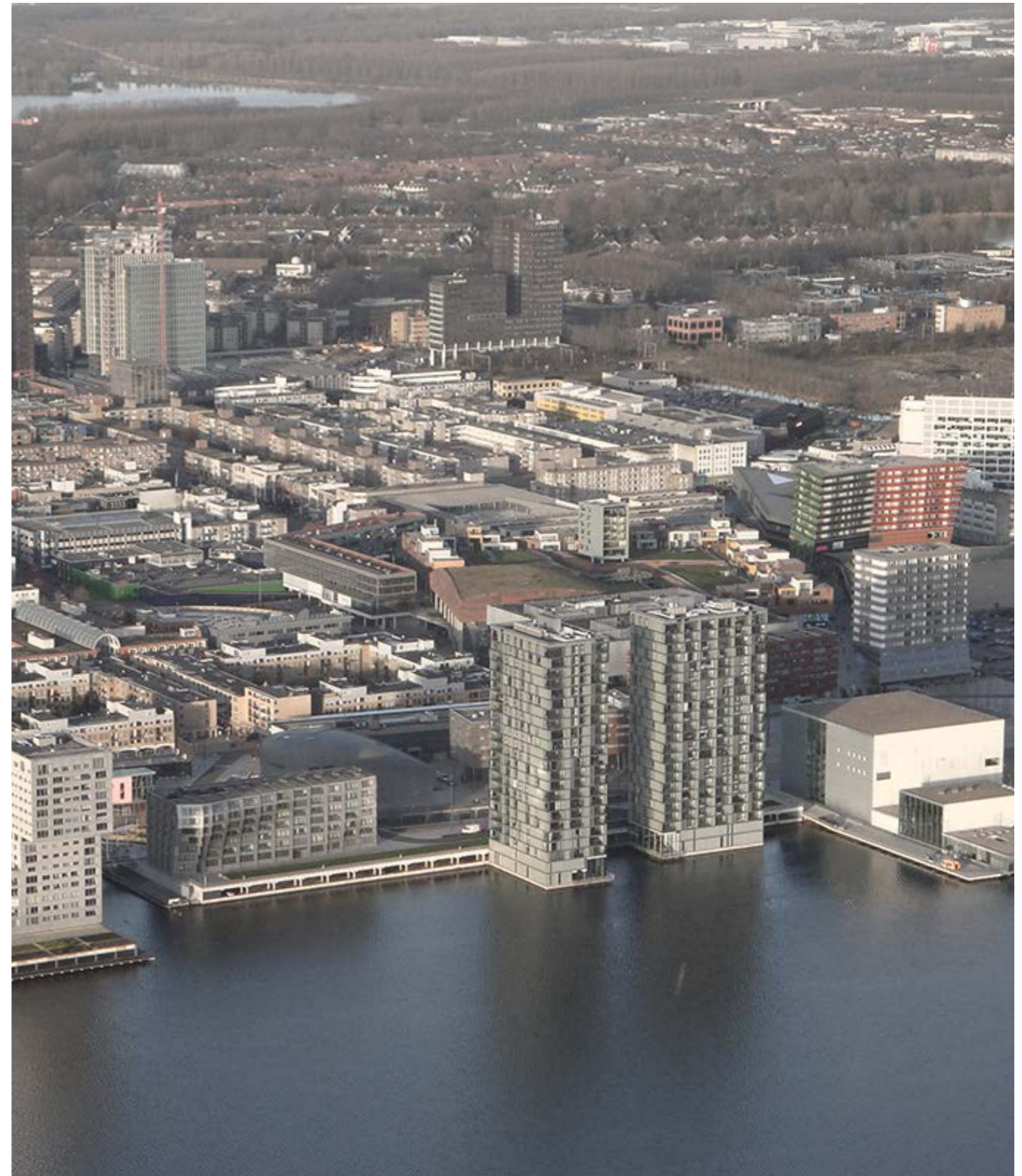
1. The building stock of the city is new, maximum 28 years old, and follows modern national standards. This requires either redevelopment or transformation of natural land to accommodate new residents.
2. The city has the good atmosphere for knowledge-related profession and creative crowd.
3. Existence of national policies that incentive greener vehicles.
4. The municipality always work on improving the regional connection and accessibility. These connections can support partnerships within the cities and the region and boost the economic growth.

Weakness

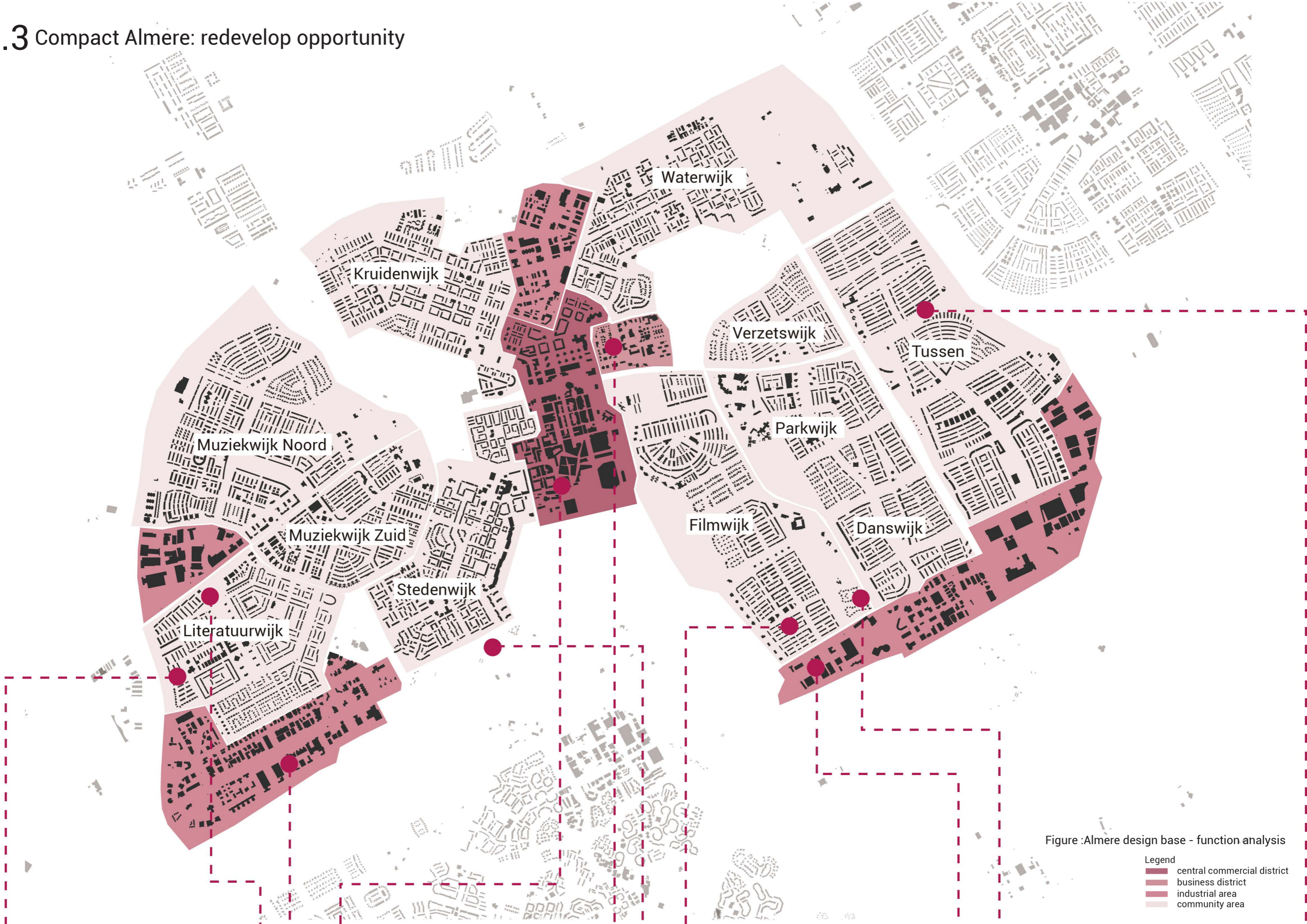
1. Long distance between the neighborhoods, which are not walkable or crossable by bike, therefore motivates the use of the private vehicles.
2. The street space in Almere is excessive and the system makes people easily get lost. The street system is lack of public activity and therefore always empty.
3. Unattractiveness of the public spaces and facilities. The amount of public facilities that function as meeting places and foster interactions is in shortage.
4. Low density for being a suburban city, focusing on sprawl rather than densification, which brings higher costs in infrastructure compared to higher densities.
5. The city is design to be the "dormitory" city, which leads to high number of commuters within the city.
6. Lack of small retail shops in the city center to supply the demand of local enterprise.
7. The city if Almere is lack of identity. People feel unsafe and lonely within the city.

Threat

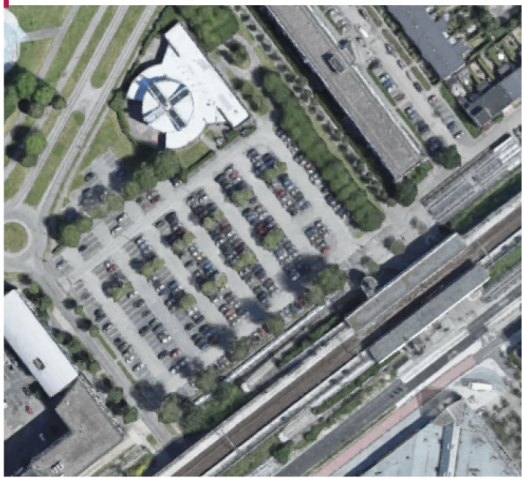
1. Current financial crisis with its negative economic externalities such as lack of job opportunities and decrease in investments.
2. Only one direct road that connects Almere with the region, the A6 causing a bottleneck.
3. The competition with suburban cities within AMA. The competition presents in all sectors, economic and social.
4. The urban growth task put pressure on nature space. The fast growth of Almere, partly caused by a national pressure to Almere to grow and house people due to its location in the region. This fast growth can also lead to an overload of infrastructure if not planned carefully.
5. Culture, leisure, economy and night-life dependency on Amsterdam.
6. Almere lack of attractiveness for new residents due to the negative image of an unattractive urban environment.



5.3 Compact Almere: redevelop opportunity



Parking lot in community



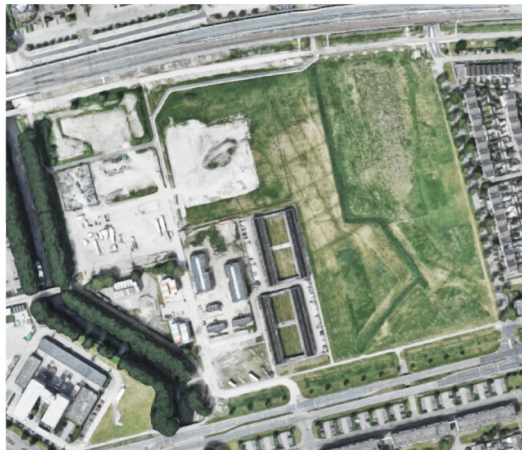
Parking lot in city center



Community center



Campus neighborhood



Block in low efficiency



Mixed-use border



Business district



Industrial area



Highway



Street space in low efficiency

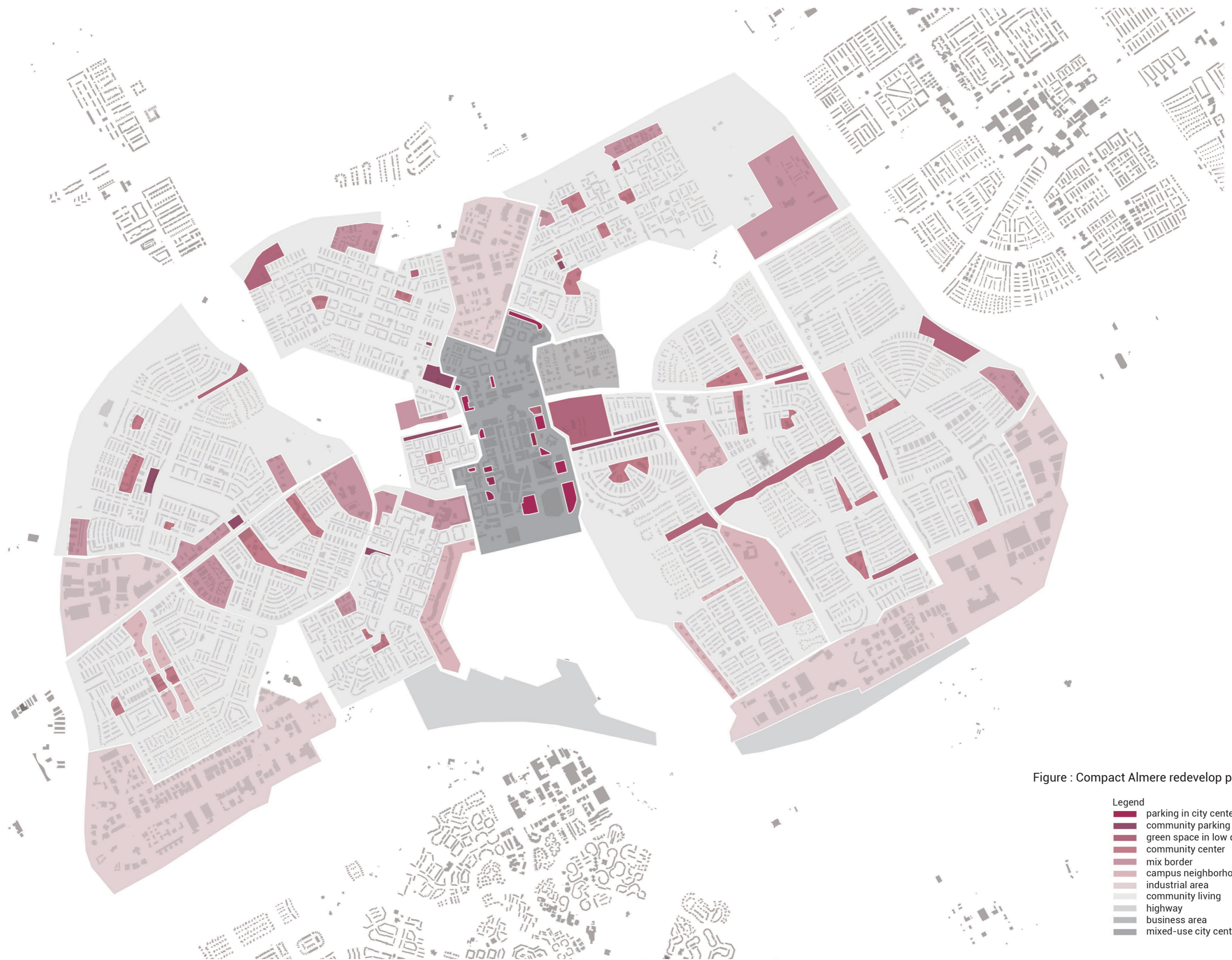


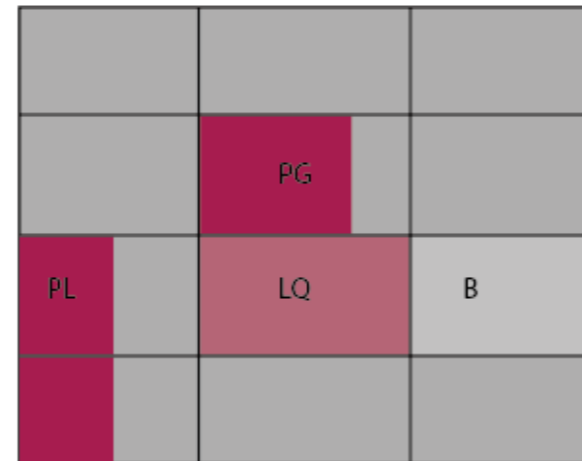
Figure : Compact Almere redevelop pattern

- Legend
- parking in city center
 - community parking
 - green space in low quality
 - community center
 - mix border
 - campus neighborhood
 - industrial area
 - community living
 - highway
 - business area
 - mixed-use city center

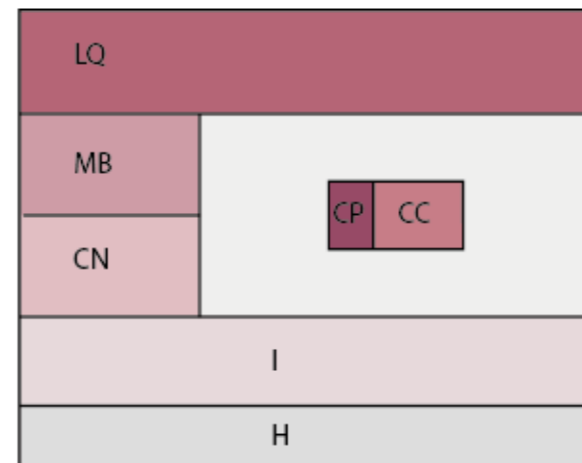
Redevelop pattern

The compact Almere design aims to look for the redevelopment opportunities in the center area of Almere city. As explained in Chapter 4, with the application of automated vehicles, a large amount of parking space and street space will be used for more valuable urban function. The city of Almere is basically consisted of city center area and surrounding living community. The different urban function represents a different urban structure. The redevelop pattern is consisted of city center redevelop pattern and community redevelop pattern. In the city center, the main redevelop opportunities happened in parking lot, parking garage and the urban space in low quality (green space and wasted street space). In community, the opportunity is more fragmented, such as community parking, space in low quality (green space and wasted street space), community center, mix border, campus neighborhood. On the fringe of Almere city, there is a large space of industrial area which can be redeveloped to have higher density and mixed function. Due to the decrease of vehicles on the road, the large traffic infrastructure such as highway can be redesign and redevelop the saved urban space.

Taking one urban block as an example, the possible redevelop design is tested for each pattern. Statistically, the project aims to accommodate 70,000 new residents in the urbanized area. In the tested design, the data is collected such as the percentage of land that can be redeveloped for housing, the possible floors for new housing. The redevelop density¹ can be calculated and the possible amount of new residents can be computed. Then, the project can be proved whether it can achieve urban growth or not and prepared for the next step.



- parking in city center
PL - parking lot
PG - parking garage
- LQ - space in low quality
- B - business area



- CP - community parking
- LQ - space in low quality
- CC - community center
- MB - mix border
- CN - campus neighborhood
- I - industrial area
- H - highway



Space in low quality + Parking lot

In Almere, there are large amount of space that is used in low efficiency. For example, there is brown field contaminated by industrial activity, parking block. Besides, there is green space segmented by irregular street system. The streets in Almere, in general, is overly wide and occupied by large amount of street parking. With automated vehicles, the street can be released and urban block can be redivided and merged. The street and the urban space in low quality is one of the valuable land that is wasted and should be redevelop to achieve higher value.

redevelop for housing: around 40%
numbers of floors: 7 floors
possible density in average: 0.062 per sq m

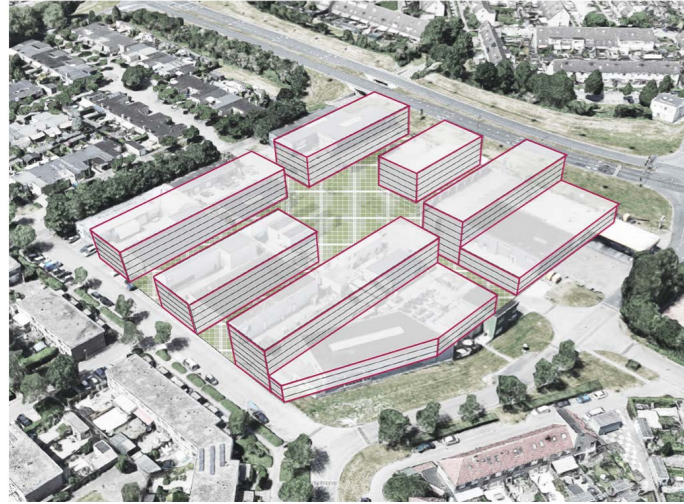


Community center

The current community center area is consisted of shops, schools, restaurants, housing and with parking in the center. The utilization rate of public space is low and the center is lack of cohesion. It is because of the public space is split by parking function and the public building is seperated by function. The current community center is the supplement for public function which can not provide social interactions. With automated vehicles, the community area can be redesign to be the more cohesive public center. On surface, the movement of people is completely free. At the same time, with mixed-use building, vertically, social interactions will be created.

redevelop for housing: around 30%
numbers of floors: 5 floors
possible density in average: 0.033 per sq m

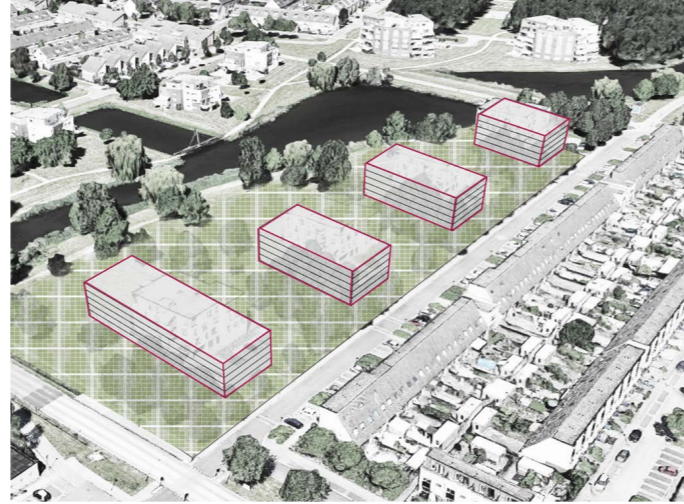
1. The cacluation for possible urban density is : urban density= area of urban block * redevelop percentage for housing * numbers of floor / housing space per person / area of urban block



Mix border

The mix border is the urban block located on the edge of community. There is repair store, bicycle store, gas station, restaurant, supermarket, and gym, etc. The building, generally, has one floor and is separated from each other with different function. The space utilization rate is dramatically low. With automated vehicles and compact development, the separated urban blocks can be combined, and the mix border area could promote new development and improve livability and attractiveness.

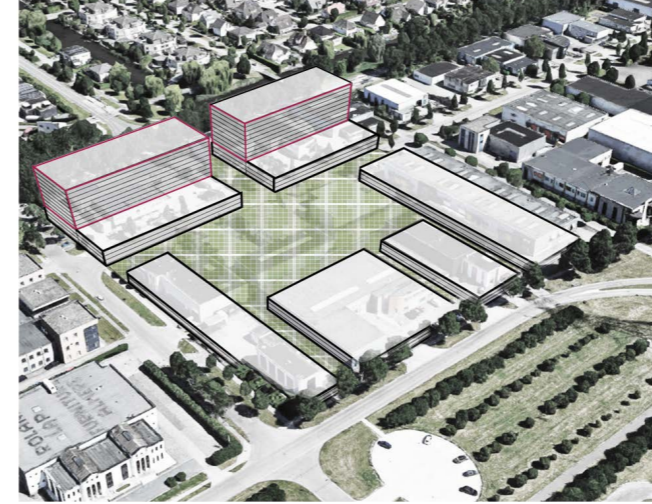
redevelop for housing: around 35%
 numbers of floors: 7 floors
 possible density in average: 0.054 per sq m



Campus Neighborhood

The campus neighborhood is the type that has high rate of green space in the block. The building has less than 5 floors and is far away from each other with green space and parking lot in between. With automated vehicles, the parking lot and part of the street space can be redeveloped to be residential building. Since the campus neighborhood area is always located near the center of the living neighborhood, in compact design, the green space should be designed as one system combined with new green parcel (transformed from the current parking function) providing attractiveness for social activity and outdoor leisure activity.

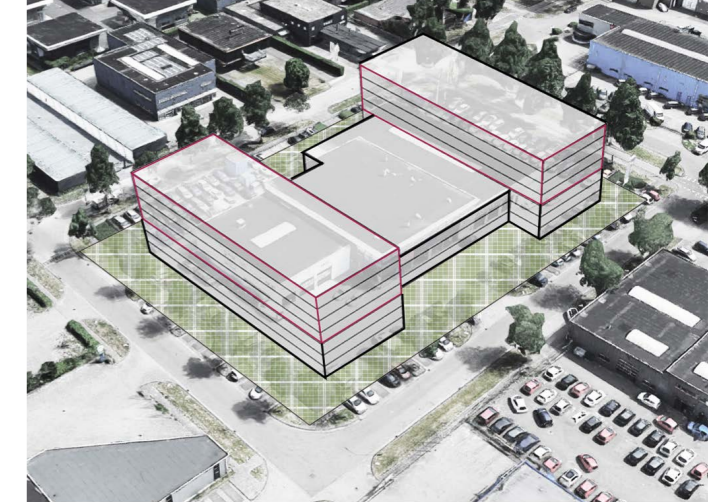
redevelop for housing: around 25%
 numbers of floors: 5 floors
 possible density in average: 0.028 per sq m



Industrial Area

In Almere, 17% of the land is used for industrial function. Most of the factories are warehouses which do not cause air pollution or water pollution. Since the industrial area is located on the edge of the city, in the compact design, the block will be denser with high-rise building. There will still be the need for low-rise warehouse. The high-rise building can be designed as housing-oriented functions mixed with office. (The redevelop percentage is space particularly designed for housing function.)

redevelop for housing: around 15%
 numbers of floors: 9 floors
 possible density in average: 0.030 per sq m



Business District

In the city of Almere, the business district is located near the city center. The current business district is consisted of shops, hotels, offices and factories. At the same time, large amount of space is occupied by parking area. With automated vehicles, the parking space can be transformed to new constructions and green space. Mixed-use development will increase in population density and allows people to access places through walking, biking, and cycling. The housing can be designed focus on single apartment for young workers. The increase in amount of single apartment reduced distances between housing, workplaces, retail businesses, and other amenities and destinations.

redevelop for housing: around 30%
 numbers of floors: 9 floors
 possible density in average: 0.060 per sq m

5.4 Compact Almere Figure Analysis



Figure : Compact Almere - figure analysis

Design base	Redevelop type	Current space (sq m)
almere central	d-01 parking lot	16805
	d-02 parking lot	13841
	d-03 parking lot	3197
	d-04 parking garage	2543
	d-05 parking lot	1375
	d-06 parking garage	2992
	d-07 parking lot	6566
	d-08 parking lot	2758
	d-09 parking garage	3129
	d-10 parking lot	6417
	d-11 green space-low quality	4550
	d-12 parking lot	2294
	d-13 parking lot	5573
	d-14 parking lot	2137
	d-15 parking lot	1625
	d-16 road space	8854
neighborhood-Stedenwijk	d-17 community parking	12492
	d-18 community center	9884
	d-19 mix border	83015
	d-20 mix border	26165
	d-21 community parking	5280
	d-22 community center	3988
	d-23 community center	9408
	d-24 mix border	19983
	d-25 campus neighbor	148121
	d-26 overpass area	549747
neighborhood- Muziekwijk	d-27 mix border	103499
	d-28 community center	31065
	d-29 community center	50788
	d-30 mix border	86733
	d-31 mix border	33684
	d-32 community parking	7701
	d-33 mix border	52823
	d-34 mix border	37104
	d-35 community center	4208
	d-36 community parking	12724
	d-37 community center	29978
	d-38 community center	7825
	d-39 green space-low quality	15762
neighborhood- Literatuurwijk	d-40 campus neighbor	97647
	d-41 community center	20220
	d-42 community center	9546
neighborhood- Kruidenwijk	d-43 mix border	40562
	d-44 community parking	23479
	d-45 community parking	1266

	d-46 community center	8147	
	d-47 green space-low quality	3437	
	d-48 mix border	66146	
	d-49 community center	10279	
	d-50 green space-low quality	45808	
neighborhood- Waterwijk	d-51 community center	20678	
	d-52 community center	3969	
	d-53 community parking	2836	
	d-54 mix border	10735	
	d-55 community center	17254	
	d-56 community center	8306	
	d-57 community center	10339	
	d-58 green space-low quality	3644	
	d-59 mix border	46159	
	d-60 mix border	338642	
neighborhood- Verzetswijk	d-61 community center	25274	
	d-62 campus neighbor	27739	
	d-63 green space-low quality	10406	
neighborhood- Filmwijk	d-64 green space-low quality	122770	
	d-65 community parking	30934	
	d-66 community center	32000	
	d-67 green space-low quality	27894	
	d-68 campus neighbor	212524	
	d-69 campus neighbor	13473	
	d-70 campus neighbor	41315	
	neighborhood- Parkwijk +Dansw	d-71 campus neighbor	108995
		d-72 community center	22736
		d-73 community center	10135
d-74 green space-low quality		11509	
d-75 green space-low quality		73273	
d-76 community center		19136	
d-77 green space-low quality		21438	
d-78 green space-low quality		16715	
neighborhood- Tussen	d-79 campus neighbor	74646	
	d-80 community center	16192	
	d-81 green space-low quality	20259	
	d-82 community center	16022	
	d-83 green space-low quality	59629	
	d-84 mix border	58857	
	d-85 overpass area	262278	
industrial area	d-86 industrial area	1394007	
	d-87 industrial area	312575	
	d-88 industrial area	1201149	
	d-89 industrial area	482273	

Urban growth task

As shown in the final calculation, with the application of automated vehicles, the compact Almere can be denser and accommodate new residents within the current urbanized land. The project focuses on potential redevelop opportunities in several stages. The possible redevelop proposal is to redevelop the parking space, public function area in order to create attractiveness for social interactions. There are nine patterns for redeveloping proposals, such as space in low quality, parking lot and parking garage in the city center, community center, community parking, mix border, campus neighborhood, industrial area, business district, and highway space. One thing in common is all the different types partly contribute to conventional parking function. With AVs, the project focus on transforming parking space into new construction to achieve higher value. As speculated, the final possible population growth is 71,099, which achieves the urban growth task for Almere 2040. Since the average density for current living space in Almere is dramatically low, there is still a possibility to accommodate more new residents.

Step 1 :

average housing space per person in Netherlands : between 30 m² to 60 m²
 choose average housing space per person = 45 m²

Step 2 :

Redevelop density = current space × redevelop percentage × numbers of floor ÷ average housing space per person ÷ current space

Step 3 :

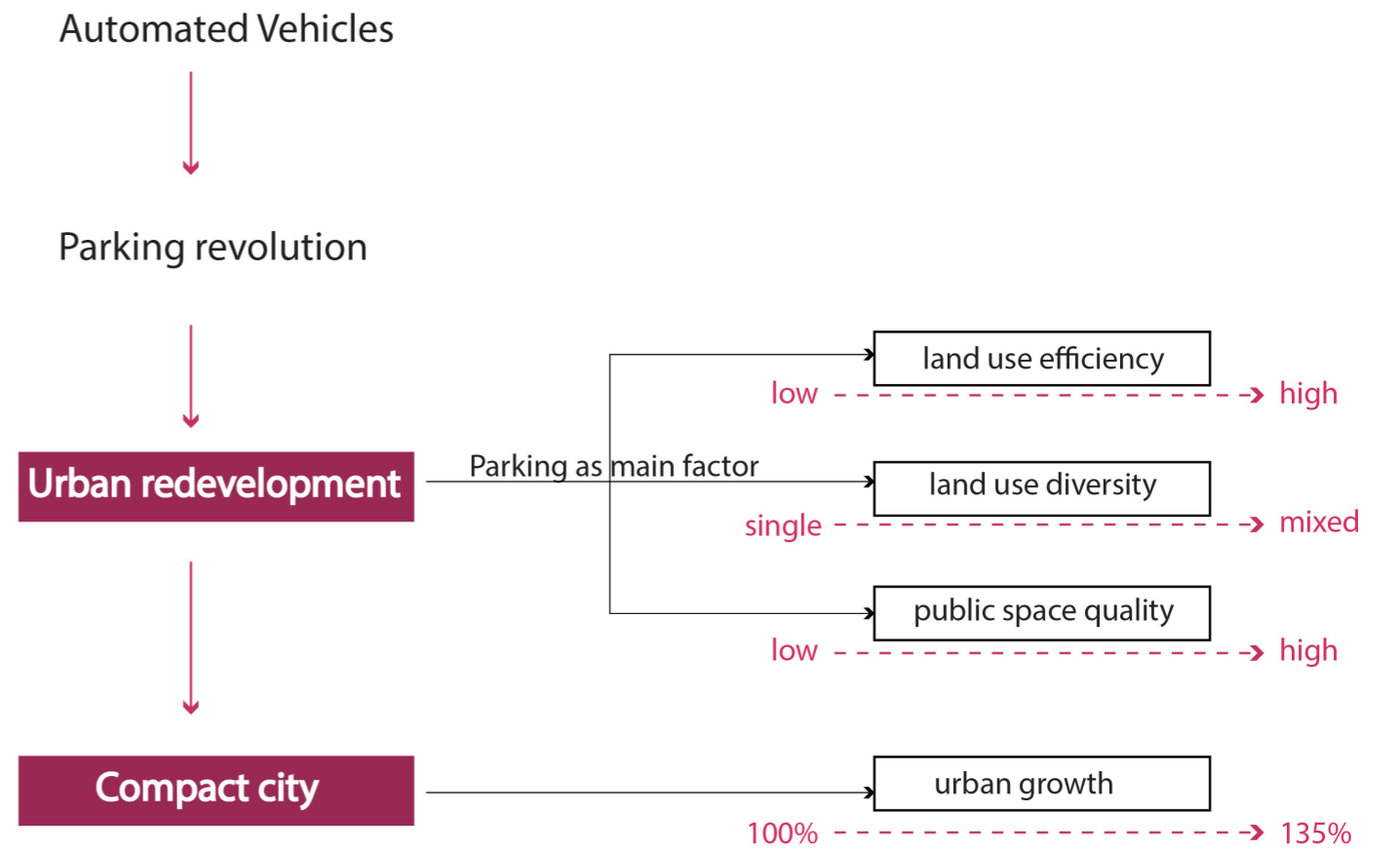
Possible population growth = Current space × Redevelop percentage × Redevelop density

Main Category	Current space (sq m)	Redevelop percentage	Numbers of floor	Redevelop space in surface	Redevelop density (per sq m)	Possible population growth
Parking lot in center	62588	50%	3	31294	0.033	1043
Parking garage in center	8664	100%	5	8664	0.111	963
Community parking	96712	50%	3	48356	0.033	1612
Green space in low quality	437094	30%	5	131128	0.033	4371
Community center	397377	20%	3	79475	0.013	1060
Mix border	1004107	35%	5	351437	0.039	13667
Campus neighborhood	724460	20%	3	144892	0.013	1932
Industrial area	3390004	15%	7	508501	0.023	11865
Business area	214547	30%	5	64364	0.033	2145
Highway area	812025	20%	7	162405	0.031	5053
Total	7147578			1530517		43710

Conclusion

Current urban growth is increasingly sprawling. Therefore, the needs for traveling between cities also increase. High automobile dependency also has impact on urban form and urban structure. Large amount of space is used for car related functions. Parking, among them, is the main factor reduce urban space quality.

With automated vehicles, there are incredible possibilities for future urban growth without taking over natural land. Massive amount of parking space can be saved and redeveloped. With new functions constructed on parking land land-use efficiency, land-use diversity and public space quality can be highly improved. In the following chapter, the project is going to practice spatially on design area (industry and community) to achieve high-quality compact city. The compact Almere will also contribute to urban sustainability by creating social interactions, public attractiveness, and social identity.





REDEVELOP PARKING SPACE

Chapter 6. DESIGN AV PARKING SYSTEM

6.1 DESIGN TASK

6.2 DESIGN AV PARKING GARAGE IN PERIPHERY

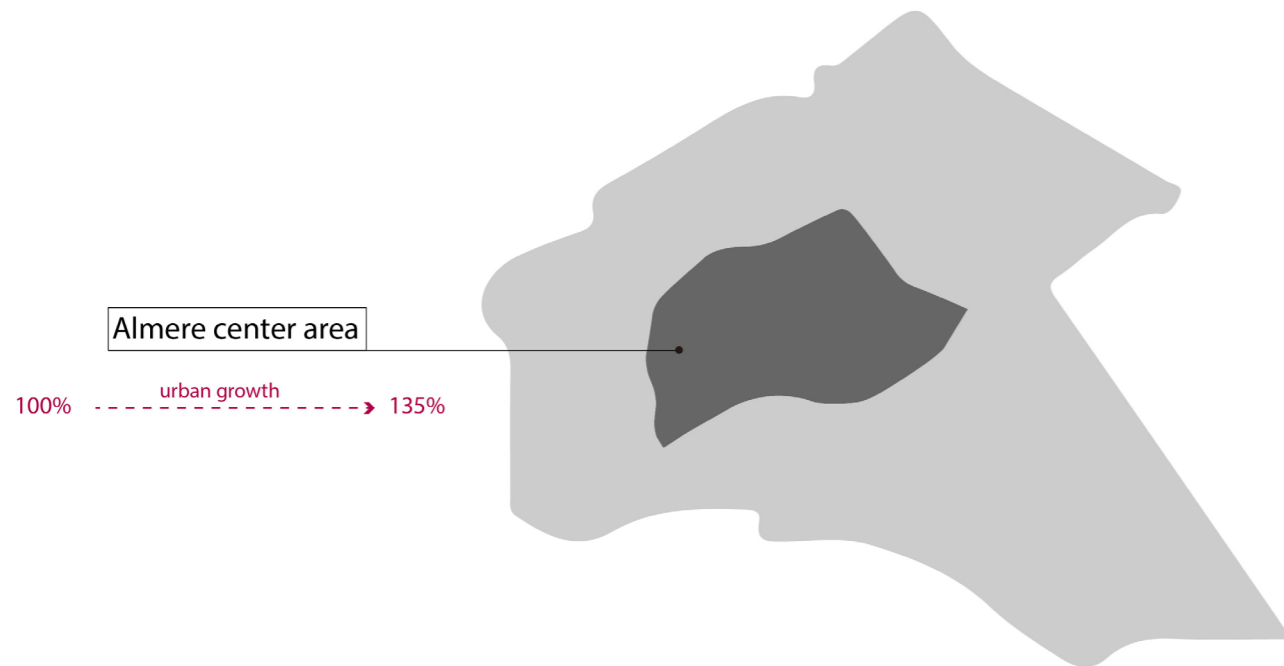
6.3 DESIGN AV FLOOR PARKING IN COMMUNITY

Current parking condition in Almere centre

A mathematical thinking is done at the beginning to understand the current parking condition in Almere center area. the car ownership in almere is at forefront of the Netherlands. Because Almere has no historic centre, it is not attractive for tourists. The role as the dormitory town makes it likely that most drivers regularly visit Almere and are therefore well-informed about its parking locations and pricing policy. There is roughly 1 km² space covered by parking function in almere centre.

The local government has fully regulated street and garage parking. Within the CBD, there is no spatial variation in parking prices. Street parking is 33 percent more expensive than garage parking, so there is a premium for parking on-street (Kobus, Gutiérrez-i-Puigarnau, Rietveld & Van Ommeren, 2013). There is

excess supply of both street and garage parking at most times of the day. In neighborhood area, there are two spots of free parking lot next to train station to encourage people to transfer to public transportation. Within community, the parking is private for residents.



Household size	2.38 people per house
Car ownership per household	0.9 car per house

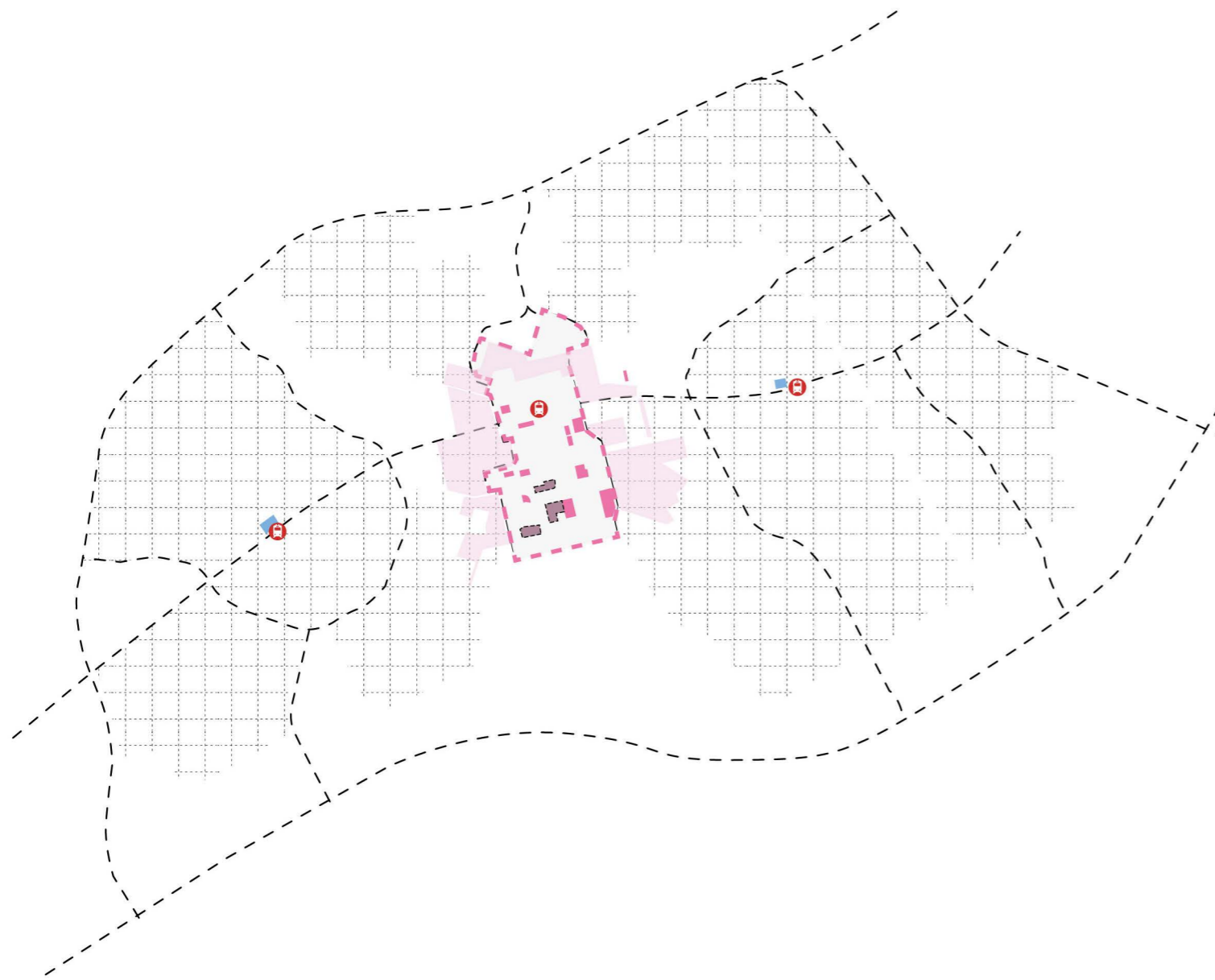


Car ownership per person	0.37 car per people
Current population in Almere centre area (2018)	110,000 people



Rough car number in Almere center	40,700 cars
Rough parking space in Almere center	1,000,000 sq meter





- parking garage





- parking garage





- street parking





- parking lot





- community parking

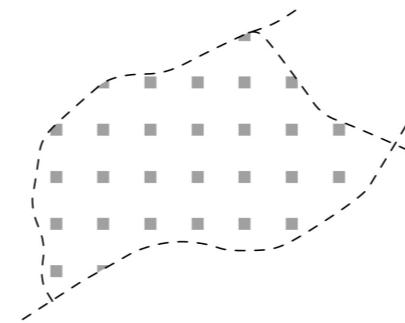
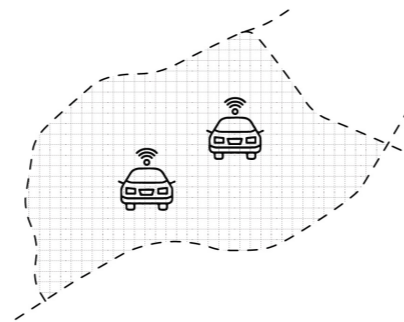
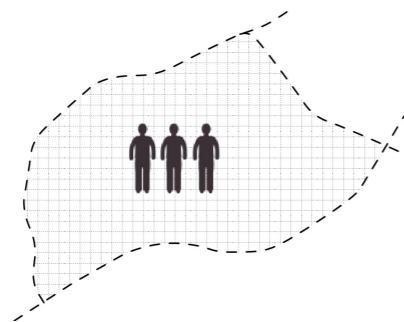
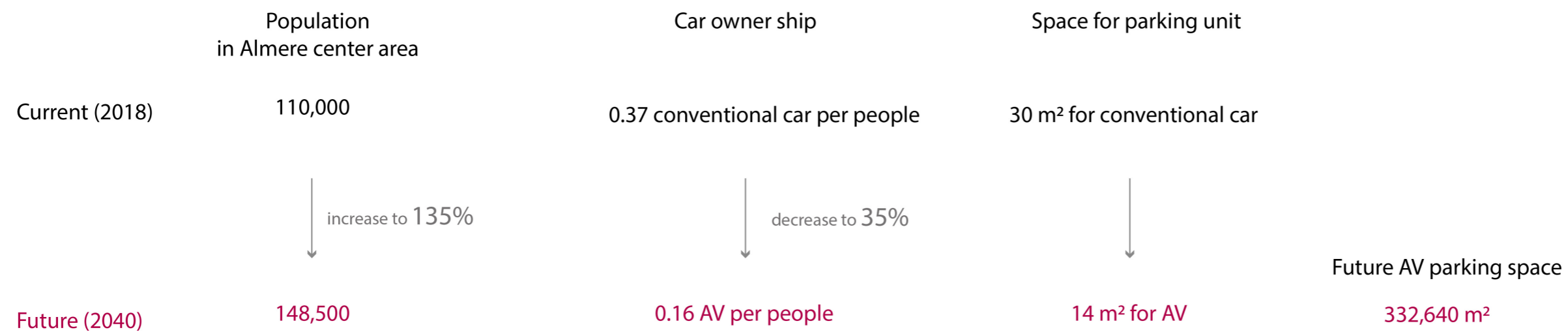





Design task

The project aims to design the future AV parking system in Almere center area. The mathematical research has been done to calculate how much space will be needed for AV parking. As explained previously, the future AV ownership will decrease to 35% compare with current car ownership. For Almere city the current car ownership is 0.37 car per people. The space for parking stall is 14 square meters. Taking future population growth into

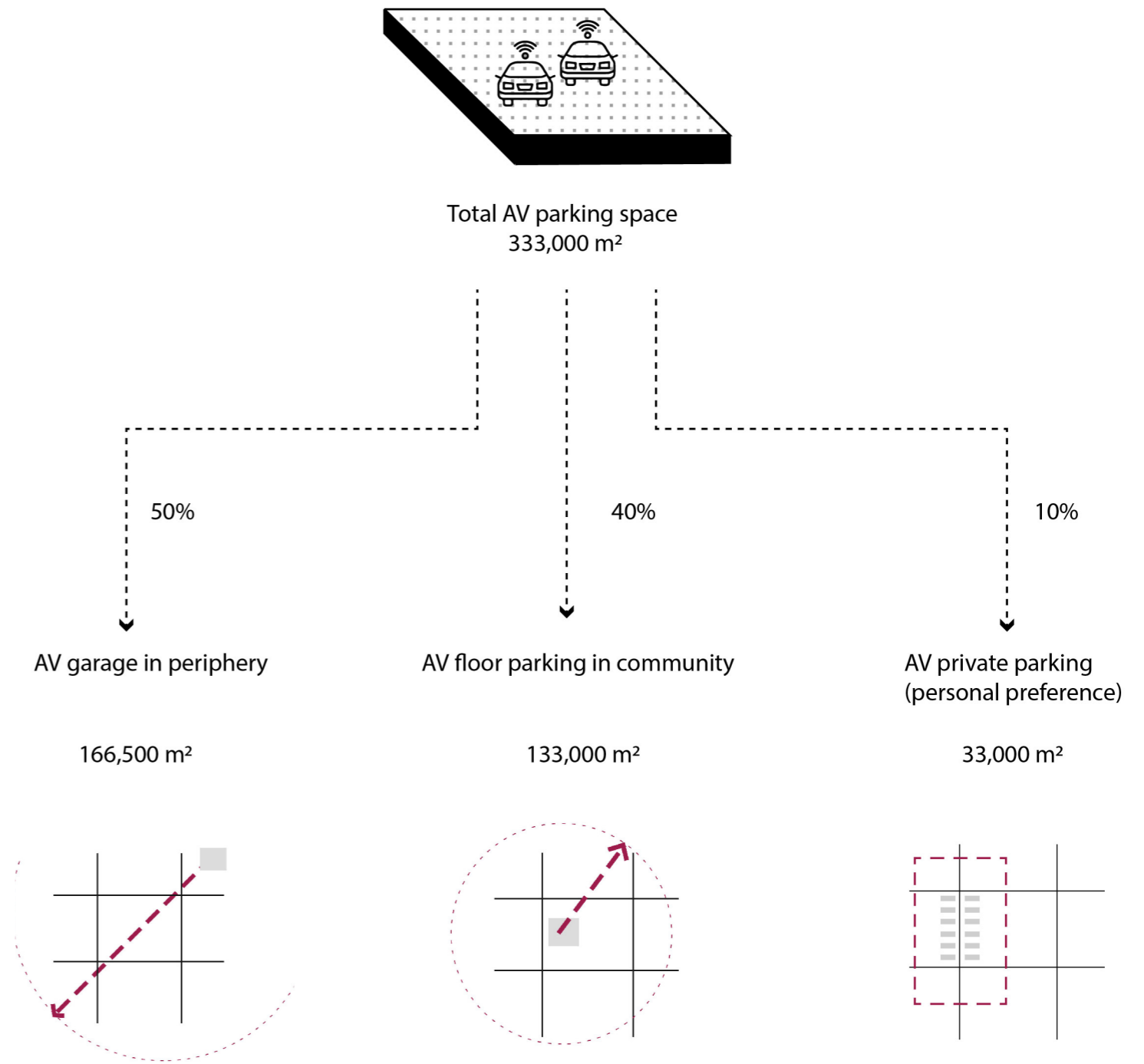
consideration, in Almere center, the total AV parking space would be 332,640 square meters. The design task is to place these parking space in the most compact and sustainable proposal.



AV parking strategy

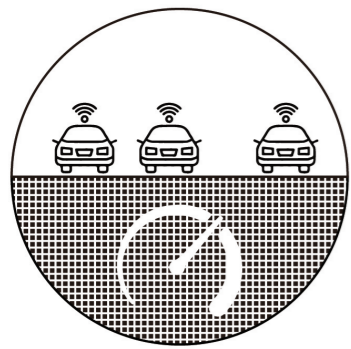
The transformation from current parking to AV parking is a long-time transition. To enhance the transferability of the project, the design strategy will provide multiple choices for AV parking. there are three categories in AV parking system, half will be placed as an AV parking garage, 40% would be suited in mixed-use building with first floor as AV parking floor. The last 10% is referred as private parking since there would still be people who want to own their personal vehicles. The place for this kind of parking may take place in their housing or somewhere nearby. In a world, it would be decided by personal preference. The project aims to design the public AV parking.

In order to achieve the highest traffic efficiency, AV parking system serve the city in different level. The AV parking garage is designed to be positioned in periphery area to guide regional transit. The AV floor parking aims to serve the community to provide high quality of sharing service. Taking AV cusing into account, it would be better to spread parking function in city to avoid unnecessary cursing.



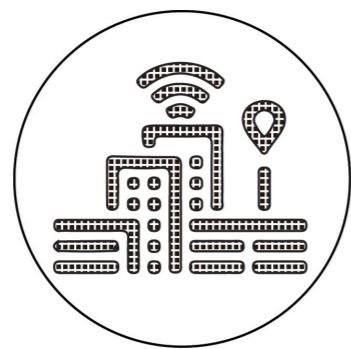
Design principle

To address the AV parking system in the compact vision, the project put forward the following principles for resilient and practical AV parking system. The design principles serve as a set of guidelines in the design process, which is derived from theoretical, analytical and empirical studies of the topic. These principles set up a blueprint for the design intervention, that envisions the impact of AV parking on built environment. With right policies, AV parking system could create an attractive AV industry park in periphery and dynamic community border with AV floor parking. Thus, to achieve the compact and sustainable development.



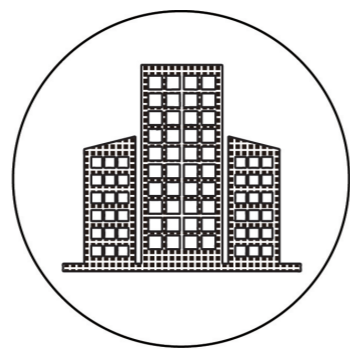
EFFICIENT TRAFFIC

The AV parking system should contribute to an efficient transit on different scales. The position should generate to a better regional and local connection. With better connection, mobility service can be more acceptable and attractive, thus lead to a lower vehicle ownership.



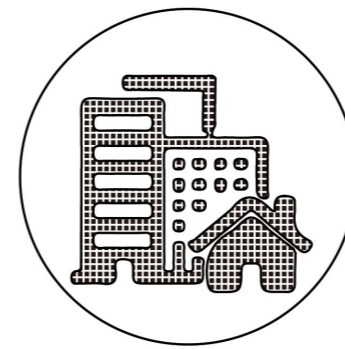
MULTI MODEL OPPORTUNITY

AV technology would shape the future of the automotive industry. Since people would no longer be owners but users, the connection between people and automotive industry can be transformed from physical to mental. This would bring new business models and space transformation in industry area.



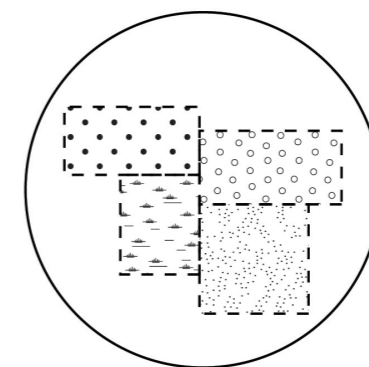
COMPACT DEVELOPMENT

The project aims to achieve overall more compact urban form. City growth should be physically limited in built-up urban area to save opportunities for future possibilities. This policy also makes an effort to reduce AV ownership avoiding endless sprawl.



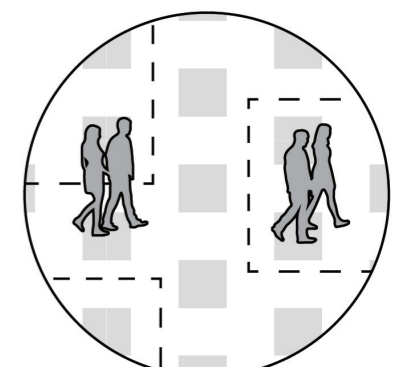
MIXED-USE DEVELOPMENT

Mixed-use development enables a range of functions such as residential, commercial, business, healthcare and entertainment function. This policy would contribute to a higher density, multi-functional environment with vitality and attractiveness.



VALUABLE GROUND SURFACE

With AV parking system, current parking land can be redeveloped with multiple urban function. To open ground floor, AV parking would start from first floor providing accessible ground activities. On the one hand, in industry area the ground floor can create economic attractiveness. On the other hand, the policy can transform the dead community border into attractive public space.



WALKABILITY

With AV parking, street space would be safer especially for children, disabled people and the elderly people. Current parking space can be recovered with diverse function to provide walkable environment. Urban blocks can be reorganized to provide larger walkable urban district.

Traffic analysis in Almere center area

The AV parking garage is designed to be placed in periphery to provide efficient regional transit. The analysis show the current street system and the value in guiding traffic flow. Since AV parking garage is part of automotive industry, six spots are chosen in industry area to have AV parking garage.

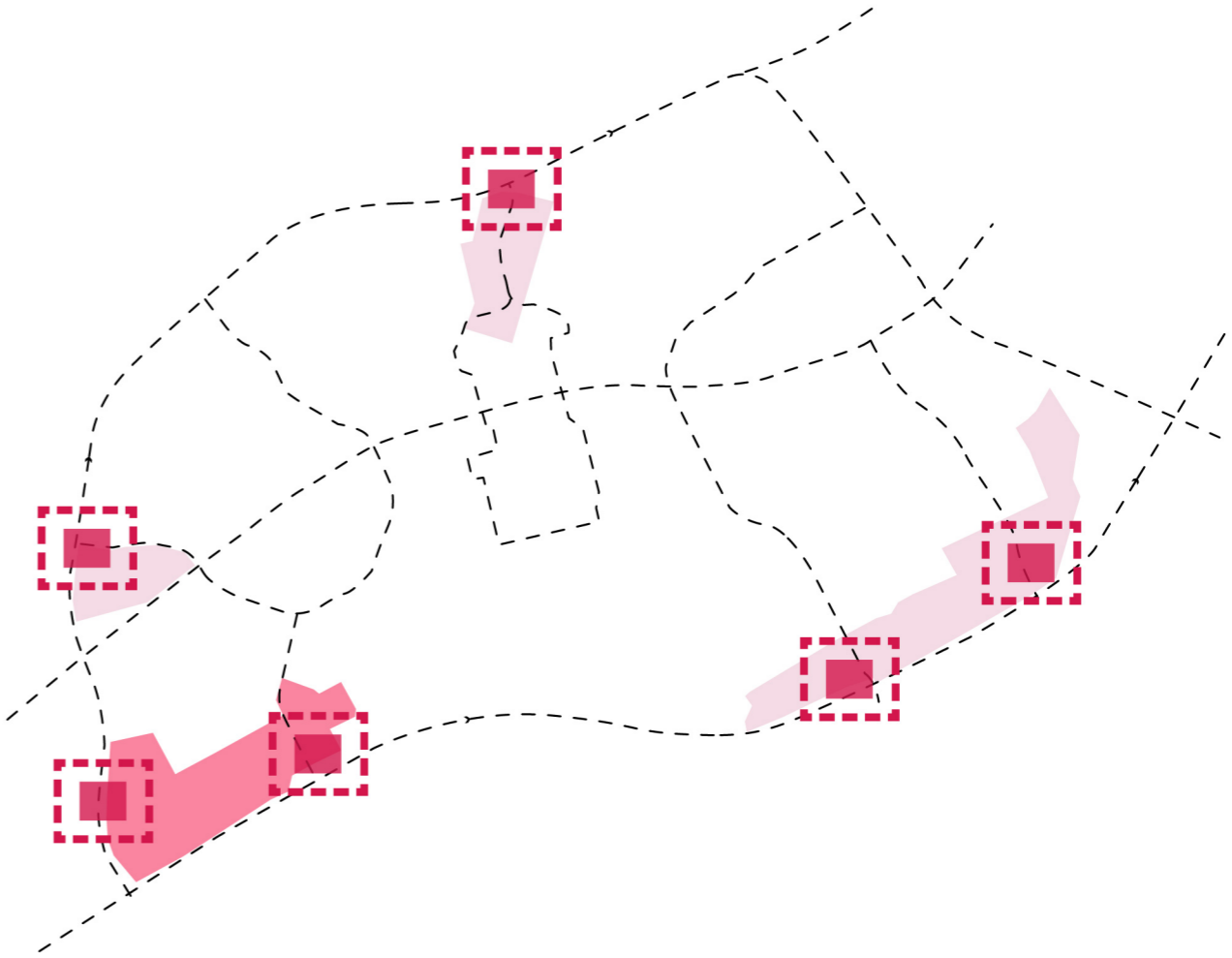
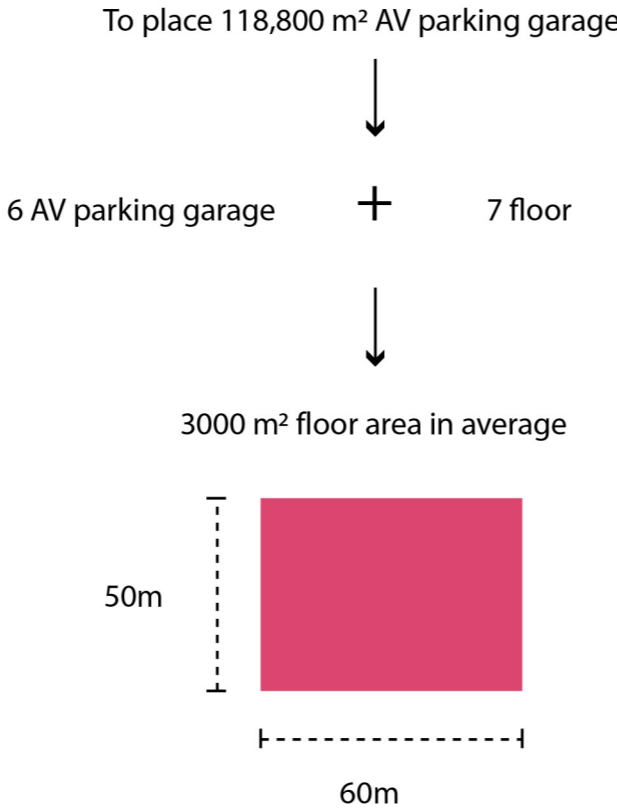
Almere center - industry area

Almere center main transit street

Almere center space syntax - 500m integration

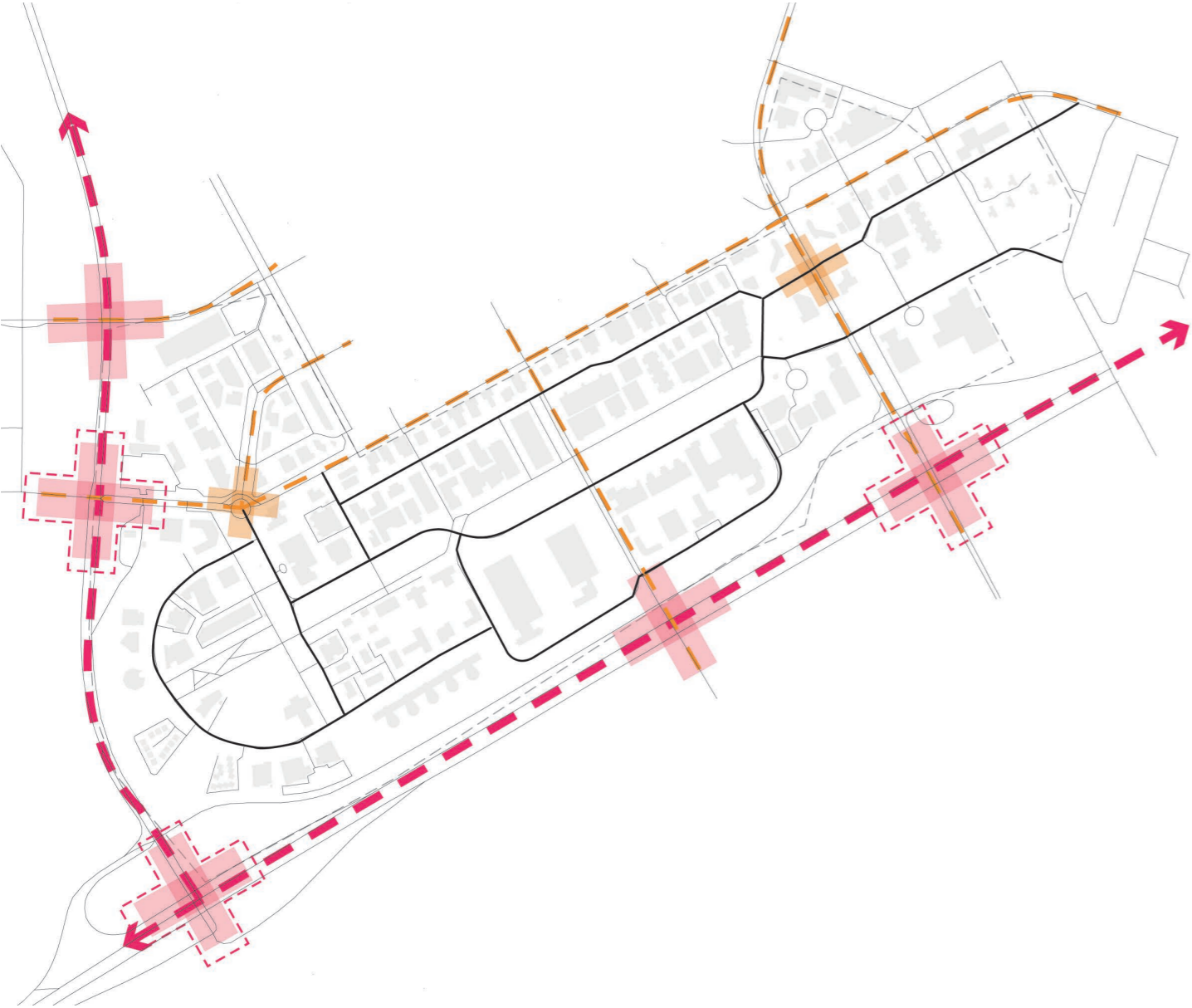


AV garage in periphery



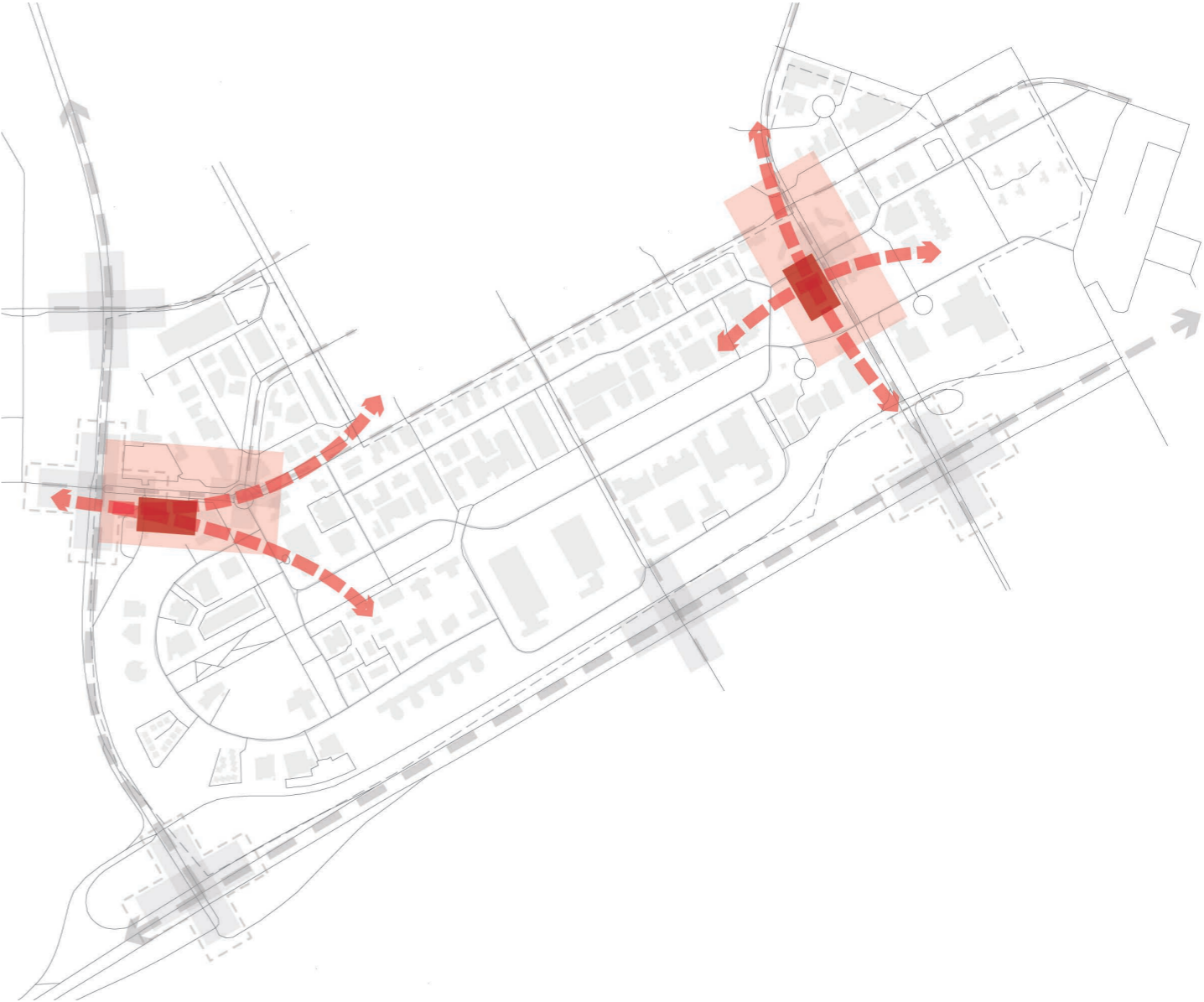
- potential AV garage position
- current industrial area
- research industrial area
- main transit street
- traffic dispersion flow

Street system analysis in industry area



- highway - regional access
- main street - urban access
- main street - internal access
- mass transit concentrate
- overpass
- traffic island

AV parking garage position

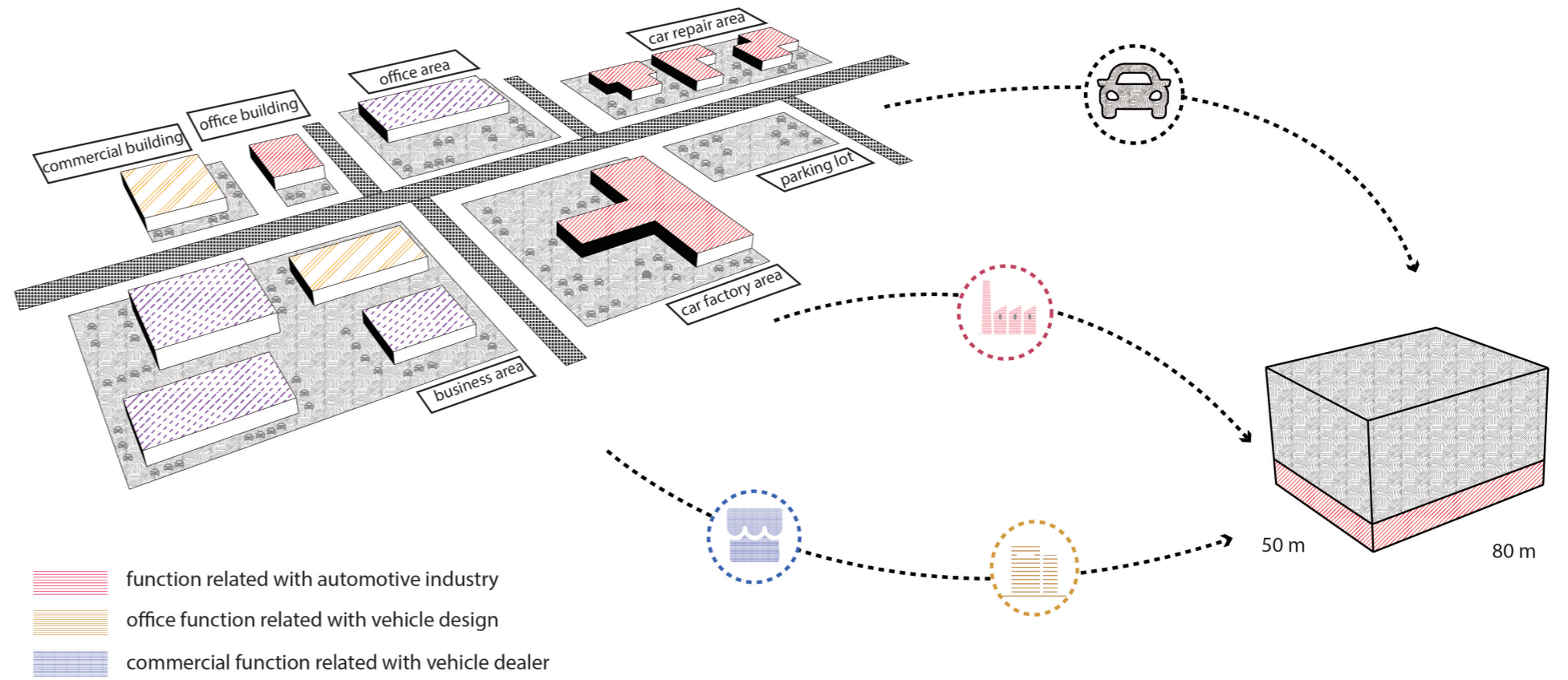


- AV garage position
- high potential area in transit guidance
- traffic flow

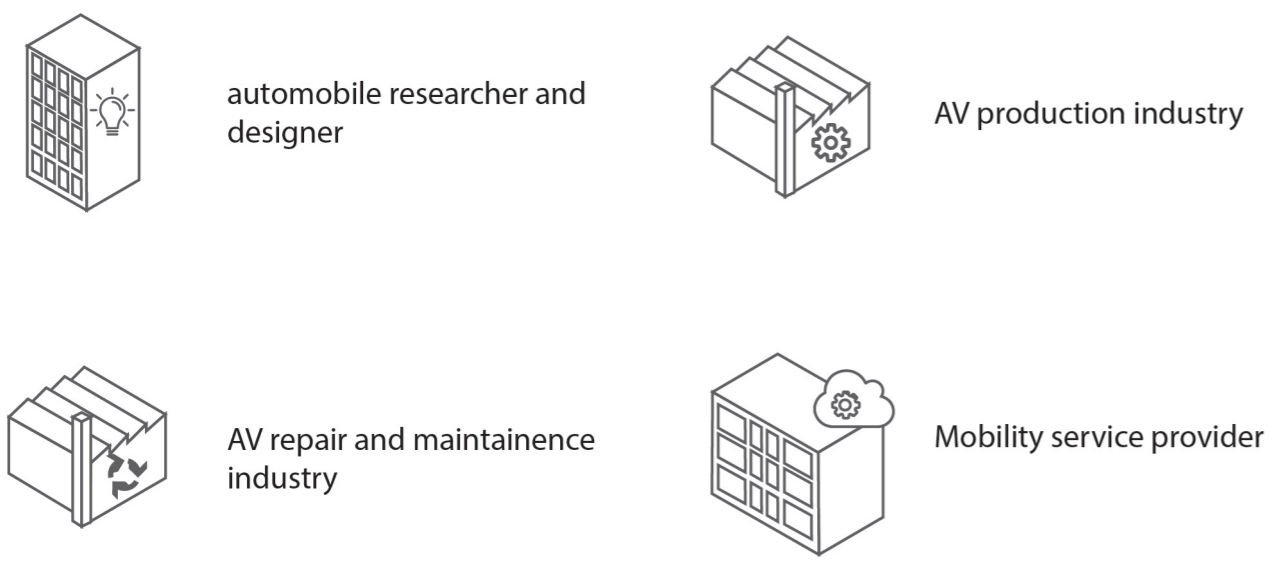
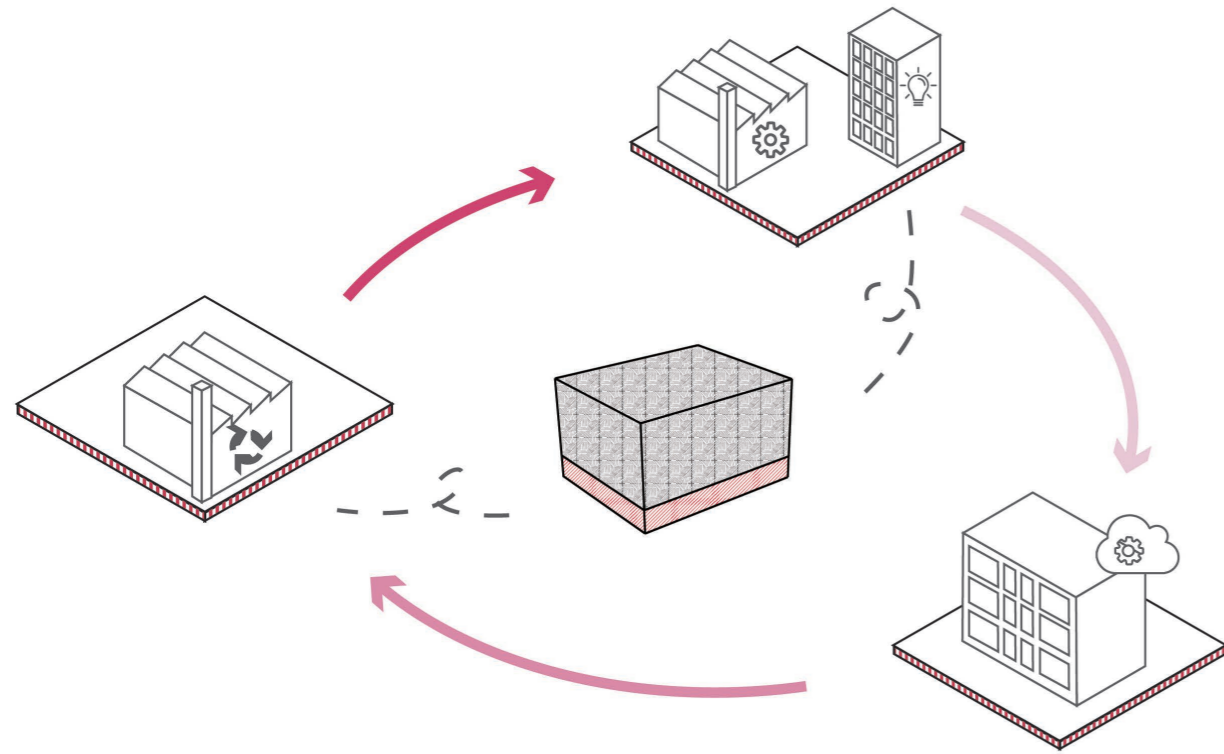
Transform automotive industry

AVs will bring the huge changes for current automotive industry. More space can be freed up and transformed in this transition. Due to the decrease of vehicle number, the current vehicle production would be transformed into AV production, repair and maintenance, and the amount would decrease as well. There would be more companies working as the designer related to AV design or digital system. The service provider would also be identified as the main function for mobility related company. The ground floor for AV garage is designed to contain these new function as the priority. The scheme shows how the AV industry park is designed with AV garage as the main function, attract new business opportunities and compact housing. In the whole Almere center area, for the industry area which is currently lack of car related function, the ground floor can also be used as parking function or accommodate new start-ups.

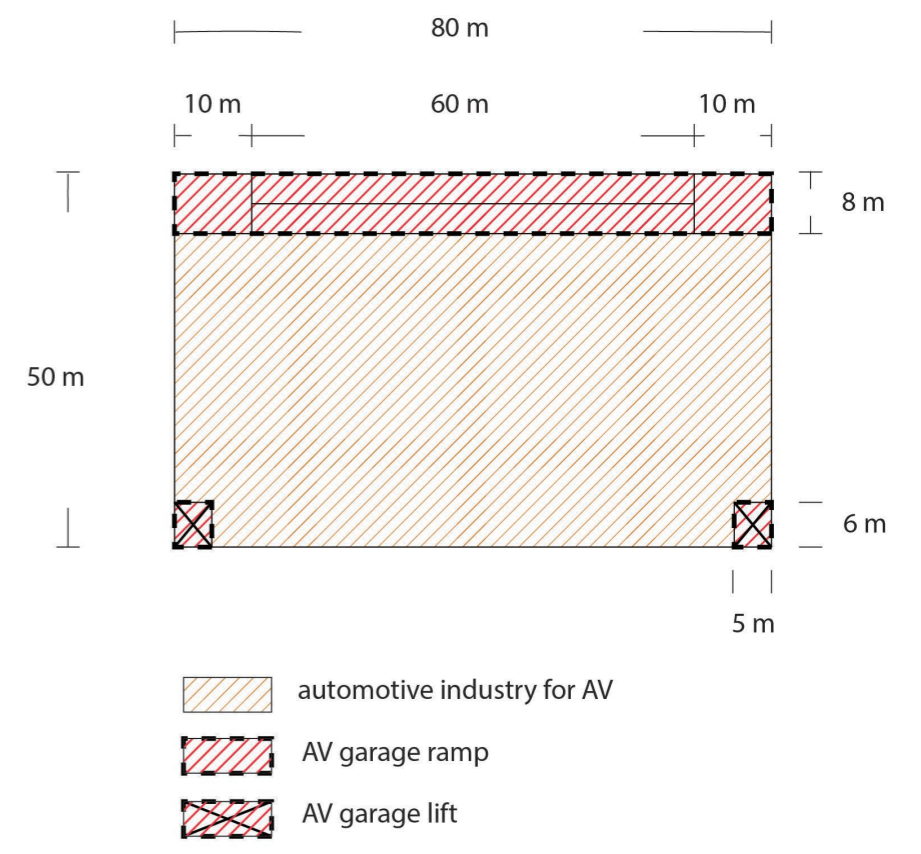
Function analysis of industrial area



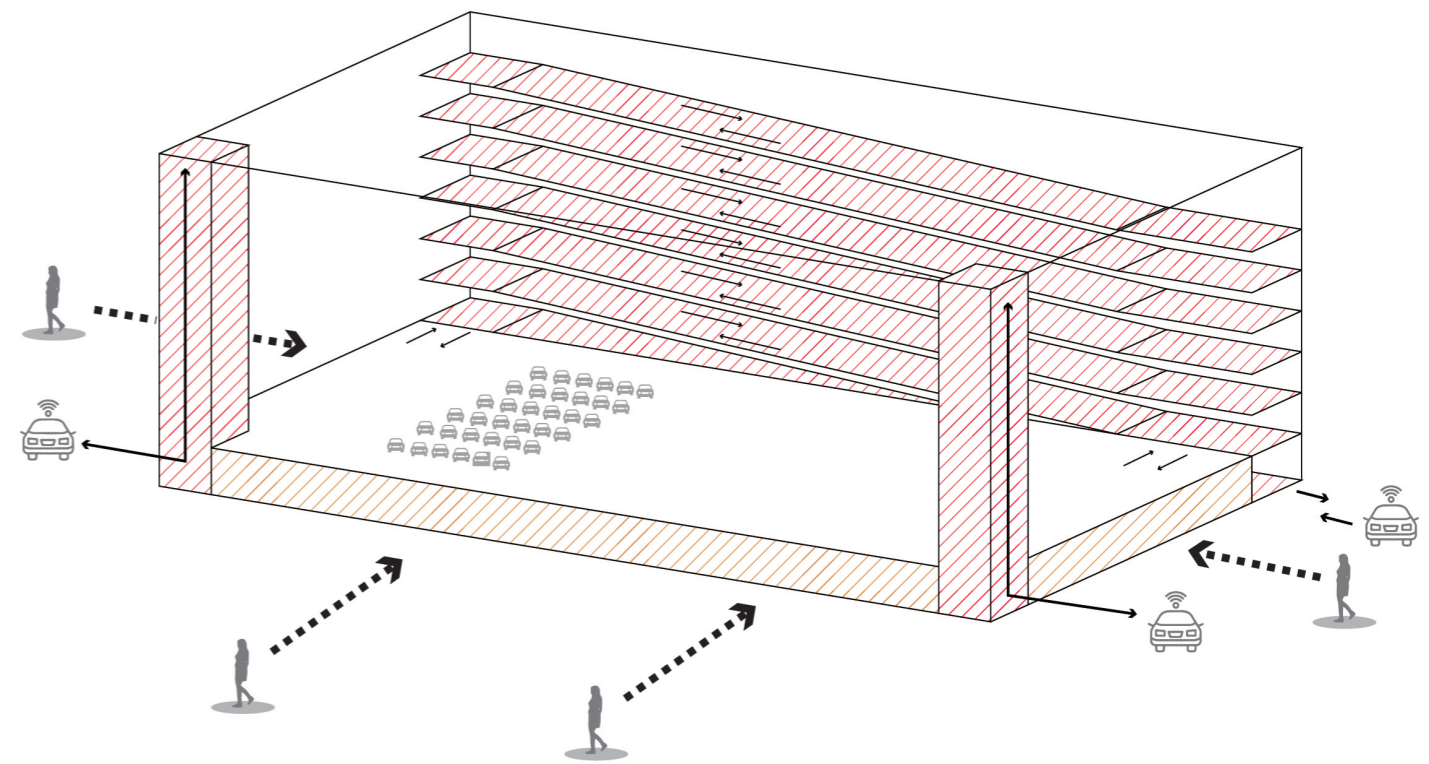
Transformation of current automotive function

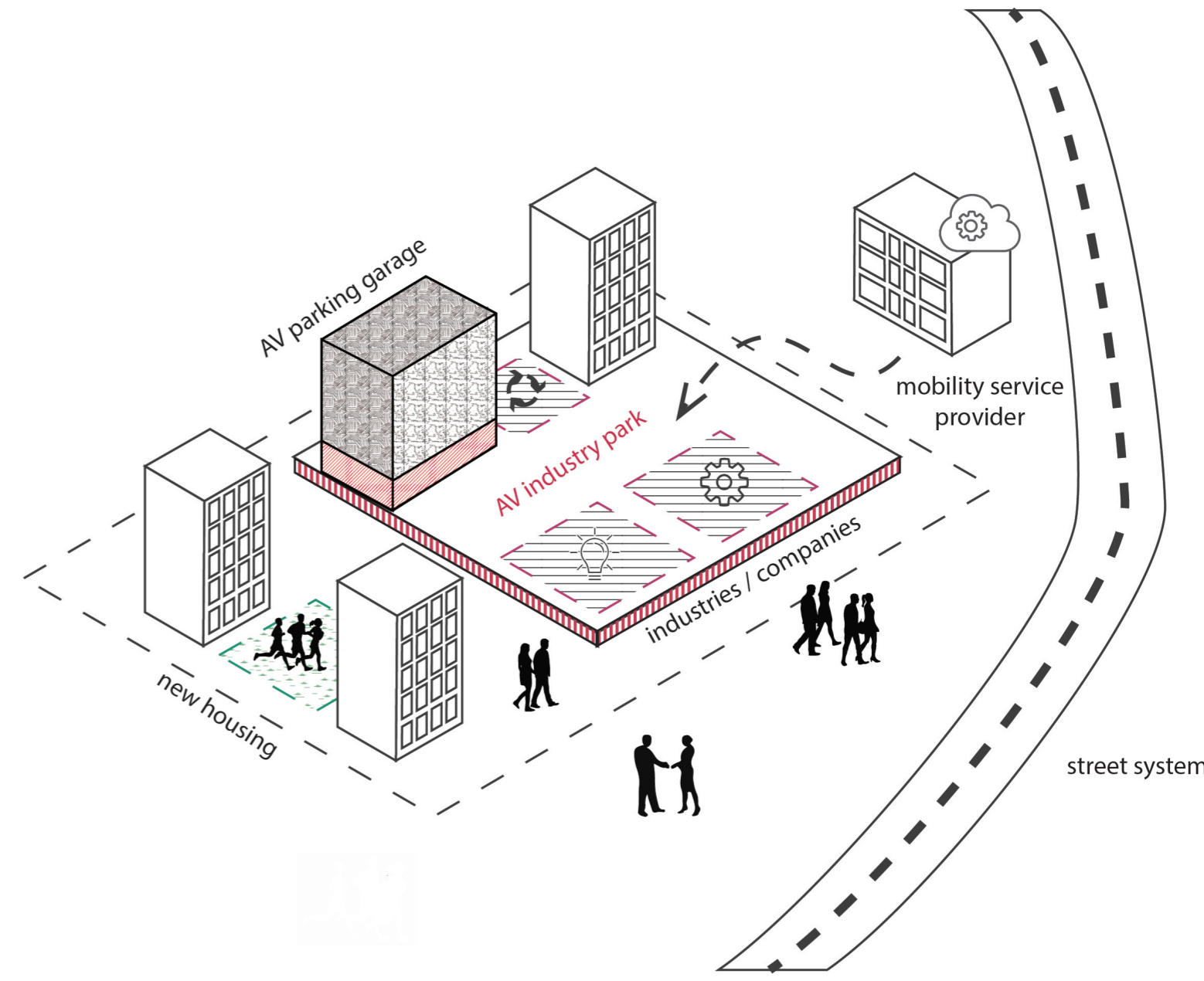
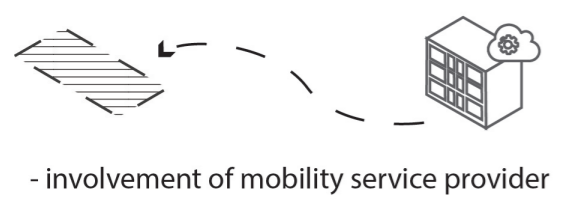
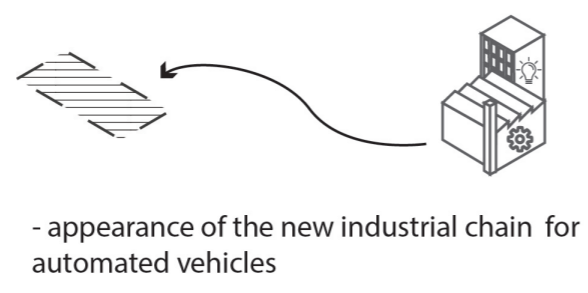
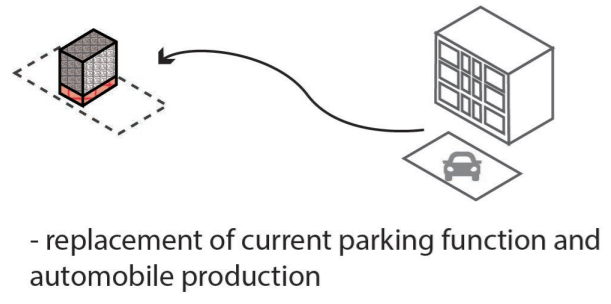


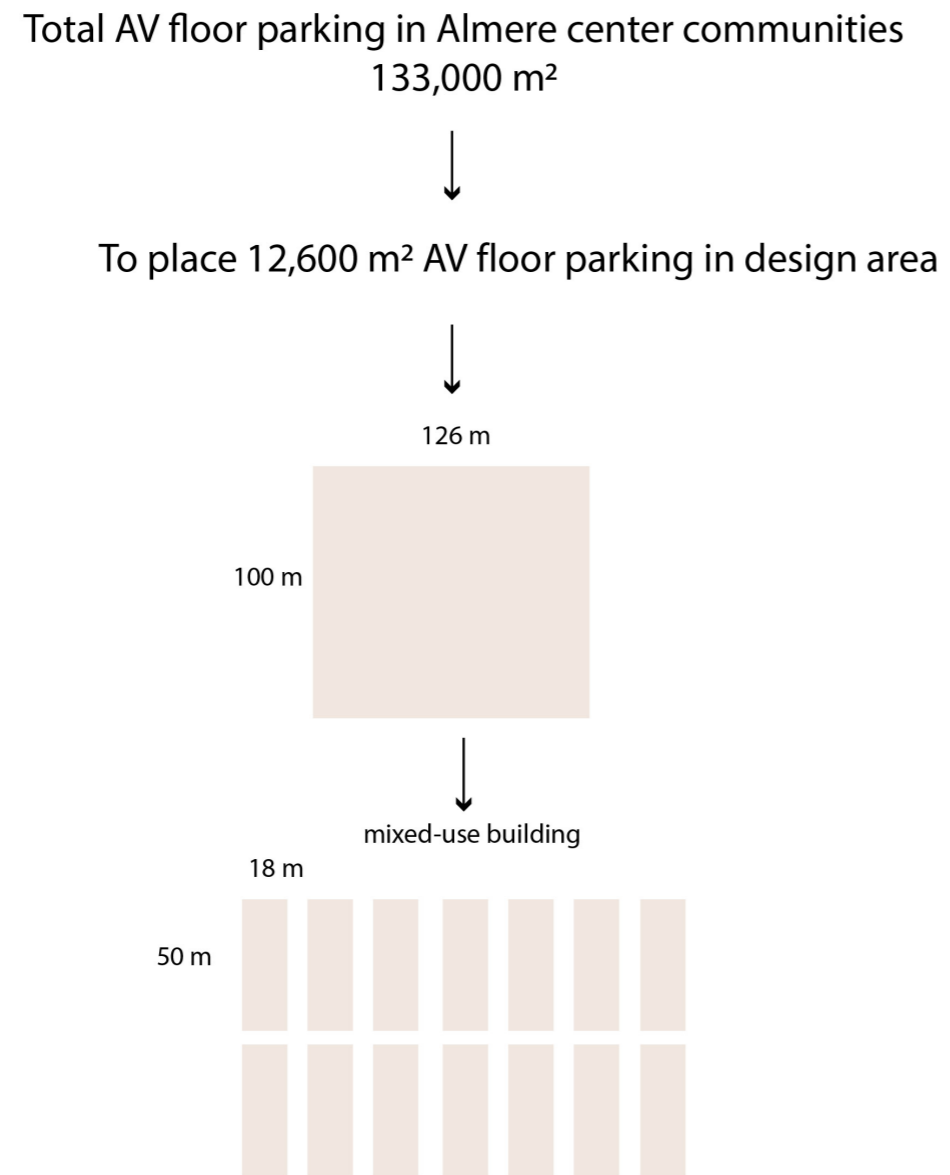
AV parking garage ground floor layout



Flow analysis of AV parking garage



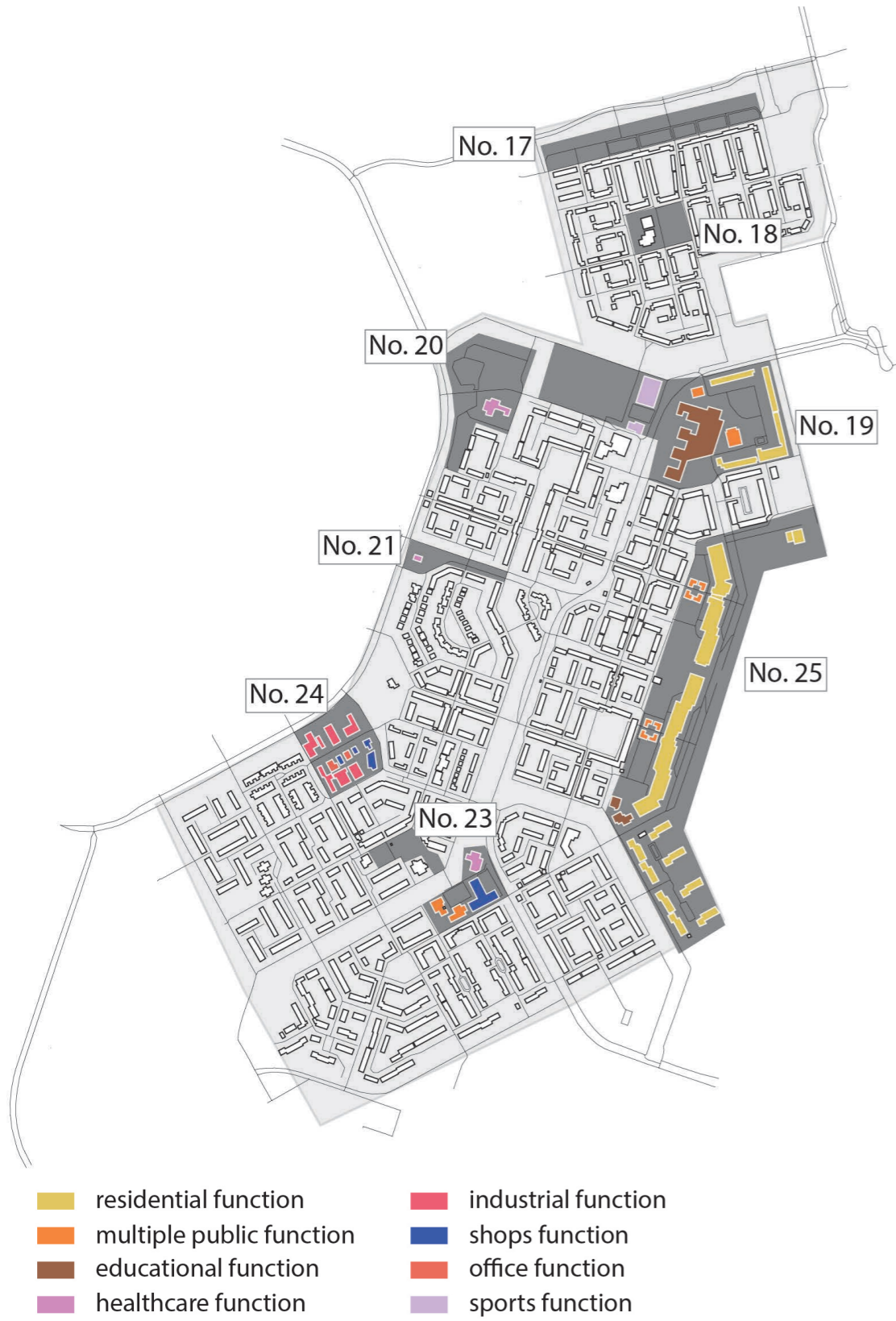




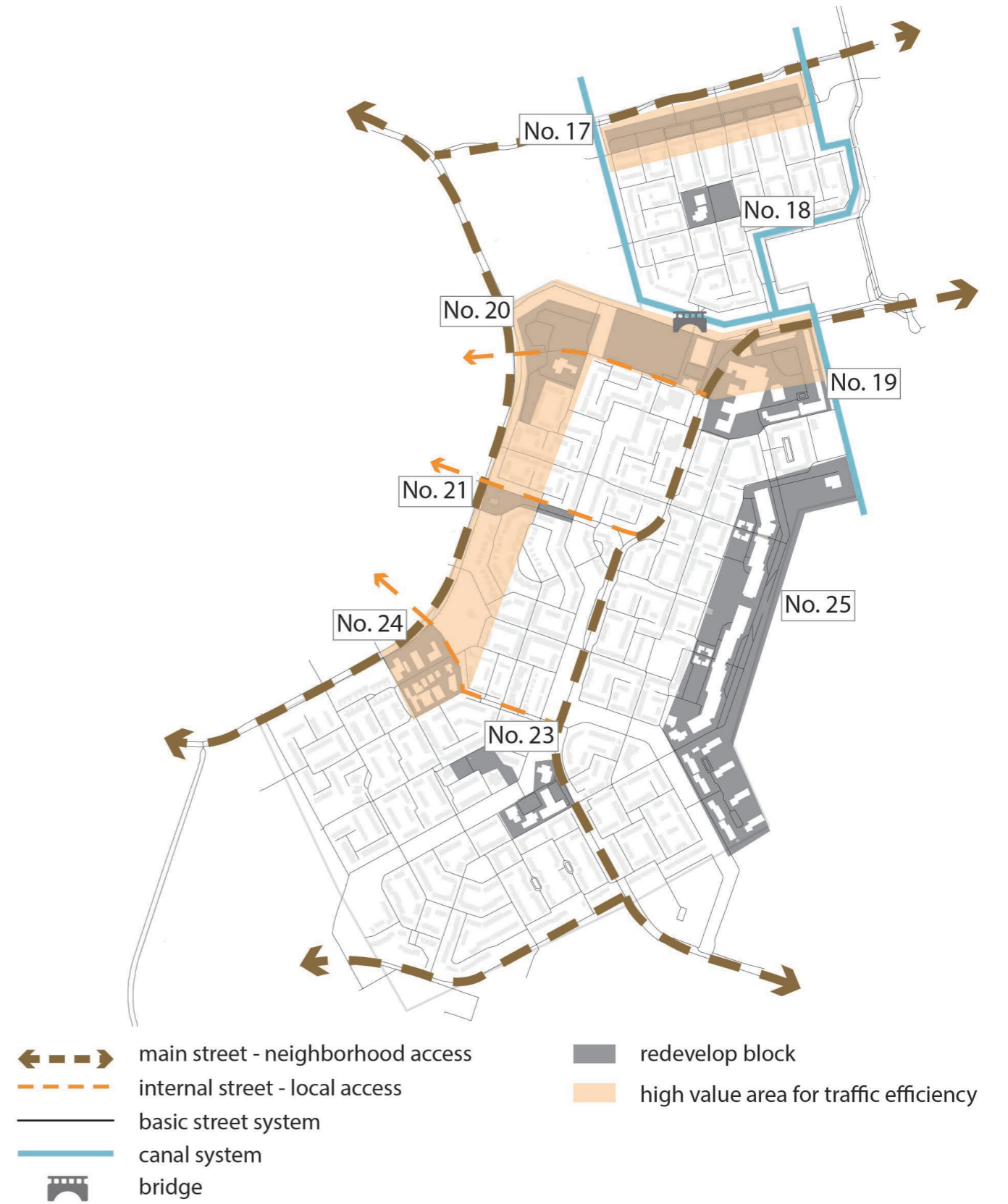
AV floor parking in community



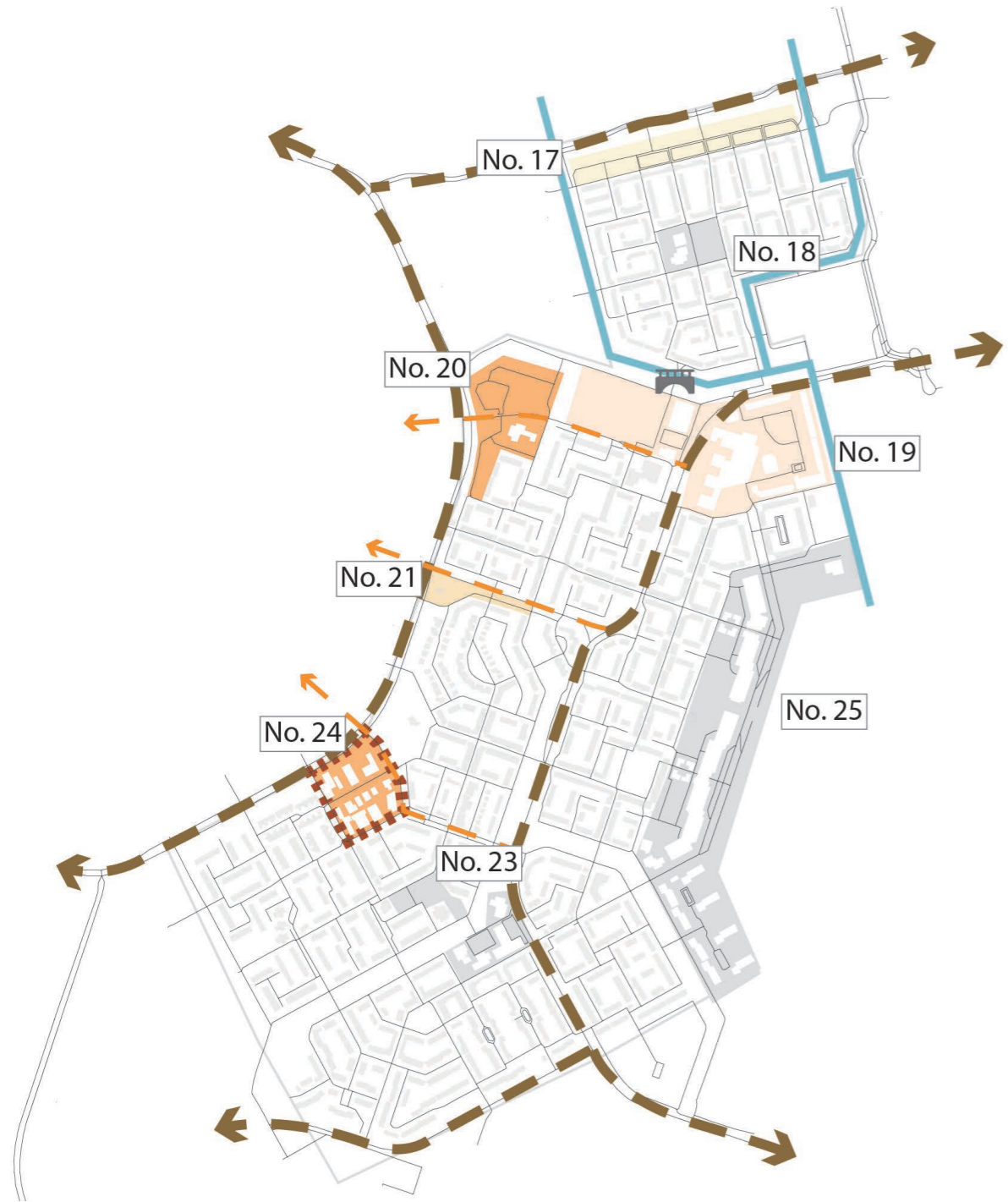
Building analysis of redevelop area



Traffic flow analysis



Possible position for AV floor parking



- main street - neighborhood access
- internal street - local access
- basic street system
- bridge
- canal system
- low to high value to place mixed-use building with AV floor parking
- transform parking function
- design area

Service range

Current function

Redevelop space for building surface (m²)

No. 24
mix border



$20000 * 35\% = 7,000$

No. 20
mix border



$26000 * 35\% = 9,100$

No. 21
community parking



$5000 * 50\% = 2,500$

No. 19
mix border



$83000 * 35\% = 29,050$

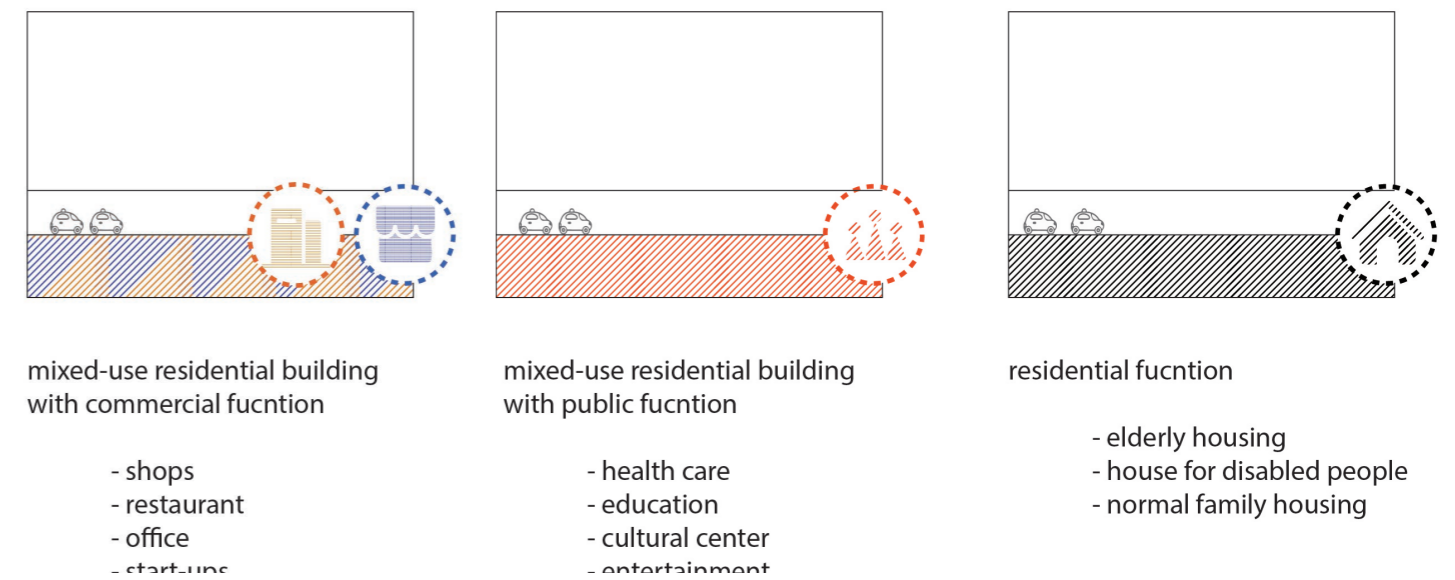
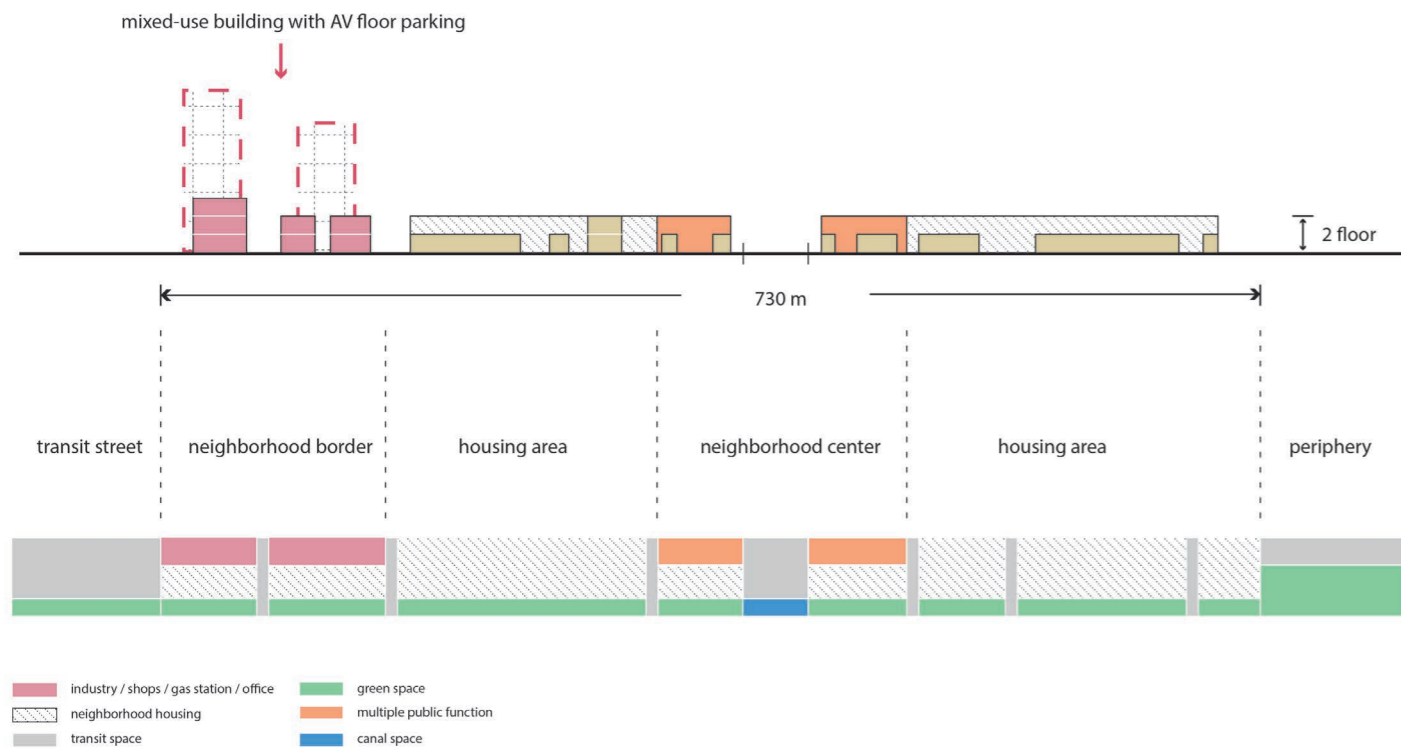
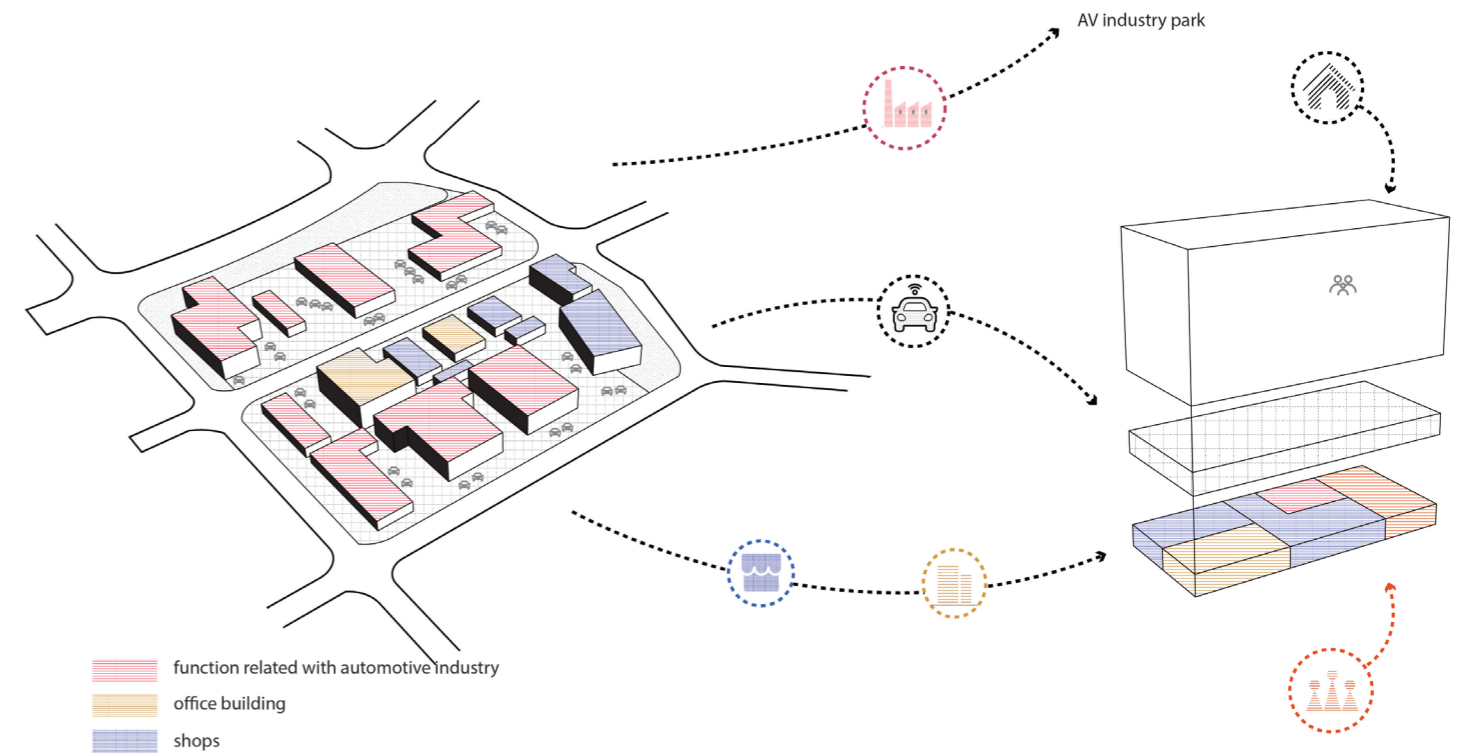
No. 17
community parking



$12000 * 35\% = 4,200$

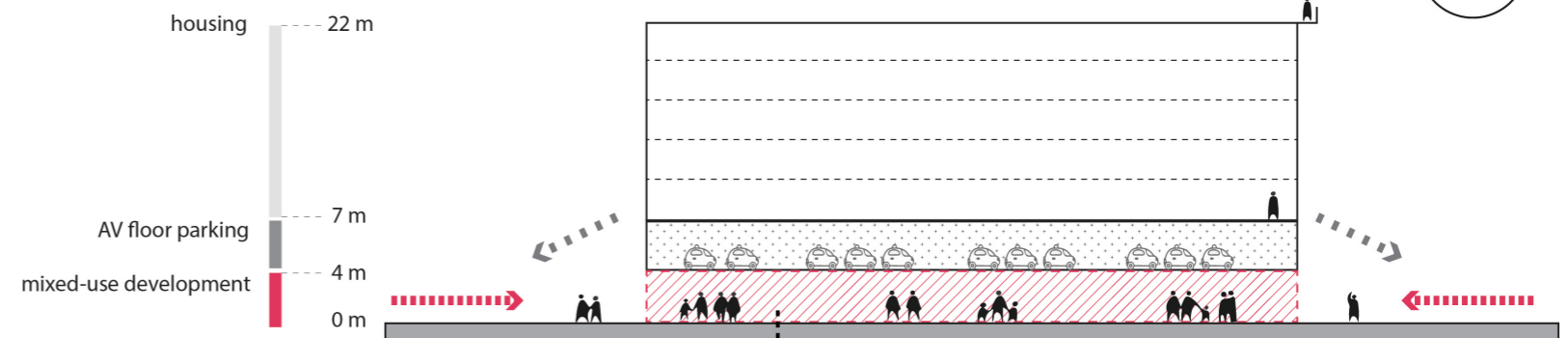
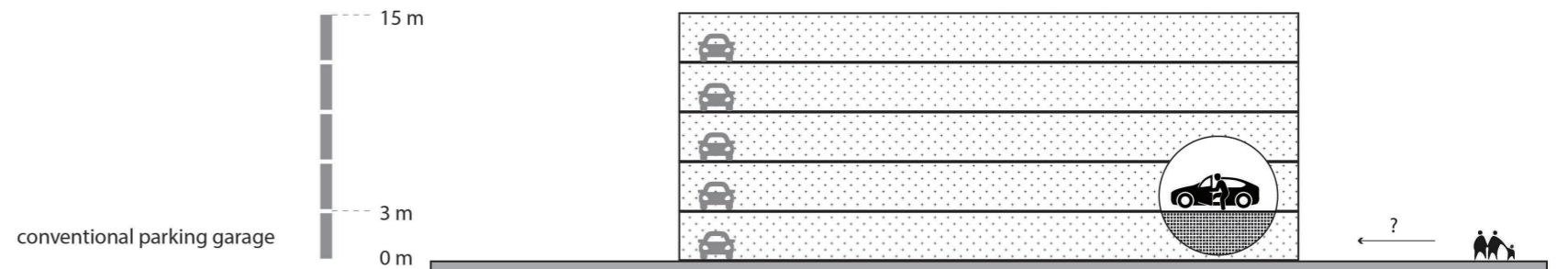
Mixed-use building with AV floor parking

The AV floor parking are placed in mix border in community, where the area is currently used in low utilization rate, or has low urban quality destroyed by car industry and ground parking. The current function related with automotive industry is moved to AV industry park in periphery. Combing with the outdoor activity strategy the low-quality border can be redefined into an attractive community integration and generate the sense of belonging



Transformation from current AV garage into mixed-use building with AV floor parking

The parking floor suited in first floor. Compared with the conventional parking, the ground floor can be opened up to have multiple function, such as shops, offices, cultural function, healthcare and housing.



- | | | |
|--------|---------------------------|------------|
| | | |
| shops | elderly housing | culture |
| | | |
| shops | house for disabled people | education |
| | | |
| office | normal family housing | healthcare |

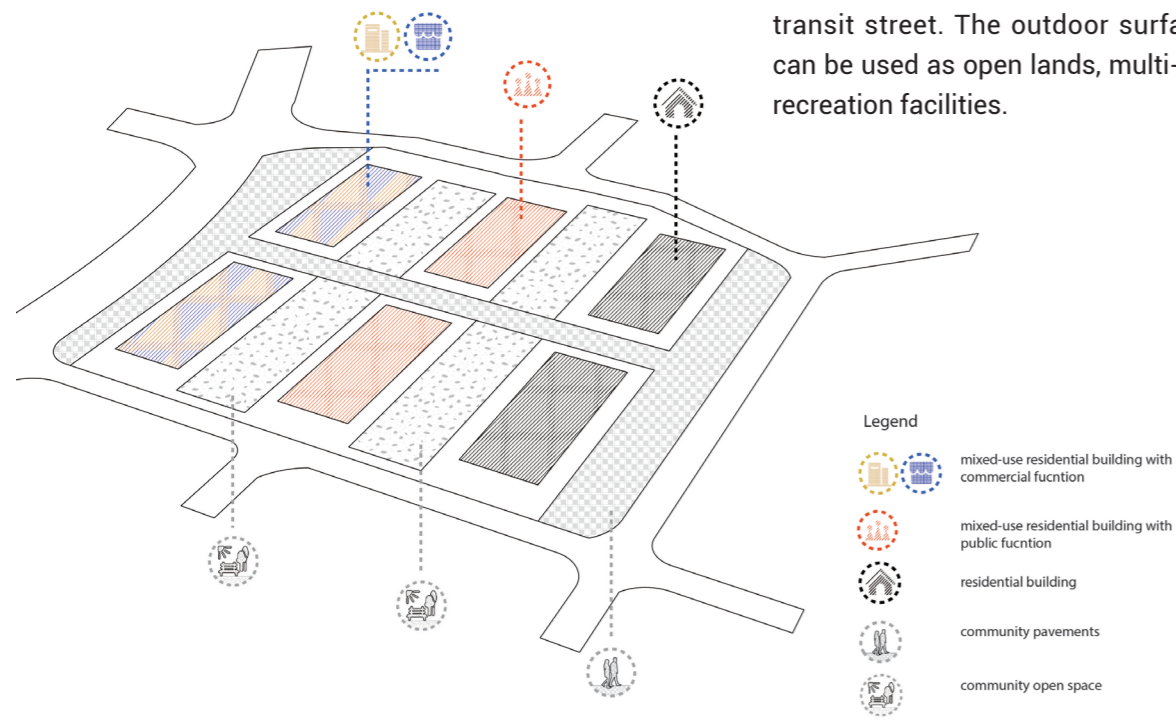
open ground floor
high value for ground activity



Design analysis - function analysis on surface

The project aims to transform the low quality community border into attractive urban district. As AV parking autonomously on the first floor, the community border can be reorganized and the ground space is designed to

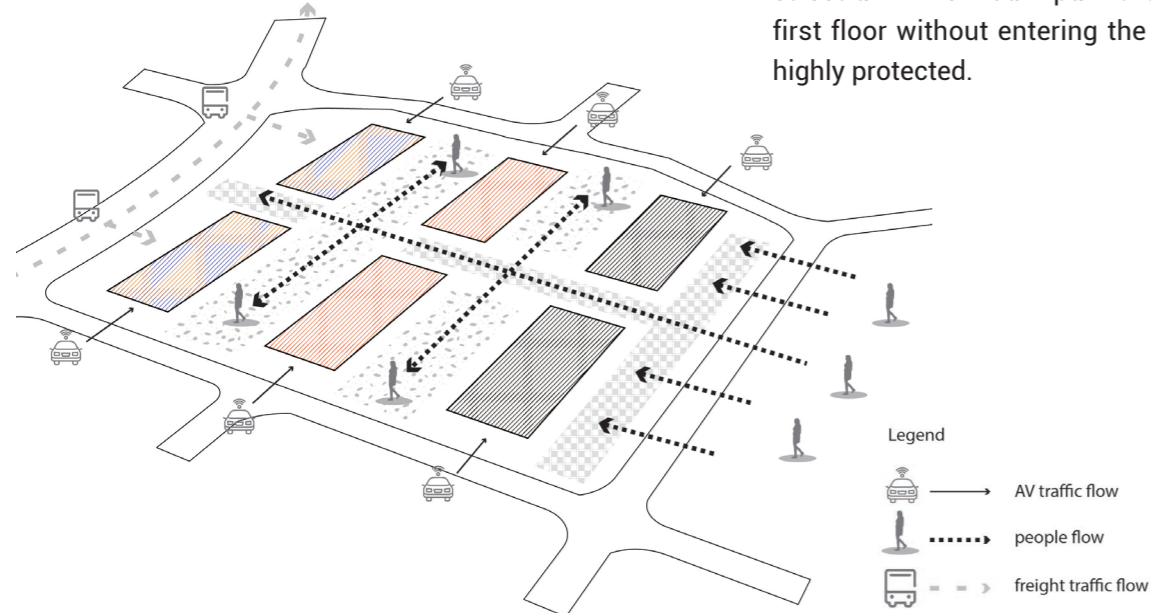
contain diverse and dynamic functions. The placement for mixed-use buildings is based on the publicity. The building with residential function on ground floor is placed close to community street. The building with commercial function on ground floor is placed close to transit street. The outdoor surface between buildings can be used as open lands, multi-use trail corridors with recreation facilities.



Design analysis - traffic flow analysis

With the new layout and surface function, the community border can be attractive on aspect of traffic flow as well.

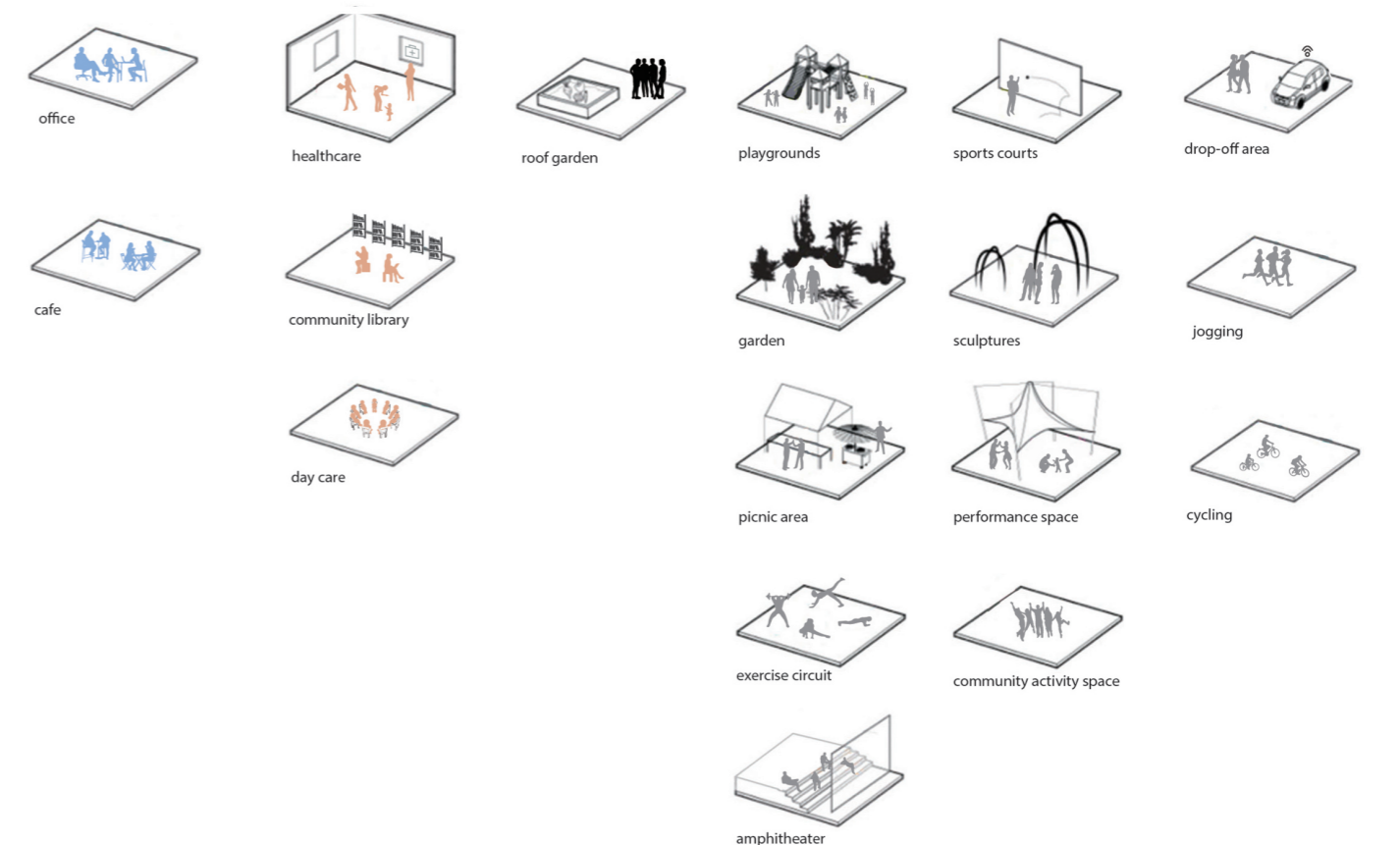
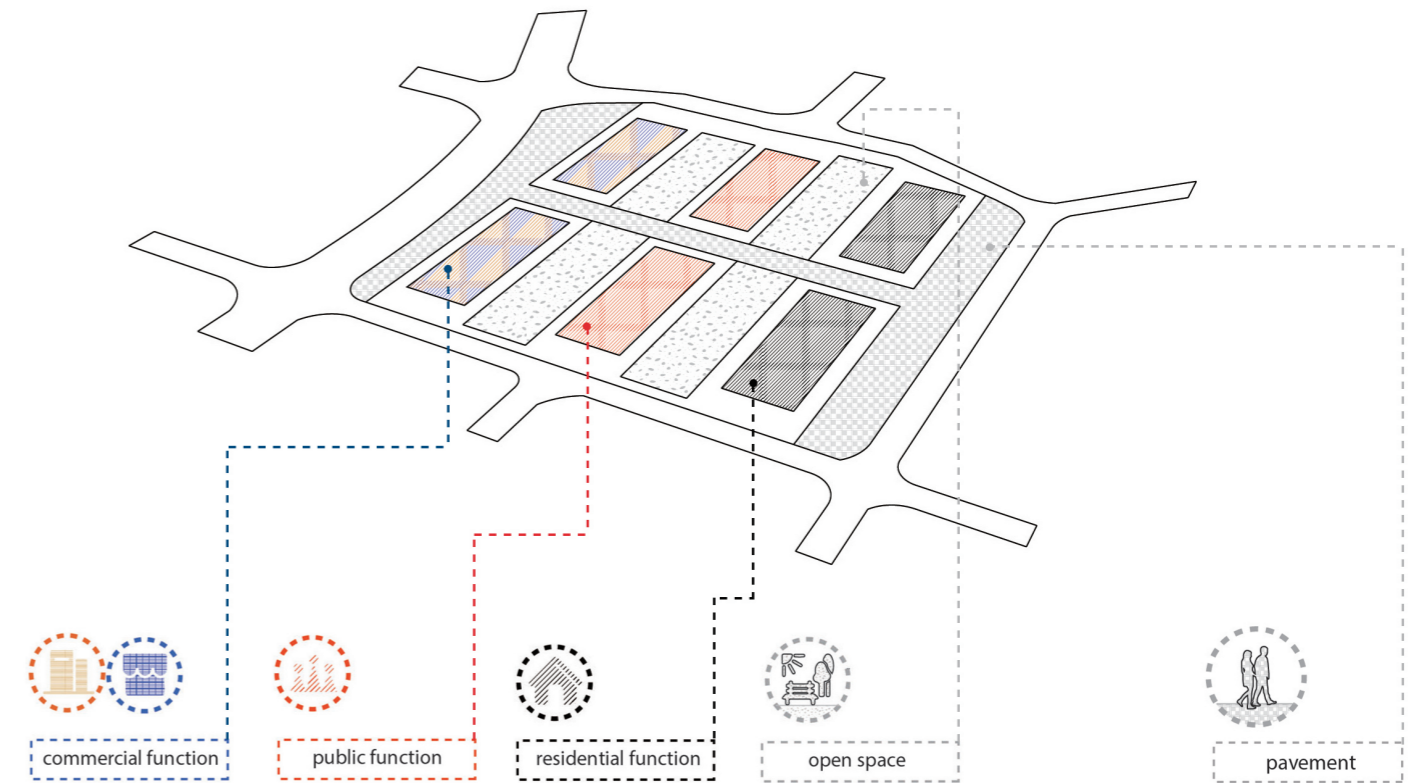
The commercial function is placed next to the transit street and AVs would park themselves directly on the first floor without entering the block. The walkability is highly protected.



Design surface elements

With AVs, the surface can be resealed to provide diverse physical activities. The attractive neighborhood

intervention is designed based on different kinds of physical elements.



Active community activity program

The project aims to design a full day and part day programs with a variety of activities in neighborhood border to keep different kinds of actors engaged and active all day long. The main actors can be divided into four types, including residents (people live in design area), neighbors (people live in nearby neighborhoods), businessman (people work in design area), visitors (people visit friends, access to public service, participate in outdoor activities).

Based on diverse surface elements, the project can provide different kinds of neighborhood activities such as commercial activities, business activities, night activities, community activities, and outdoor activities. By analyzing differences between activity period and popularity, the design will achieve an attractive neighborhood border and create a sense of belonging.

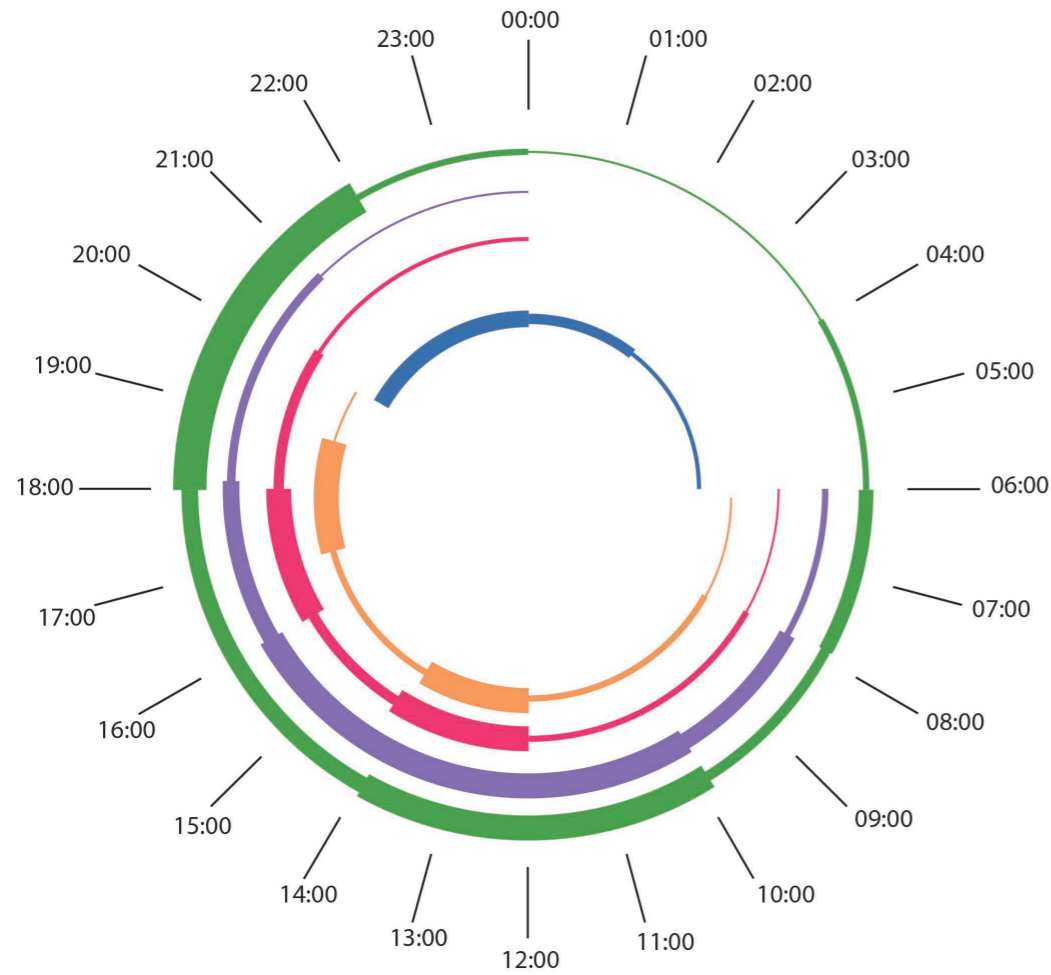
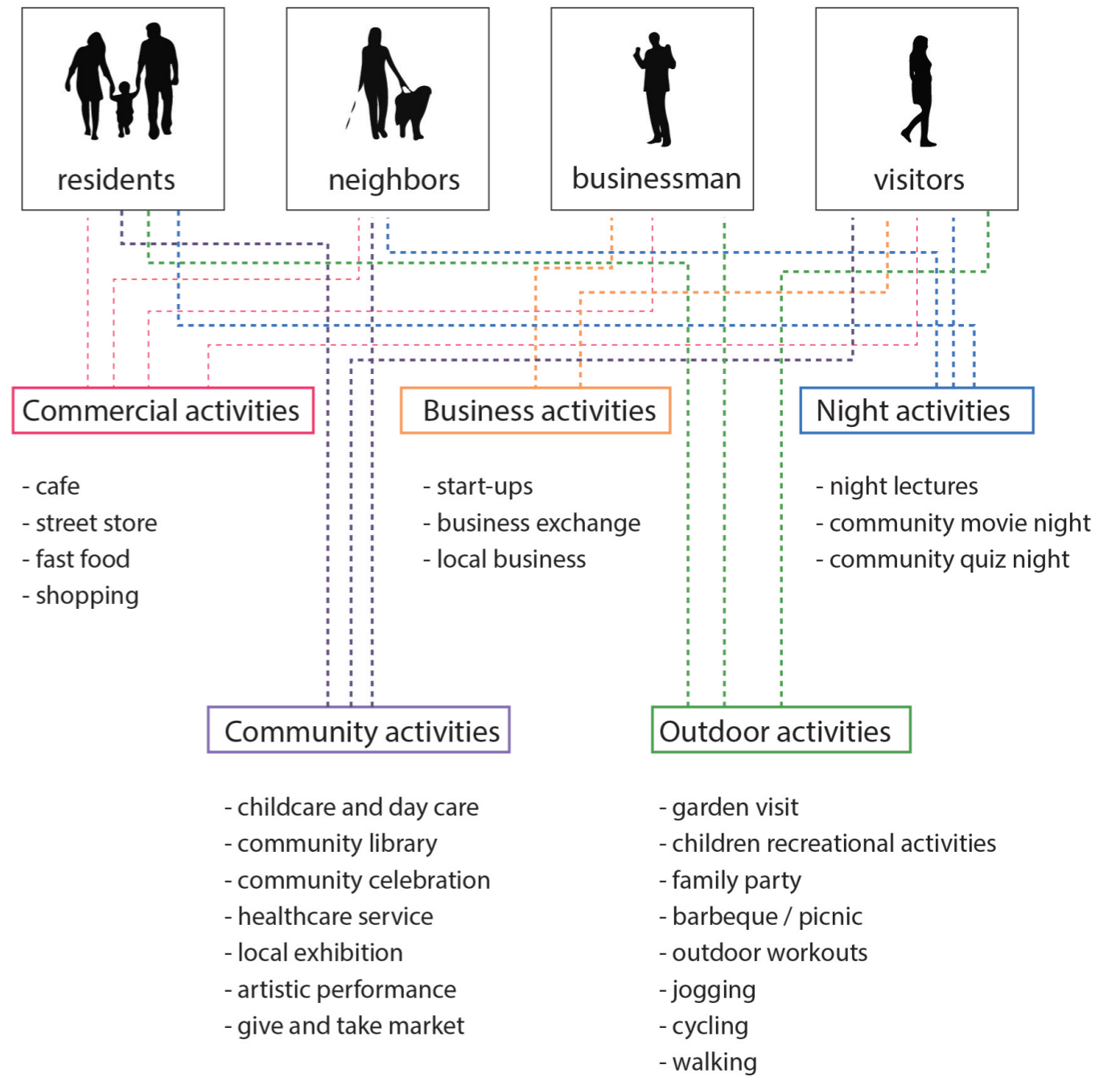


Figure : Activity analysis all day long



Design analysis - activity strategy on surface



REFLECTION

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This Project - Embrace urban growth, avoid urban sprawl

Research Group - Design of urban fabric

MSc Urbanism / Faculty of Architecture

Mentor Team - Rients Dijkstra & Dominic Stead

'How to design a compact Almere in a future of automated vehicles and contribute to urban sustainability?'

The role of automated vehicles

Automated vehicle (AV) technology is a rapidly developing technology that promised to revolutionize the form and function of our urban spaces. Exactly how and when AVs will impact the built environment is difficult to predict due to the uncertainty surrounding major factors, such as the size and design of AVs, the changes of the ownership models, the costs of AVs. However, we can see a vision of the future that illustrates some of the built environment challenges and opportunities that may arise with the transition to an AV world. The possible changes have impacts on different urban system, in different scenarios, it may lead to the opposite outcomes. The project is built on compact scenario where the government and sharing mobility take the lead in future AV world.

Parking revolution

Conventional parking consumes a significant amount of land, especially in suburban area where auto use is highest for commuting. Almere city is considered as a dormitory town for Amsterdam. The daily commuting between Almere and Amsterdam is busiest route in the Netherlands. The current number of car ownership is 0.37 per people. Taking 30 square meters as the average standard current parking space, there are almost 220-hectare space is consumed by parking function. In addition to parking, cars also require a significant number of supporting used such as gas station, repair shops and car washes. In compact scenario, mobility would be consumed as a service which lead to the shift from private ownership to public ownership. When autonomy is fully applied, the ownership would decrease up to 80%. Besides the ownership, the AV parking stall can also be shrink to free up parking space for new development. There are several reasons, the AV is considered to be designed smaller than conventional vehicles, the autonomous parking system would save the space for opening a vehicle's door, and parking stall stacks can be achieved to save space.

Mathematical analysis is done through research and design to come up with the most possible AV parking dimensions and number of AV ownership. The project proved that the average AV parking space is 14 square meters and the number of AV ownership will decrease to 35%. For Almere city, the number is 0.16 AV per people (the current number of car ownership is 0.37). The project designs an AV parking system in Almere centre area, to place 332,640 square meter AV parking space in total. To design flexible parking system, achieve the high service efficiency and make the transit clear conventional parking space, the project came up with three categories. The AV parking is divided into AV parking garage located in periphery area (50%), AV floor parking in border of community (40%). The last 10% of AV parking space is considered to be private for people who still want to own their personal vehicle. The position is highly related with their own preference, so the project did not give the fixed position for this category.

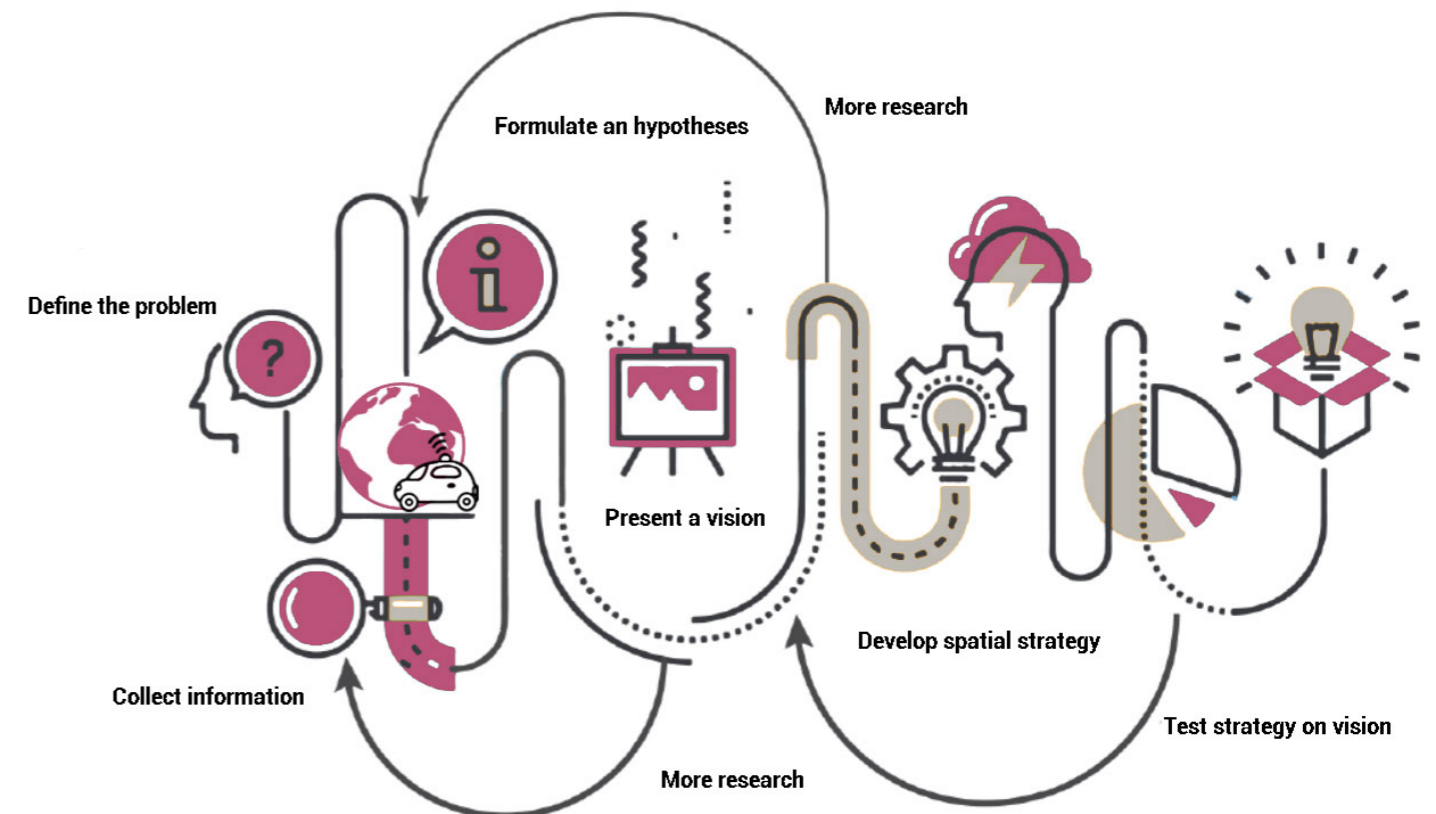
In the project, AV periphery parking is positioned in industry area, due to the good connection with highway which can achieve higher traffic efficiency in regional scale. The AVs are parked in AV parking garage in several floors from first floor. The ground floor is designed to be mixed-use development, adding AV supporting function as priority. The current automotive industry would be transformed by AVs, such as less vehicle production, less gas station, more repair and maintenance, more service provider. Large amount of space can be freed up due to the industry transition and transform the current parking space to place AV parking garage and achieve compact development such as new housing.

The AV floor parking are placed in mix border in community, where the area is currently used in low utilization rate, or has low urban quality destroyed by car industry and ground parking. The parking floor suited in first floor. Compared with the conventional parking, the ground floor can be opened up to have multiple

function, such as shops, offices, healthcare and housing. Simultaneously, the outdoor space have different activity strategy, to transform the low-quality block in to a walkable, accessible, and sustainable community border.

The relationship between research and design

There are different relations between research and design according to Nijhuis (2012): research for design, research through design and research on design. All these three process are used in this project. Such as the theoretical research and literature review is used to understand the board context for sprawl and compact development. Scenario building can be seen as the main method for research through design to find out the background condition to make the project more reasonable. The impact of automated vehicles on built environment is firstly build upon the researches done by related association and department, during the design, adjusted by the original thinking. The idea of research on design has been done exploring AV ownership, size of parking stall and designing AV parking system in periphery area and community border. Through this system-approach, the design proposal is build on the solid knowledge base.



Relevance to graduation studio

Urban Fabric studio focusses on the topic of Automated Mobility, exploring the possible impact on built environment within different scenarios and aiming to foster a sustainable and liveable urban environment. The studio considers the Amsterdam Metropolitan Area (AMA) as the research field, the project gets the initial input from understanding the growth of AMA and identify the city of Almere as the dormitory town, the typical outcome of urban sprawl, with low-density and single-use development. The sprawl presents as an unfolded urban form. One of the most important factor shaping the sprawl form is the rising affordability of the private automobile. The research between urban form and urban mobility perfectly fits the study goal, which is the relations between tangible and intangible structures in different contexts. The rise of autonomous mobility would bring a significant change in how people moving around and urban structure related with traffic. The project research the tangible and intangible convert and test the design intervention in Almere centre area. The scenario building is also practiced in this project to establish a solid storyline. The use of scenarios widen the research and explore what to stimulate and what to avoid in the aim for the compact future.

Reflection of the selected methods

During the elaboration of the project different methods were used. The methodology consists of a theoretical and contextual framework followed by a strategic and design framework based on the knowledge gained from the relationship between urban form and mobility. In order to build a solid knowledge base, certain tools were specifically developed. These tools are literature review, data analysis, mapping, site visit. The reflection on their adequacy is based on their contribution to the final results. In particular, it is interesting to focus on the two main stages of the work. Because each of them required identifying, recording, understanding, meaning-making, and transmitting information pertinent to the stable base

for the project.

The literature review is used to build the knowledge base for understanding the relationship between urban form and mobility, and possible impacts on built environment with AV intervention. Both of them work on the intervention between tangible and intangible structure. The former presents the long term study based on empirical evidence. The latter is a futuristic research and exploration. Learning from the past provided the critical thinking for knowledge-rich AV future. The project practiced a systematic study of parking revolution with AV intervention. Without this particular step, the transition from the abstract to the concrete dimensions would have been unrealistic.

Data analysis is used to provide a mathematical thinking in transforming numbers into space. This is crucial to design a fulfilled vision. The basic numbers are gathered from different aspects, such as conventional parking dimension (vehivle size, parking stall, parking garage ramp, parking floor height), population (in current and future). Combining with knowledge base for AV, the AV parking dimension and AV ownership is proved to be the scientifically convincing. This helped the project to promote a realistic future vision and solid design.

Social and ethical relevance

As described during the thesis, with AV applied, large amount of space can be freed up by parking revolution. Multipole strategy and design can be practiced creatively. The project provide the compact development and valuable surface design aims to embrace the sustainable future.

Nowadays, car-parking takes over the valuable land in city and eliminate the quality of space. Such as the board ground parking is chartered as one of the main factors that making community border less attractive. With AV parking revolution, those urban blocks can be redeveloped to provide efficient transit, start new local

business, accommodate new residents, obtain outdoor activities, and celebrate community meetings. These interventions would create a sense of belonging which the most Almere residents think is lack of.

In the larger context, the coverage of AVs and sharing mobility could serve to improve accessibility for disabled people and the elderly. For the whole society, access to transportation is closely linked to opportunities for employment, education, health care, and recreation. For ecology issues, with the decrease in AV ownership, the carbon emission will drop as well, which is a way to prevent global warming. The free up car-parking space can be redeveloped and contribute to environmental-friendly function. For economy, automotive industry will be affected. The trucking and freight industry will be among the earliest adopters of automotive driving as companies seek to improve transport efficiency. Autonomous driving systems will free drivers from the task of driving, and eventually many driver jobs will be eliminated when such systems become a reality. This will enable for city to have new start-ups in AV park and local business in community border, resulting in an increase in economic benefits.

Project transferability

The project deals with compact development in Almere city intervened with parking revolution. The main futuristic numbers are scientific convincing. To make the project transferable, the project did not look at the extreme condition, research and original exploration has been done to firstly have the possible range then choice was made based on the current situation. The design structure, for example, the AV parking stall and future ownership, the space for AV parking in Almere centre area can be directly used in other AV related projects. For AV parking system, there is also an extreme that all AV can be parked in skyscraper in periphery. The project provided different parking solutions to achieve better service efficiency and transferability. In a larger picture, for design size, the project focus on Almere

center area. In general, the statistic (AV parking stall and future ownership) can be applied to other Dutch cities. The parking system can be applied to mid-size or larger cities where are capable to hold both AV parking garage in periphery, AV floor parking in community and AV private parking. For those small-size, cities may only have AV floor parking are more flexible or several cities may share one AV parking garage.

Limitation

Despite reviewing municipal documents and visions for the Almere city, a major limitation was the government-oriented AV control. Federal policy needs to be made to avoid AV spread everywhere. In thesis, government should make the price hierarchy to limit the ability for AV travel. Without control, such as people travel further to have new housing in green area is likely to happen. In the coming research period, I would try to contact stakeholders and cooperate with municipality. This would be helpful in policy design. In report, the economic activity proposal is made, such as the ground floor for AV parking garage and new housing in community border (with AV floor parking) is designed to place new business at priority. The current Almere economic condition and future competitive strength need to be explored. The strategy proposal can be further defined.

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