CITIES ON THE MOVE: ENVISIONING CITYSCAPE IN THE AUTONOMOUS VEHICLE ERA

Abstract

As cities have developed in response to a rapidly changing environment since the industrial revolution, a variety of circumstances and issues have arisen. In cities, technology development and the rise of private automobiles have been related to urban sprawl, traffic congestion, environmental degradation, and mobility inequalities. Currently, autonomous vehicles are bringing a paradigm shift in mobility as technological innovations accompany the fourth industrial revolution. As cities undergo renewal through new mobility, recent developments in driverless technologies should be considered for their long-term impact on the built environment. The purpose of this thesis is to propose a design, along with a set of scenarios, for a transportation hub in the era of autonomous vehicles to address complex mobility requirements. Through bringing together existing case studies, research on autonomous vehicles, and drawing conclusions regarding the relationship between mobility and urban landscapes, this thesis explores how autonomous vehicles will affect the future built environment in a set of timelines. Considering the future transportation hub will require programs and infrastructure to support autonomous vehicles, this thesis also provides a vision of the future of transportation modes and how they interact. Finally, a transportation hub design model and automation city model for the AV era will be proposed.

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Autonomous vehicles, autonomous urbanism, transportation, shared mobility

Introduction

The change in transportation in cities affects urban space and structures. In most of the pre-medieval cities, where horses were used as a means of transportation only by nobles and armies, the spatial structure of villages was defined according to the limitations of walking. Medieval cities built roads based on the width of carriages, and Le Corbusier's Ville Radieuse was designed to contain effective means of transportation. There has always been a crucial link between transportation technology and the growth of cities — whether it was the introduction of locomotives or the advent of automobiles, each introduced a new foundation for city planning at the time.

The fourth industrial revolution has brought about changes in transportation, and the era of autonomous vehicles is rapidly approaching. A range of companies are experiencing breakthroughs on the technical front. Google Waymo's self-driving service completed more than 709,000 miles with a safety driver in the state of California, and South Korea is pursuing full autonomy by 2035 and will be tested with the upcoming Genesis G90.

Along with various scenarios, the following perspectives have been explored by researchers when developing autonomous cities: Electrification, Decentralization, Digitization, Autonomous, and Shared Mobility (Lombardi et al., 2018).

There is, however, a lack of data on the scenario of what cityscapes could be imagined when autonomous vehicles are expected to be introduced in the near future, along with assumptions about what cityscapes will look like when the fully automated vehicle has come. We also need to imagine what cityscapes are expected within the new urban development context.

Considering the necessity to set scenarios for AVs within a set of timelines, this paper presents Split, Croatia, as a possible site of impact, and a possible location for AVs. It is based on the concept of a future city that is based on an international Expo. By comparing two sets of timelines, it will be possible to envision how AVs will integrate into complex mobility environments. The transportation hub design and autonomous city environment will be discussed.

Analysis of Existing Research

Methodologically, a variety of articles, reports, and design studies related to autonomous urbanism were reviewed for analysis, planning, and design.

PEDESTRIAN-ORIENTED STREET ENVIRONMENTS

As driverless cars become more common, they will be more compact than today's cars. As a result, street widths will be reduced, and curbside parking will disappear (Cohen, 2017). With shared fleets replacing individual ownership, the number of vehicles on the road may be substantially lower in the AV future, resulting in even less lane space required (Schlossberg et al., 2018). In this newly created space, designers will develop pedestrian-friendly spaces with wider sidewalks or gathering places for the community.

REDUCED PARKING SPACE

By eliminating people from the parking process (as well as the staircases, elevators, and circulation spaces humans require before and after they park their cars), we could reduce parking space requirements by two square meters per vehicle (Quintal, 2015). Also, Audi's strategy in Somerville is to plan a garage exclusively for self-parking cars, which will save 62 percent of the area of assembly row, or the equivalent of $100 million in monetary values (Chin, 2015). As parking demand progressively decreases, there are myriad options for the reuse of reclaimed parking space for other uses (Barber et al., 2018).

SMART MOBILITY SYSTEM

'Mobility as a Service' (MaaS) refers to the idea of bundling personal mobility services in a seamless, coherent way. It is expected that mobility providers and consumers will be able to reduce transaction costs using MaaS and the delivery of multimodal trips. MaaS offers a focus on public transportation — efficiency gains could increase public transport's market share, while car ownership decreases (Kim 2018).

A space lab at IKEA explores the ways we can repurpose space on wheels for a more fulfilling life (Space10, 2018). By installing programs on vehicles, low-income communities will be able to improve their access to stores and markets, and medical professionals will be able to visit people in need.

FUTURE MODEL

To envision a future model in the AV era, a set of timelines and scenarios were set based on the Gartner Hype Cycle (Blosch & Fenn, 2018). It is important to consider the

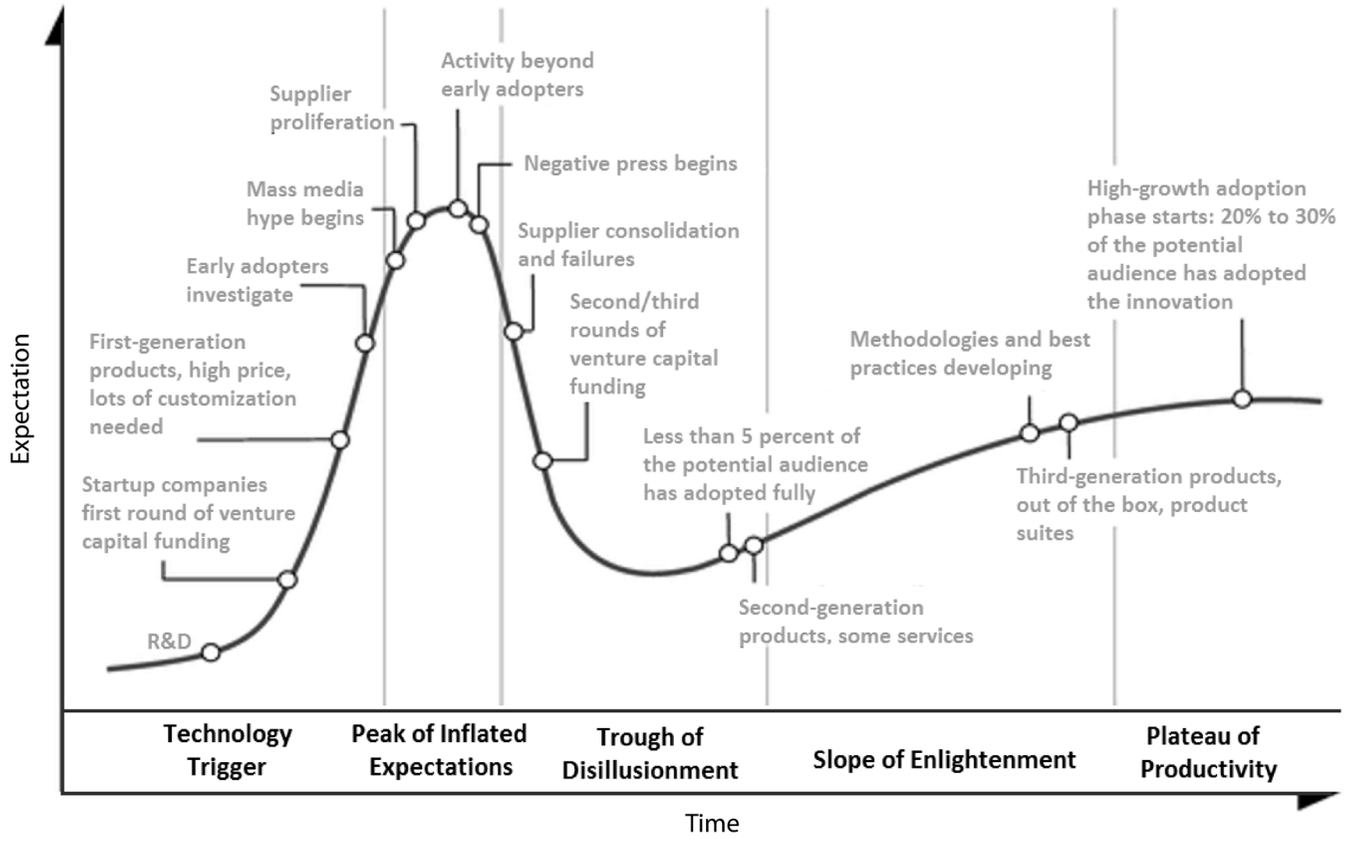

Figure 1: Gartner Hype Cycle. (Source: Gartner.)

Gartner Hype Cycle now (Figure 1), given that we are in phase of the Peak of Inflated Expectations with regards to AVs (Shieh, 2022). The hypothesis of the timeline has been set as there will be an international expo in 2035 as new urban development that becomes a future city in 2050. In alignment with Gartner's hype cycle, it is expected to enter a phase of Slope of Enlightenment in 2035, and a phase of Plateau of Productivity in 2050 regarding AV technology.

THE TRANSPORTATION HUB MODEL: 2035

As the heart of the future city, the transportation hub plays a significant role in enhancing Expo's experiential character. There was a major focus not only on AV exhibits but also on the interaction between future modes of transportation, such as maglev, AVs, subways, and micro-mobility. As a transportation hub, the building ensures that all visitors have easy access to a variety of transportation platforms throughout the city. In this phase, automobile and AV parking spaces will be separated to allow future conversion to other programs and for smart parking systems for the AVs (Figures 2, 3 & 4).

THE AUTOMATION MODEL: 2050

In 2050, the mobility system and transit network will be different from the timeline of 2035 (Figure 5). As a result of fully automated shared vehicles, a wide range of automated travel options will be available, including a flexible shuttle service, a rapid bus service, automated rail, ferries, and air taxis. The proliferation of shared, electric, and automated vehicles will prevent pessimistic scenarios of the AV era such as urban sprawl, congestion, and pollution.

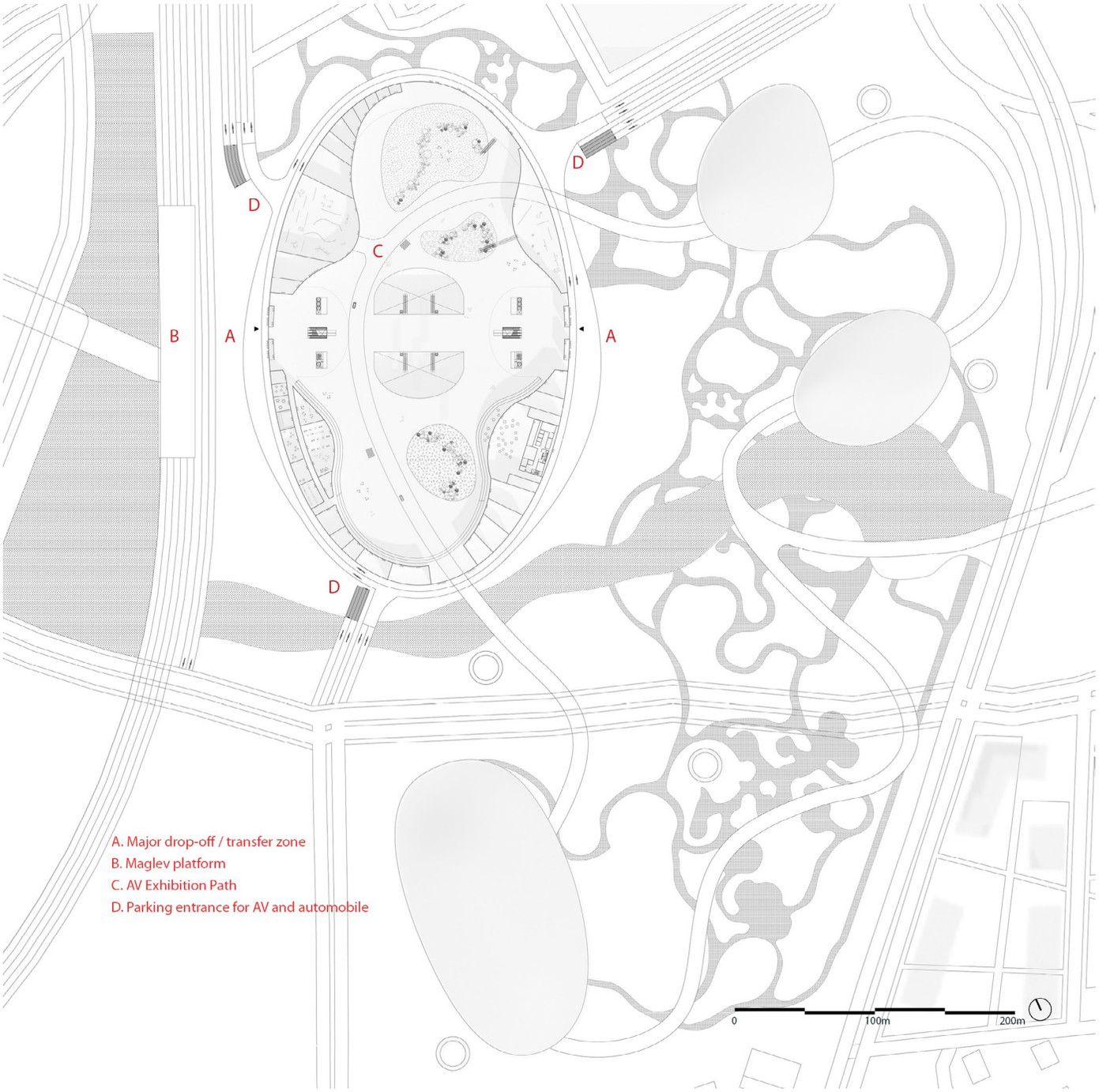

Figure 2: Site plan. (Source: Author.)

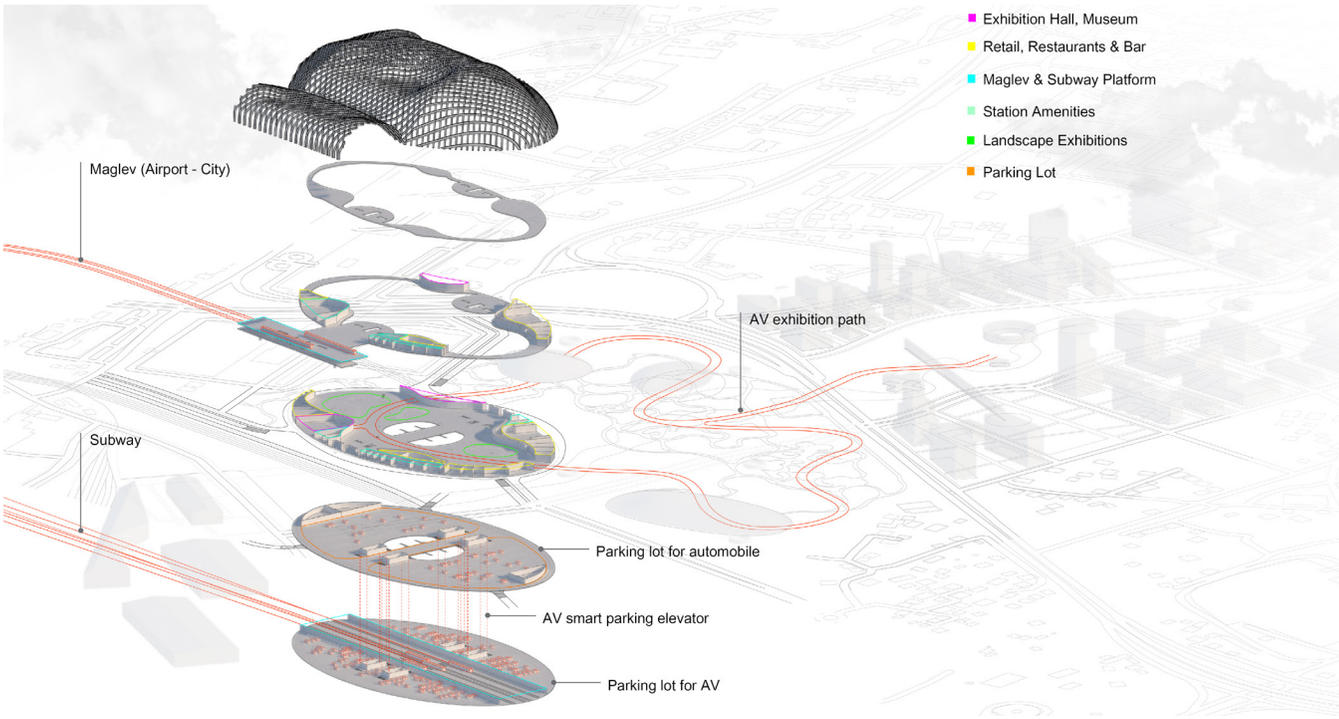

Figure 3: Program diagram. (Source: Author.)

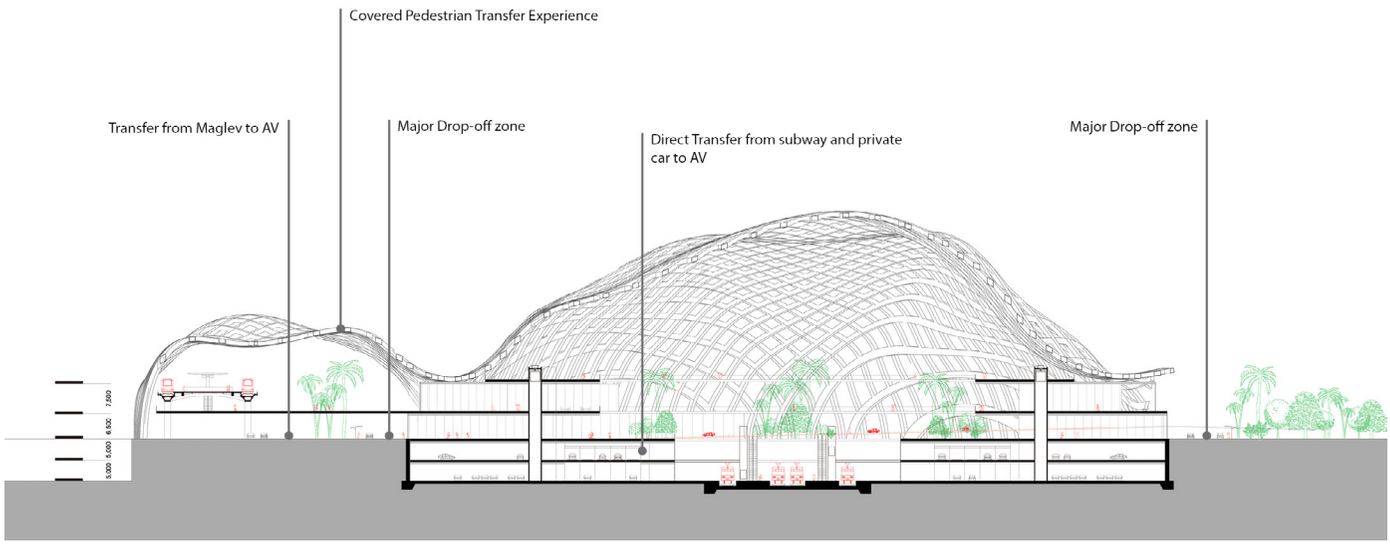

Figure 4: Section. (Source: Author.)

Figure 6: Major street design. (Source: Author.)

There will be an expansion of the public space for pedestrians in the AV era as the car lanes will be narrowed, crossing will be safer with AV technology, and personal vehicles will become more important. Additionally, streets are envisioned as vibrant public spaces that support various outdoor activities beyond adjacent buildings (Figure 6).

COMPARISON OF MOBILITY HUB AND HYBRID NEIGHBORHOOD IN 2035 AND 2050

Two timeline scenarios of a newly developed city are presented to show potential scenarios in the AV era. A mobility hub and hybrid neighborhood shown in 2035 illustrating reclaimed public space, condensed parking, a reclaimed highway, and ground-level parking (Figure 7). By 2050, dynamic AV drop-off areas will be created, and highways will be transformed into urban forests and public spaces. Temporary pavilions from the Expo will be relocated to the suburban area for AV parking, maintenance, and charging.

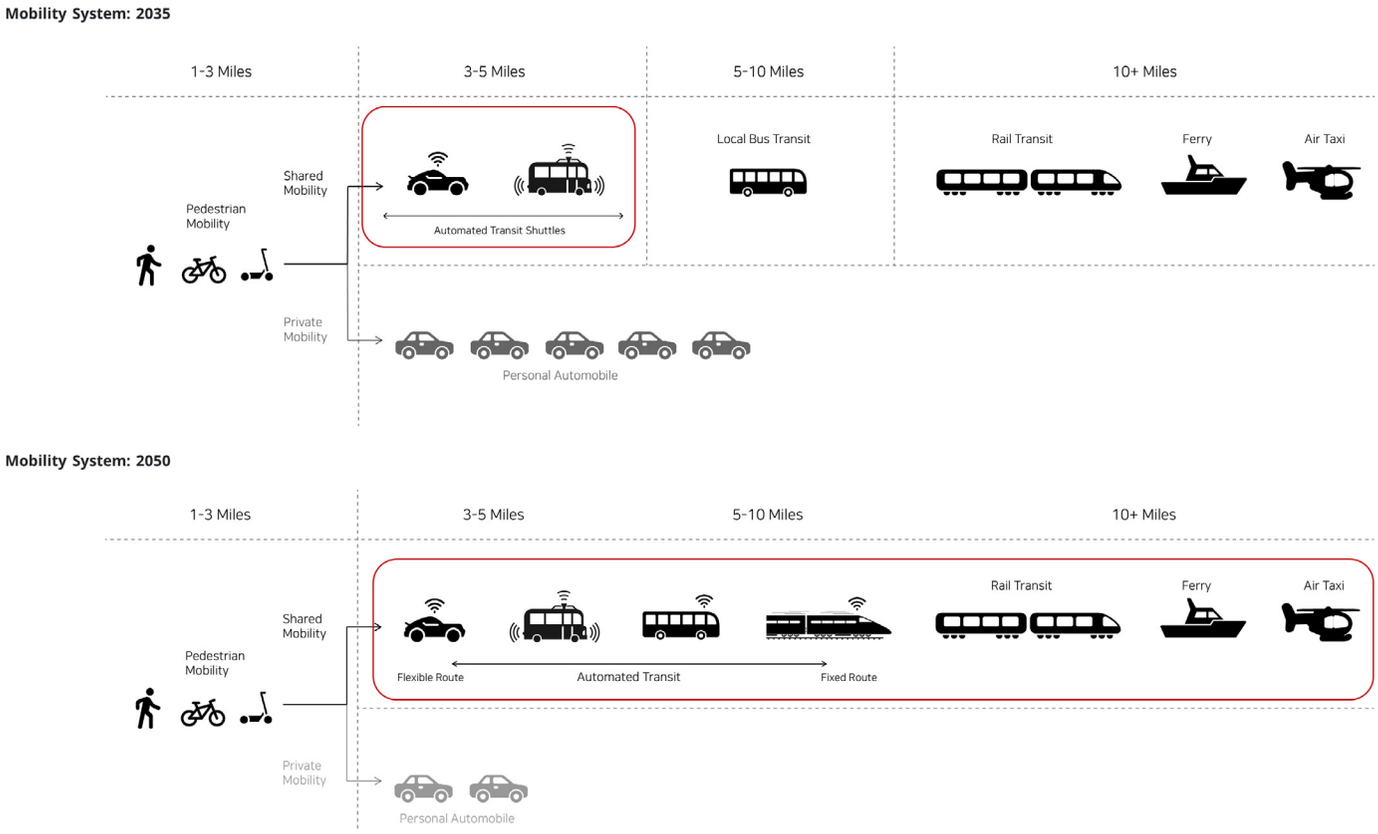

Figure 5: Mobility system. (Source: Author.)

Additionally, hybrid buildings feature AV drop-off areas at their entrances. Furthermore, the ground floor parking would be transformed into a dynamic public space.

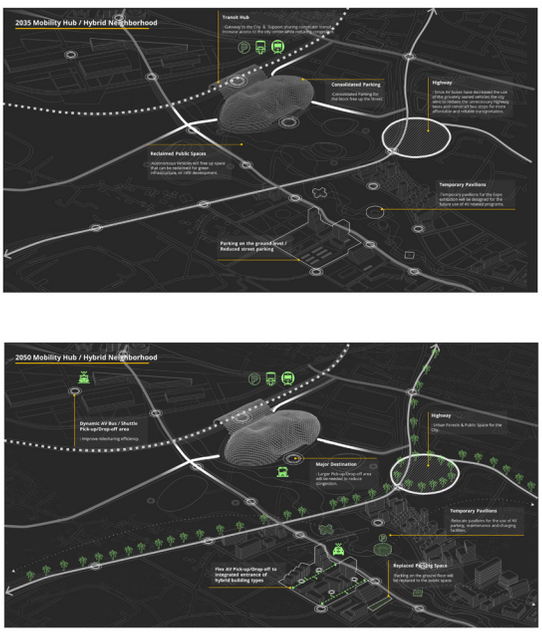

Figure 7: Mobility hub and hybrid neighborhood comparison. (Source: Author.)

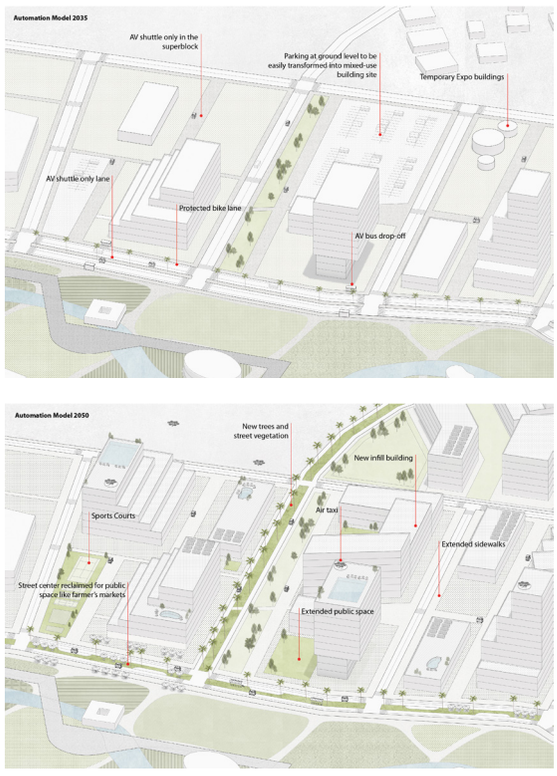

Figure 8. Hybrid neighborhood comparison. (Source: Author.)

For hybrid neighborhoods in 2035, there will be an AV shuttle-only lane, while regular cars will still be allowed on the road with protected bike lanes (Figures 8 & 9). In the superblock, an AV shuttle will be able to run on-demand routes. After full automation in 2050, sidewalks extended, new trees and vegetation, and the street center will be reclaimed for public space like farmer's markets. The ground floor's parking lot will be transformed into a public space such as a park or sports court, as well as an infill building to accommodate hybrid programs since walkable neighborhoods are necessary. It may also be possible in this phase to commercialize air taxis, with multiple roof drop-offs

Conclusion

In response to the rapid advancement of AV technology, this study presented possible scenarios for urban development with a set of timelines. Furthermore, this study gives a general overview of how changes in transportation can affect urban development, including transportation hub, street spaces, and building environments. Since this study was proposed on the premise of several assumptions, the proposed model cannot apply to all scenarios in the autonomous future. However, this study may contribute to the studies on possible urban development scenarios in the autonomous era, thus contributing to the practical implementation of a sustainable urban environment.

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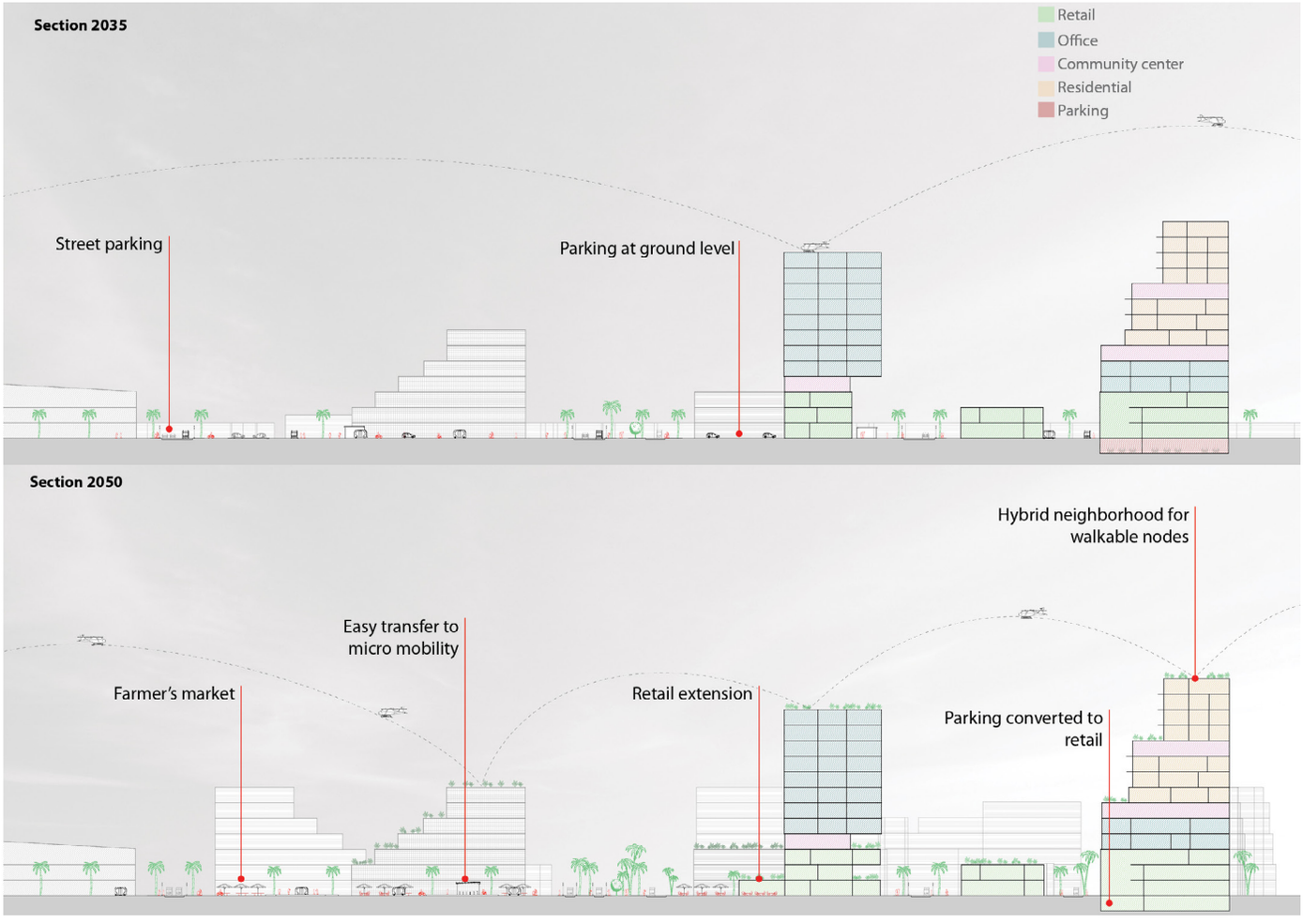

Figure 9: Section view comparison. (Source: Author.)