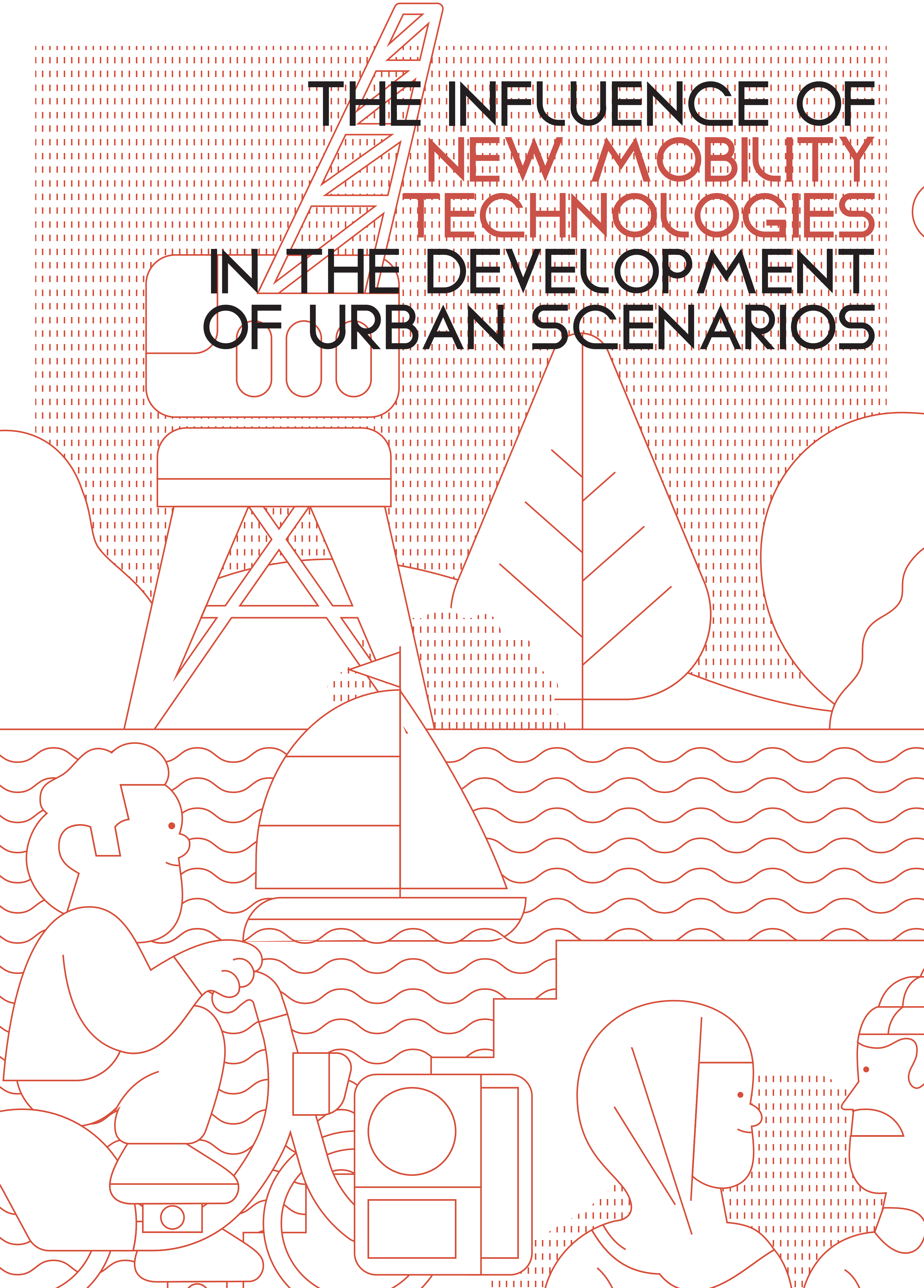
THE INFLUENCE OF NEW MOBILITY TECHNOLOGIES IN THE DEVELOPMENT OF URBAN SCENARIOS



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L'INFLUENZA DELLE NUOVE TECNOLOGIE PER LA MOBILIT NELLO SVILUPPO DI SCENARI URBANI

THE INFLUENCE OF NEW MOBILITY TECHNOLOGIES IN THE DEVELOPMENT OF URBAN SCENARIOS

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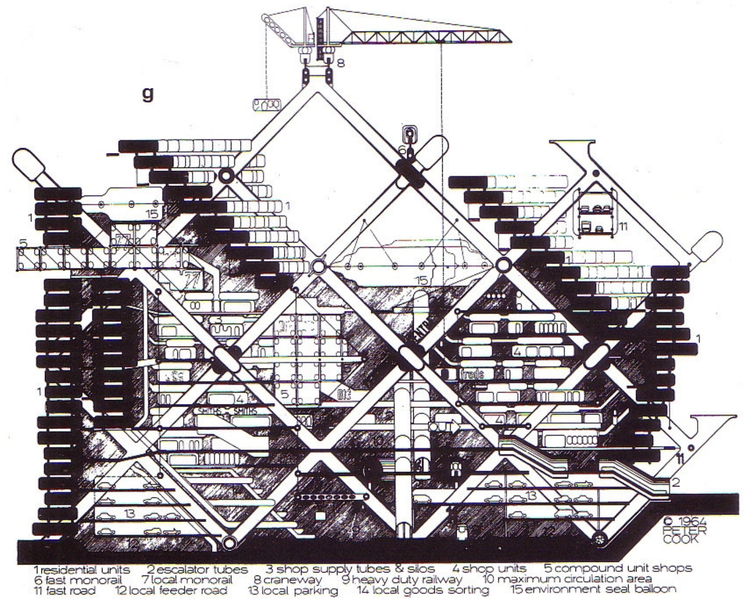
ABSTRACT

Mobility is the most significant factor on urban appearance and people's lifestyles, also the innovation of mobility depends on new technologies. At present, urban modification is becoming an obstacle in the future mobility innovation process. Therefore, it is important to choose new technologies that the city may or need to have during planning.

How to choose has become a problem for planners. The purpose of this paper is to study the influence of new technologies of Mobility. First analyze the technologies' causes, assessment of mobility, and the trend of urban space. Secondly, I aggregate and extract solutions through case studies. In order to make these solutions more visual, I try to produce the references for the promotion of mobility through modularization. Finally, use this way to transform and design on the mobility in case city Shenzhen, for conceiving the future urban public space, architectural features, and new lifestyle.

INDEX

1. INTRODUCTION



"Plug-in-city", Peter Cook, UK(1964)

"By 2030, 60% of the world's population will be urban. To help cities cope with this massive population growth, urban transport solutions need to safely and sustainably improve the way people get from A to B.
This new mobility system, as outlined by Airbus, includes critical pieces such as electric and autonomous air vehicles, on-demand air services, Unmanned Traffic Management solutions and well-integrated transportation infrastructure.
Urban Air Mobility supports the larger mobility system, advancing the shift from individual vehicle ownership towards shared mobility as a service. With important collaborators these systems integrate sustainably and harmoniously into cities, delivering unprecedented and seamless multimodal door-to-door transport."
"City and the sky above, 2019/2020 UABB", MVRDV, Airbus

"In the last decades, the exponential growth of the population has been mirrored by a restless increase in motorized vehicles. According to the 2018 World Bank report, the number of vehicles on the roads will double in the next 30 years, reaching 2 billion units by 2050. If we extend the western per capita car ownership value to East Asian countries, we can expect the largest wave of motorization ever witnessed by the planet. For this reason, we have to imagine an unprecedented social, technological and economic shift that will fundamentally change the way people and products move.
Thanks to new technology and socio-economic components, we can imagine a systemic change that moves away from the current mobility model and can prevent the already problematic traffic condition from becoming even worse."
"Transforming the Landscape of Mobility, 2019/2020 UABB", Mobility in Chain (MIC), Tiziano Cattaneo, Carmelo Ignaccolo

"Recent developments in driverless technologies are bringing discussions about the urban environment to the forefront. Automotive and technological industries are envisioning the future of our cities and developing the vehicles themselves without establishing a conversation with the architectural discipline. Yet, proposed driverless scenarios appear to emphasize consensual solutions where idealized images of the street seamlessly integrate their technologies. Ignoring the immediate future, these visions focus on a more distant time where technology dominates: driverless cars populate the road, human behavior and city infrastructure remain unchanged, and society has learned to live with autonomous vehicles."
"Driver Less Vision Shenzhen, 2019/2020 UABB", University of Technology Sydney - Harbin Institute of Technology

"Conventional streets are static and rigid, but people's needs change throughout the day. Fortunately, automation technology and the sharing economy allow for a street that is radically different. The Autonomous Street changes its function and configuration on-demand. With the press of a button, mobile stores and health clinics pop-up. Food and beverage carts arrive just when people need a cappuccino or a sandwich. An extra traffic lane avoids congestion during rush hour. Benches arrive when there are not enough places to sit. And when people want to be entertained, a basketball court or performance venue rolls in."
"The Autonomous Street, 2019/2020 UABB", Kohn Pedersen Fox Associates

"Recent developments in driverless technologies are bringing discussions about the urban environment to the forefront. Automotive and technological industries are envisioning the future of our cities and developing the vehicles themselves without establishing a conversation with the architectural discipline. Yet, proposed driverless scenarios appear to emphasize consensual solutions where idealized images of the street seamlessly integrate their technologies. Ignoring the immediate future, these visions focus on a more distant time where technology dominates: driverless cars populate the road, human behavior and city infrastructure remain unchanged, and society has learned to live with autonomous vehicles."
"Driver Less Vision Shenzhen, 2019/2020 UABB", University of Technology Sydney - Harbin Institute of Technology

"cars will become fantastic objects used as game simulators to enhance the virtual pleasure of driving, an experience almost completely forgotten by self-driving users. These equipped car bodies will be parked in living rooms and not in garages, recreating the intimate relationship between the vehicle and its owner. They will provide a dream like background for a lifestyle that has been radically transformed by the new forms of mobility."
"Self-parking Bang, 2019/2020 UABB", MOTOElastico

Quotations are extracted from 2019/2020 UABB(Shenzhen) "Eyes of the city"

URBAN MOBILITY

Psychological Actuation

Although mobility is not a simple geographical movement, our improvement of mobility must start with the most basic unit -- the street. Based on the proposed hierarchy, it is possible to estimate the order of importance of the involved items in the process of choosing modal transportation decision making in an urban area. User-specific rankings about the importance of each of the available transportation modes need to drive each decision in mobility.[1] We can use Maslow's psychological pyramid to reflect people's psychological needs for streets and the trend of streets in the future. From the bottom of the basic needs to the top of the self-fulfillment needs. (Fig. 1.1)

In addition to the influence of people's psychology on urban mobility, there must also be the influence of street space on mobility. The movement in the street is the basic movement unit of mobility, while the movement between nodes is not a simple linear distance, and the time of movement is determined by the space quality of this distance. In order to meet the economic needs and social needs, pedestrians in the street and the buildings along the street to carry out the "unconscious" seamless flow, no doubt, this is our ultimate goal. A new way to define every little node, big node, and hub of the street. To accommodate and facilitate a seamless flow it is not just key to optimize functionality but also to enhance the interactivity of building systems with users. The more intelligent/ smart buildings become the less that needs to be expressed in impressive and excessive formal complexity but rather enhanced by clarity and spatial openness in architecture with intelligent use of light and materials. [2] Therefore, the concept of seamless multi-link transportation is also based on meeting the needs of people in the first point.

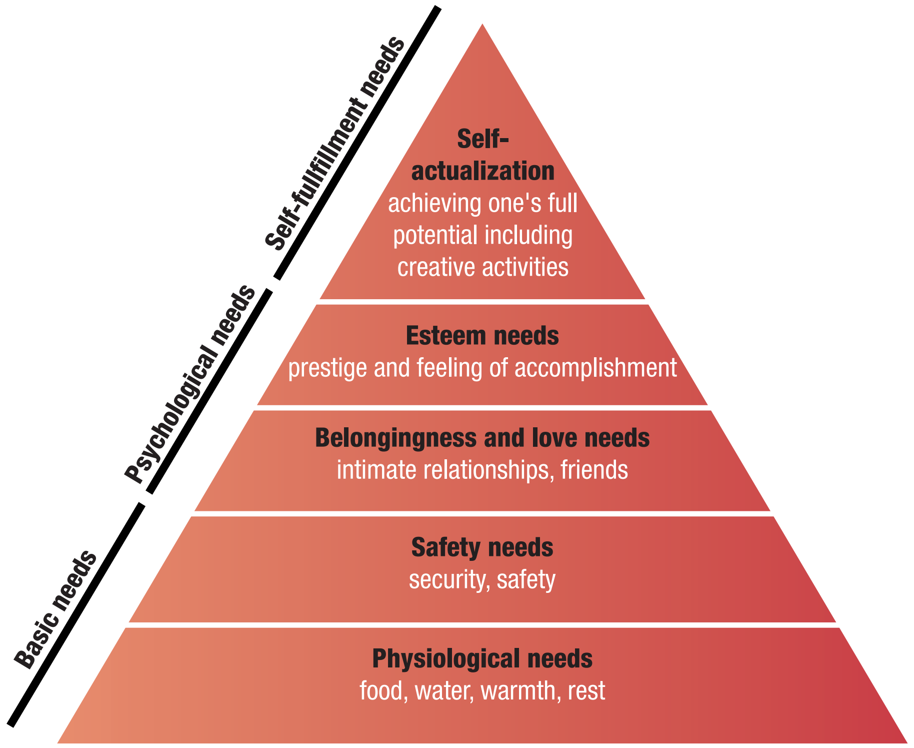


Fig. 1.1. Maslow's Pyramid with urban mobility concept

1 KAAN Architecten+RNDR, *Flow City*<http://eyesofthecity.net/flowcity/>

2 Meyer, G., & Shaheen, S. (2017). *Disrupting Mobility: Impacts of Sharing Economy and Innovative Transportation on Cities (Lecture Notes in Mobility)*. New York, United States: Springer Publishing.

Technological Actuation

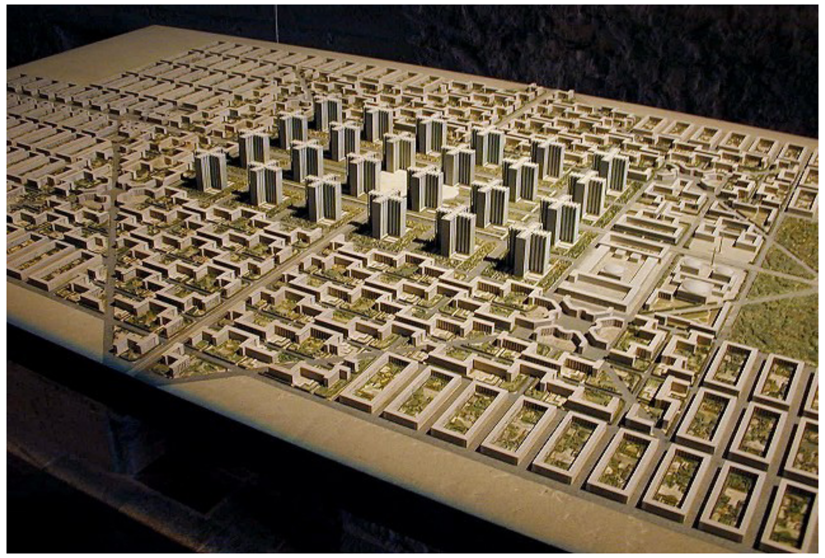


Fig. 1.2. "Ville Radieuse", Le Corbusier,1924
https://www.archdaily.com/411878/ad-classics-ville-radieuse-le-corbusier

During the past era of new technology——automobile's popularization, Le Corbusier's extreme vision in the eyes of others has also largely become the origin of real urban mobility, that is, extreme connectivity and efficiency. In 1924, Le Corbusier described and published his unrealized urban masterplan——Ville Radieuse. In this village, roads run through each other in all directions, and urban mobility has risen from the change of once detailed pavement to the plan of urban field. At that time, the arrangement of orderly green space and a large amount of architectural lighting were unprecedented. He describes not just a village, but a whole society with new lifestyles. Though radical, strict and nearly totalitarian in its order, symmetry and standardization, Le Corbusier's proposed principles had an extensive influence on modern urban planning and led to the development of new high-density housing typologies.[1]

Doubt and rejection must accompany every new technology, such as blockchain and face recognition. The ancients regarded the vehicle's innovation as to the destroyer of cities and the enemy of traditional architecture. Excluding the "characteristics" of air pollution and the increase in traffic accidents, the only visible feature of the automobile for people who still rely on horse-drawn carriages as their primary means of transport, is just speed. Because the slow industrial society does not have a high demand for speed. However, people's doubts about technology do make sense, just as the mobile phone has become our organ, the car has become one of the owners of our city.

To tell the whole truth: it is the Golden Calf of modernity. We have surrendered ourselves irredeemably to automobility. And one thing is clear: for a very long time to come, our societies north and south, east and west, will neither want nor be able to exist without the car, but only with it. What might peaceful coexistence look like?[2]

1 Gili Merin, *AD Classics: Ville Radieuse / Le Corbusier*<https://www.archdaily.com/411878/ad-classics-ville-radieuse-le-corbusier>

2 McFee, J. (2017). *City Maps Ludwigsburg Germany*. Zaltbommel, Netherlands: Van Haren Publishing.

Although people have made many improvements and innovations in mobility to adapt to and cater to the new technology of the vehicles. This is Harvey Wiley Corbett's vision of America's cities of yesterday's tomorrow(Fig. 1.3). There are also special urban Spaces for cars —— drive-in theaters, which are not ordinary parking lots. People can sit in their cars to watch movies and eat popcorn(Fig. 1.5). The target unit has changed from people to cars and people. But the number of cars will continue to surge, and urban population growth has not peaked, and car ownership is far from saturated.

As the car started to infiltrate the streets, there became an ever-decreasing amount of space left for the public. A parked car requires thirty times more road space than a person standing, and a moving one sixty times more than a person walking.[1]

If not, the city will belong to the car, and people will have to find ways to replace or improve it. Architects have also come up with several ideas for urban buildings to accommodate the mobility risks of the proliferation of cars. For Americans, "the right to mobility became a national preoccupation and appears to have superseded previous concerns for the right to assembly guaranteed by the First Amendment."[2]

Fig.1.3. Harvey Wiley Corbett's City Section. 1913.

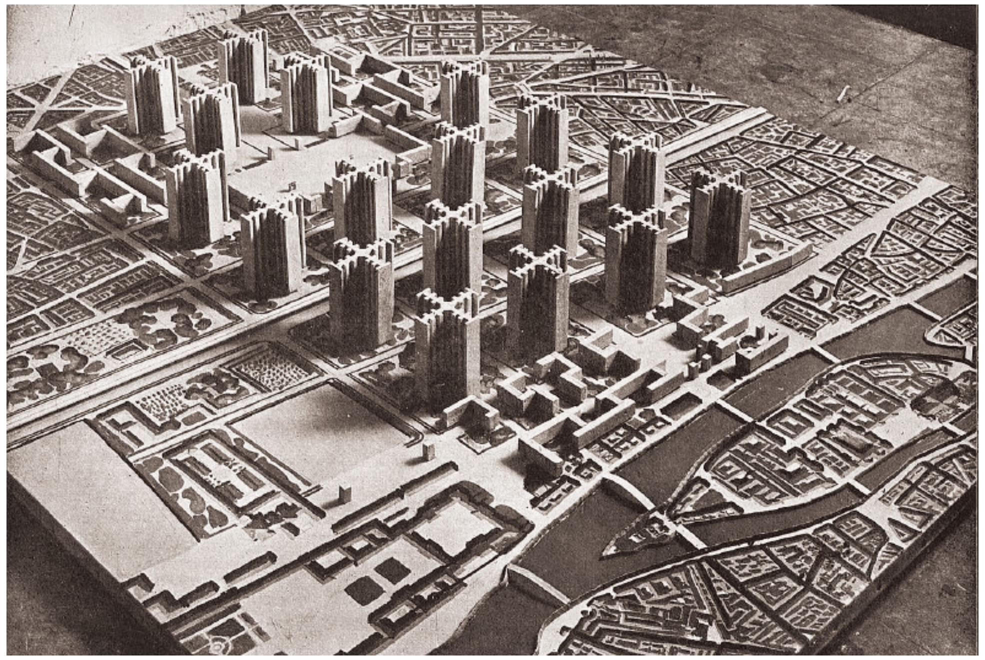


Fig. 1.4. Le Corbusier's "Voisin" plan for Paris, from his proposal for the Radiant City (1922-25).

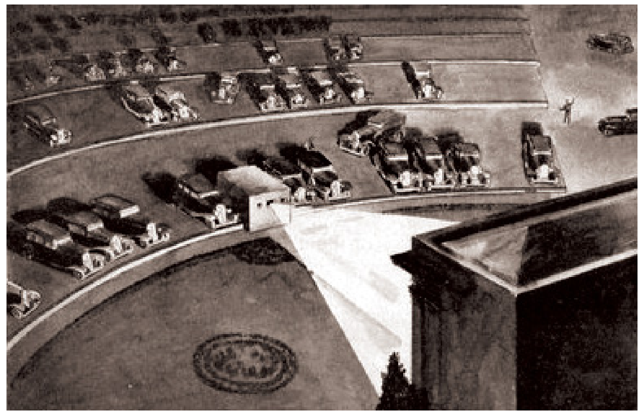


Fig. 1.5. The world's first drive-in movie theatre in Camden, New Jersey, 1933.

1 Klose, D. (1965). Metropolitan Parking Structures: a Survey of Architectural Problems and Solutions. New York: Frederick A. Praeger, Inc.

2 Jennings, J. (1990). *Roadside America: The Automobile in Design and Culture (1st ed.)*. USA: Iowa State Pr.

Enter “New Urbanism.” Dense skyscrapers and straight traffic routes became blueprints for new urban planners. Gradually, people realized this oppressive urban mobility and almost put humanity aside, transforming the city with an extremely rational perspective and what they called correct mobility.

Propagated vigorously by architect Léon Krier, the ideology entailed a return to the traditional European city, in turn conjuring images of romantically dense, small-scale architecture and walkable streets. The fruits of the New Urbanists' efforts are visible at some neo-traditionalist planned communities around the world, most notably, Truman Show-Esque Seaside, Florida in the U.S. and Poundbury, Dorset in England, designed with the help of Prince Charles.[1]

In the context of the new technology-driven environment, it will also be the case in the future to be able to bear the pressure of "exclusivity" in the construction industry and to pursue urban amenity and be recognized by people in solitude. Therefore, mobility needs to be driven by technology as well as a group of people to guide it so that it cannot be too biased or cold-blooded.

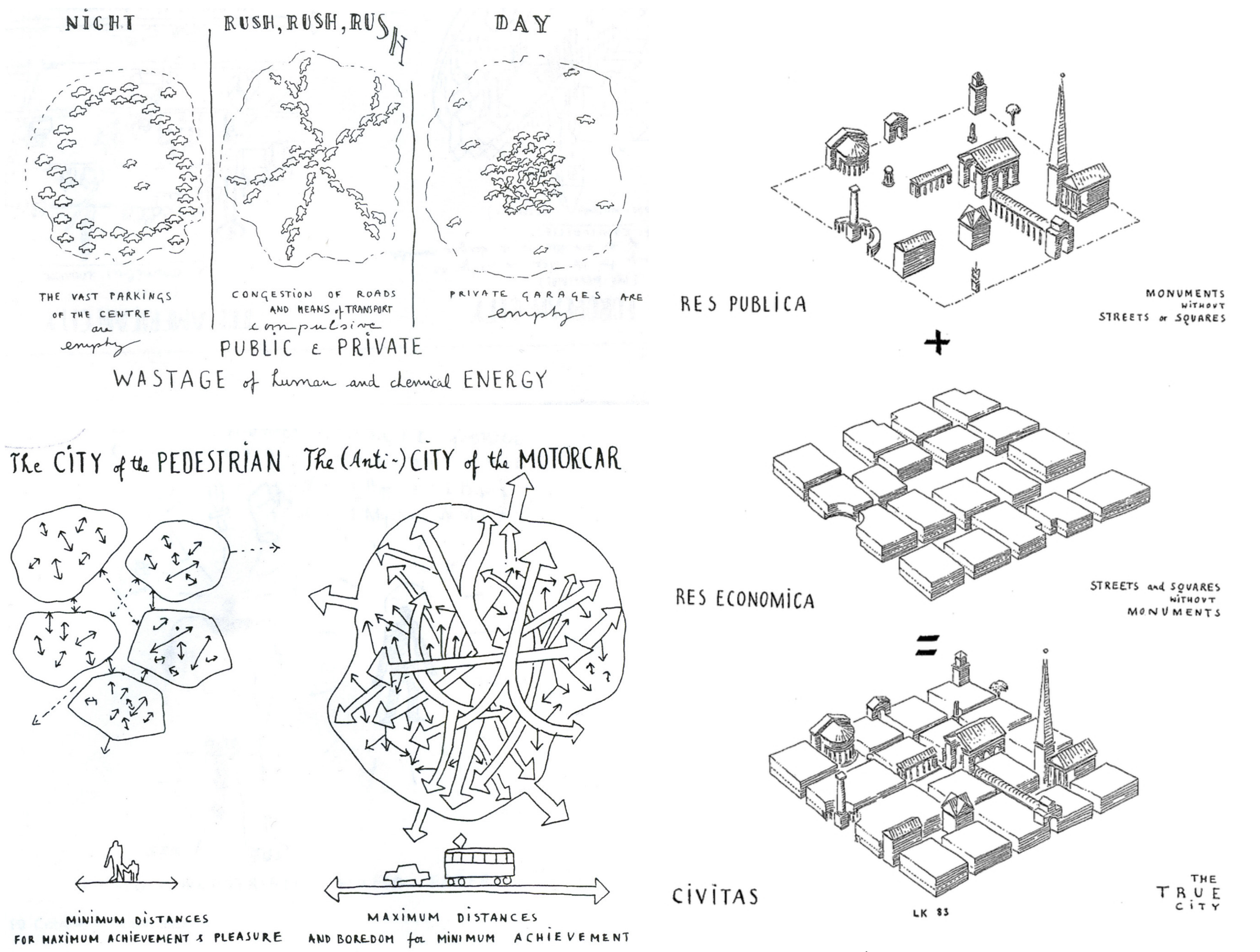


Fig. 1.6. Léon Krier critiques on modern planning, zoning, and car-centric development.

1 Ella Comberg, *A Different Kind of Architectural Drawing: Léon Krier's Sketches*<https://www.archdaily.com/896720/a-different-kind-of-architectural-drawing-leon-kriers-sketches>

01
CO_2 Emission Factor

About CO_2 emission, transport is responsible for nearly 30% of the EU's total CO_2 emissions, of which 72% comes from road transportation.[1] (Fig. 1.7)Cars account for the largest share of emissions, which is why new technological innovations in automobiles are the focus of worldwide attention.

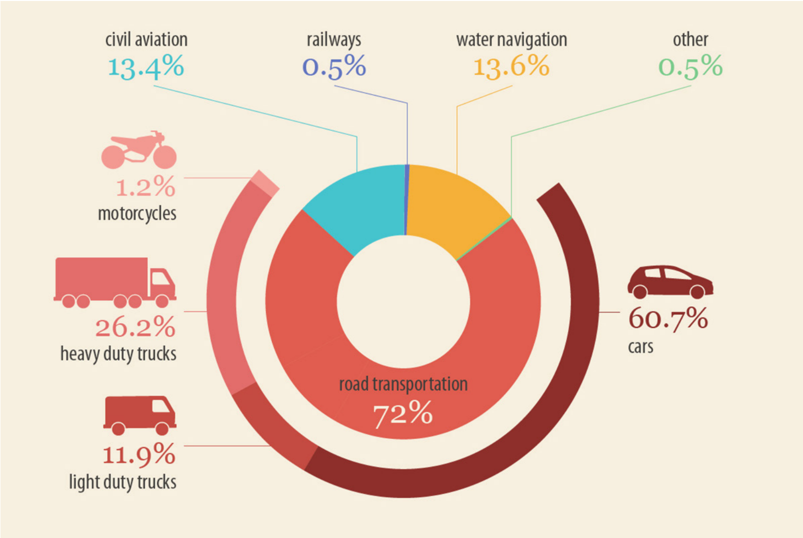


Fig. 1.7. Transpot CO2 emissions in the EU, emissions breakdown by transport mode(2016)

1 European Parliament. (2019). *CO2 emissions from cars: facts and figures (infographics)* (20190313STO31218). Retrieved from https://www.europarl.europa.eu/news/en/headlines/society/20190313STO31218/co2-emissions-from-cars-facts-and-figures-infographics

In the conventional sense, the only two ways to reduce CO2 emissions are inventing more efficient vehicles or abandoning the fuel used.

Are electric cars cleaner? Are they the end goal of mobility technology?

The fact is not, Although the carbon dioxide emission of electric vehicles is low, they are far less environmentally friendly than ordinary diesel vehicles in the process of production, storage and waste disposal, which can be seen in the yellow labeled fuel production(Fig. 1.8).

So electric cars are by no means the end of new mobility technology. It may require more helper design, such as service design, that is, how to efficiently share usage. Other new technologies may also be needed, such as technology overlay, which adds flight and navigation capabilities.

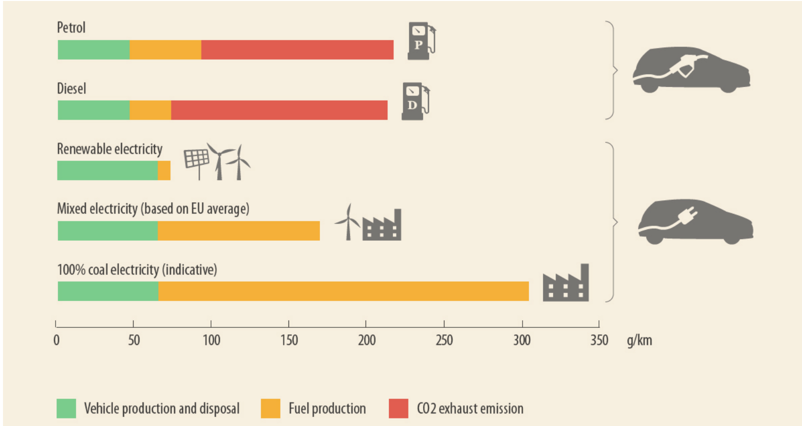


Fig. 1.8. Transpot CO2 emissions in the EU, range of life-cycle CO2 emissions for different vehicle and fuel types(2014)

2016 in China, only DIDI, one ride-sharing company, reduced CO_2 emissions by 1.44 million tonnes (directly and indirectly), equivalent to the CO_2 emitted by 910,000 cars in a year, or by 48.11 million trees in a year.[1](According to the calculation standard as a car travels 10000km and emits 1580kg per year.A tree absorbs 30kg CO_2 per year)

1 CBNData, & DIDI. (2016). *2016 smart travel big data report(2016 智能出行大数据报告)*. Retrieved from http://cbndata.com/report/382/detail?isReading

02
Economic Losses Factor

In terms of referring to the statistical data of various relevant aspects, we can divide mobility economic loss into direct economic loss and indirect economic loss.

Direct economic loss mainly refers to the time consumption of commuters. (Fig. 10)

Indirect economic loss mainly refers to the treatment costs caused by traffic accidents, fuel consumption and exhaust emissions, including the economic loss caused by premature death caused by health effects

Fig. 1.9. Road traffic situation in Shenyang,China(09/10/2019)
<http://news.haiwainet.cn/n/2017/1010/c3541092-31143289-4.html>

The direct cause of the economic loss of mobility is traffic congestion. But how to advance by traffic congestion considerations.

In China, GAODE(**高 德**) map app is a commonly used vehicle navigation software for Chinese citizens. Its data more reflect the actual situation and have a high reference value, which also helps the government to make various decisions on mobility. It compiles China's traffic indices and updates them every five minutes.
Direct Congestion economic loss index
=Driving delays in every 10 minutes * Average pay per minute

The index is the cumulative economic loss every ten minutes. As shown in the figure, in the 100 cities of the big data sample in Gaode statistics, the accumulated national economic loss index of every 10 minutes was 2,718 yuan, which was still the data performance at 1 am under the background of the known outbreak of the new coronavirus, and the economic loss of tens of thousands of yuan per 10 minutes was normally achieved.

If we calculate based on an average of 5,000 yuan: 52,560 10 minutes per year, 660 cities in China, a total of direct economic loss would be 173,448,000,000 yuan (about 22,236,923,096 euros). However, due to different app users, the choice of travel route may be better and personalized, so the actual data must be larger.

*Fig. 1.10. Intelligent CT Real(01:00 01/02/2019) - Time Diagnostics by Gaode map traffic big data（**高德地图交通大数据**）*
<https://report.amap.com/diagnosis/index.do>

Every country has a period of rapid growth in motor vehicle ownership, but only China has experienced unprecedented growth in speed, scale and magnitude.[1] Huapu LU[2] points out that we have entered a new phase of congestion——total congestion phase.

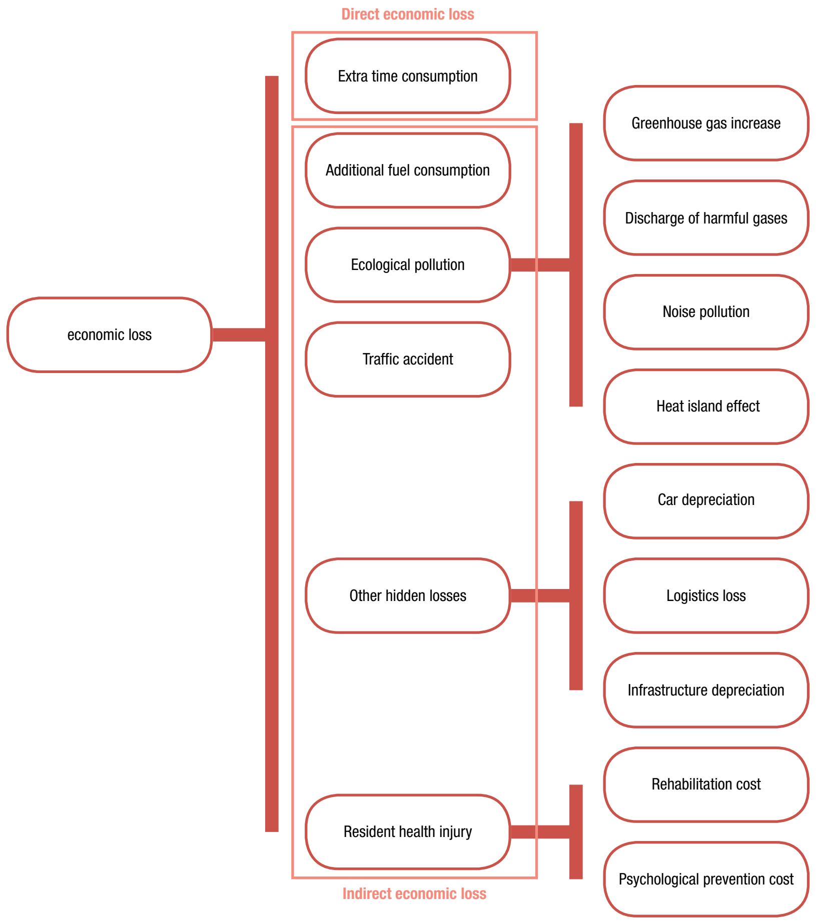


Fig. 1.11. Indirect economic loss factor
Edit the source from China Population,Resources and Environment

(Fig. 1.11) The chart has been used many times in other cities to estimate and calculate the damage caused by traffic congestion. In their article, the editors detail each of the available formulas. They calculated the economic cost of traffic congestion in Beijing in 2010. (Fig. 1.12)[3]

Project	Additional time	Additional fuel consumption	Additional ecological pollution	Additional traffic accident	Loss of health risk for residents
Daily cost of congestion (ten thousand yuan)	5508.62	32386.22	1237.88	-	-
Annual loss (RMB 100 million)	201.06	809.66	45.18	0.02	1.31
The percentage of the annual total	19.0	76.7	4.3	0.002	0.1

Fig. 1.12. Summary of economic losses caused by traffic congestion in Beijing, 2010

1 LU, H. (2010, December). *Urban congestion has entered a new phase. Road Traffic Management (道路交通管理), vol.12.* Retrieved from http://www.cnki.com.cn/Article/CJFDTotal-DLJG201012022.htm
2 Huapu LU, director of the transportation research institute of tsinghua university
3 Xie, X. (2011, January). *Assessment of ecological and economic value loss caused by traffic congestion in Beijing. China Population,Resources and Environment(中国人口.资源与环境), vol.25(no.1).* Retrieved from http://mall.cnki.net/onlineview/MagaView.aspx?fn=zgrz201101*1*

The statistical results show that in 2010, the annual economic loss caused by traffic congestion in Beijing amounted to 105.593 billion yuan, accounting for 7.5% of the total GDP of Beijing in 2010, as shown in (Fig. 1.12). Among them, the biggest loss is the time delay caused by congestion, followed by the additional fuel consumption cost caused by congestion, then the additional ecological environment pollution, the loss of residents' health risk and the additional traffic accident loss.[1]

Fig. 1.13. Night view of Beijing city
<https://moderntrekker.com/wp-content/uploads/2018/12/things_to_do_in_beijing-e1543840528375.jpg>

2016 smart travel big data report

CBNData and DIDI jointly released the *2016 smart travel big data report*. Based on the full data of didi (including Uber) platform, it interprets urban travel in China and reflects the significance brought by urban traffic, residents' life, hot events and Shared travel through intelligent travel.

In 2016, Beijing, Guangzhou and Xi 'an ranked among the top three cities in terms of traffic congestion loss with an annual per capita cost of 8,717 yuan, 7,207 yuan and 6,960 yuan respectively, followed by Shenzhen, Shanghai and Chongqing with an annual per capita traffic congestion loss of more than 6,000 yuan.

1 Xie, X. (2011, January). *Assessment of ecological and economic value loss caused by traffic congestion in Beijing. China Population,Resources and Environment(中国人口.资源与环境), vol.25(no.1).* Retrieved from http://mall.cnki.net/onlineview/MagaView.aspx?fn=zgrz201101*1*

Fig. 1.14. The average speed of Chinese cities in 2015 compared with that in 2016

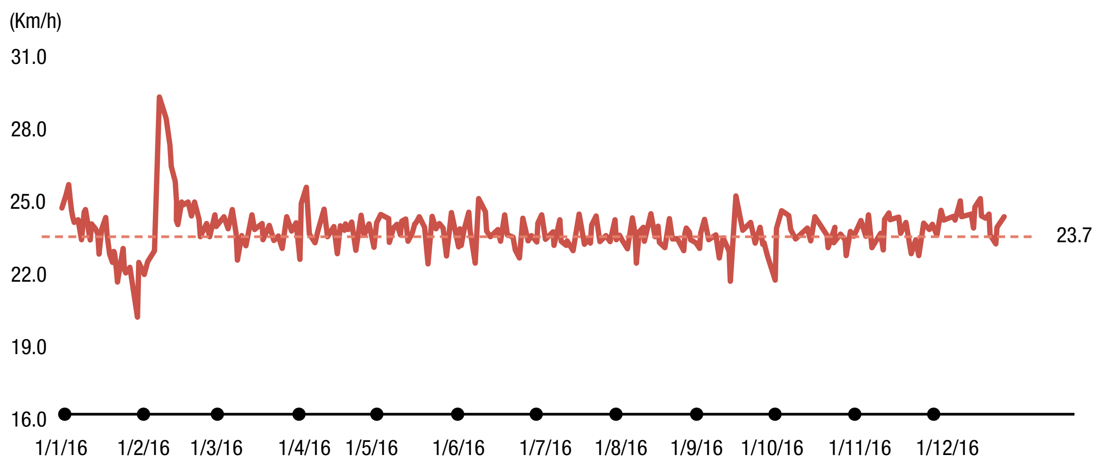


Fig. 1.15. Average annual vehicle speed in Chinese cities in 2016

The statistics of *2016 smart travel big data report* also show that the average speed of urban roads in China is 23.7 km/h, which is the same as in 2015.[1] However, the average speed of first-tier cities has increased slightly, while the average speed of third-tier and fourth-tier cities has decreased significantly. This is a positive impact brought by the popularity of DIDI's ride-sharing platform in first-tier cities, while the low penetration rate of Shared trips in second-tier, third-tier, and fourth-tier cities cannot neutralize the growing traffic jam. And it's not just cities in China, where suburban congestion is more common than urban congestion.

The same is true of transport in Europe. Heavy traffic has begun to shift from cities to suburbs. Cities in EU accession countries also reveal mixed trends in congestion. In wealthier cities, rapid growth in car ownership and use has resulted in severe congestion, most notably in Prague, Warsaw and central Moscow. Car traffic and parking management measures already widely developed in cities with a long experience of high motorization would probably have a positive effect. While it is difficult to predict what the residual level of congestion might be, based on city questionnaires it can be said that in EU accession other CEE countries, congestion is perceived as even more severe than in highly motorized OECD cities.[2] On the one hand, this shows the practical role of technology, on the other hand, it also shows the great economic demand.

1 CBNData, & DIDI. (2016). *2016 smart travel big data report(2016智能出行大数据报告)*. Retrieved from http://cbndata.com/report/382/detail?isReading

2 Head of Publications Service, & OECD Publications Service. (2002). *Implementing Sustainable Urban Travel Policies: Final Report*. France: Organization for Economic.

03

Travel Demand Factor

In 2018, according to the U.S. Travel Association, domestic travelers spent **$933 billion** in the United States—representing 86 percent of total travel expenditures. In 2018, the total national GDP of the US was 20.50 trillion yuan. In this case, only domestic travelers spent occupied 4.6% of GDP, which is even without considering foreign travel demand.

U.S. Travel Industry Direct Impact (2018)	Spending ($ billions)	Employment (millions)	Tax Revenues ($ billions)	Person Trips (millions)*
Domestic Total	932.7	7.7	147.3	2,291.1
Annual growth rate	5.8%	1.7%	4.6%	1.9%
Leisure	649.9	5.5	100.4	1,827.5
Annual growth rate	7.1%	2.9%	5.9%	2.%
Business	282.9	2.2	46.9	463.6
Annual growth rate	2.8%	-1.3%	1.9%	1.6%
General Business	156.9	1.2	26.0	
Meetings/Conventions	126.0	1.0	20.9	

Fig. 1.16. US domestic travel spent detail in 2018, U.S. Travel Association <https://www.ustravel.org/system/files/media_root/document/Research_Fact-Sheet_Domestic-Travel.pdf>

In 2016, the cumulative trips in typical Chinese scenarios:

1.77 billion(person-time) weekday commuters
1.08 billion catering and shopping
440 million leisure and entertainment
360 million hospital
250 million airports and train stations[1]

The data only showed the number of times used by DIDI to share the taxi platform, excluding the bus and subway, school, life service, and other travel scenes.

Spring Festival travel rush in China, the number of shared trips with 1.9 million in 2016 jumped to 8.4 million in 2017. In just one year, the number of Shared trips has increased to 4.4 times.

1 CBNData, & DIDI. (2016). *2016 smart travel big data report(2016智能出行大数据报告)*. Retrieved from http://cbndata.com/report/382/detail?isReading

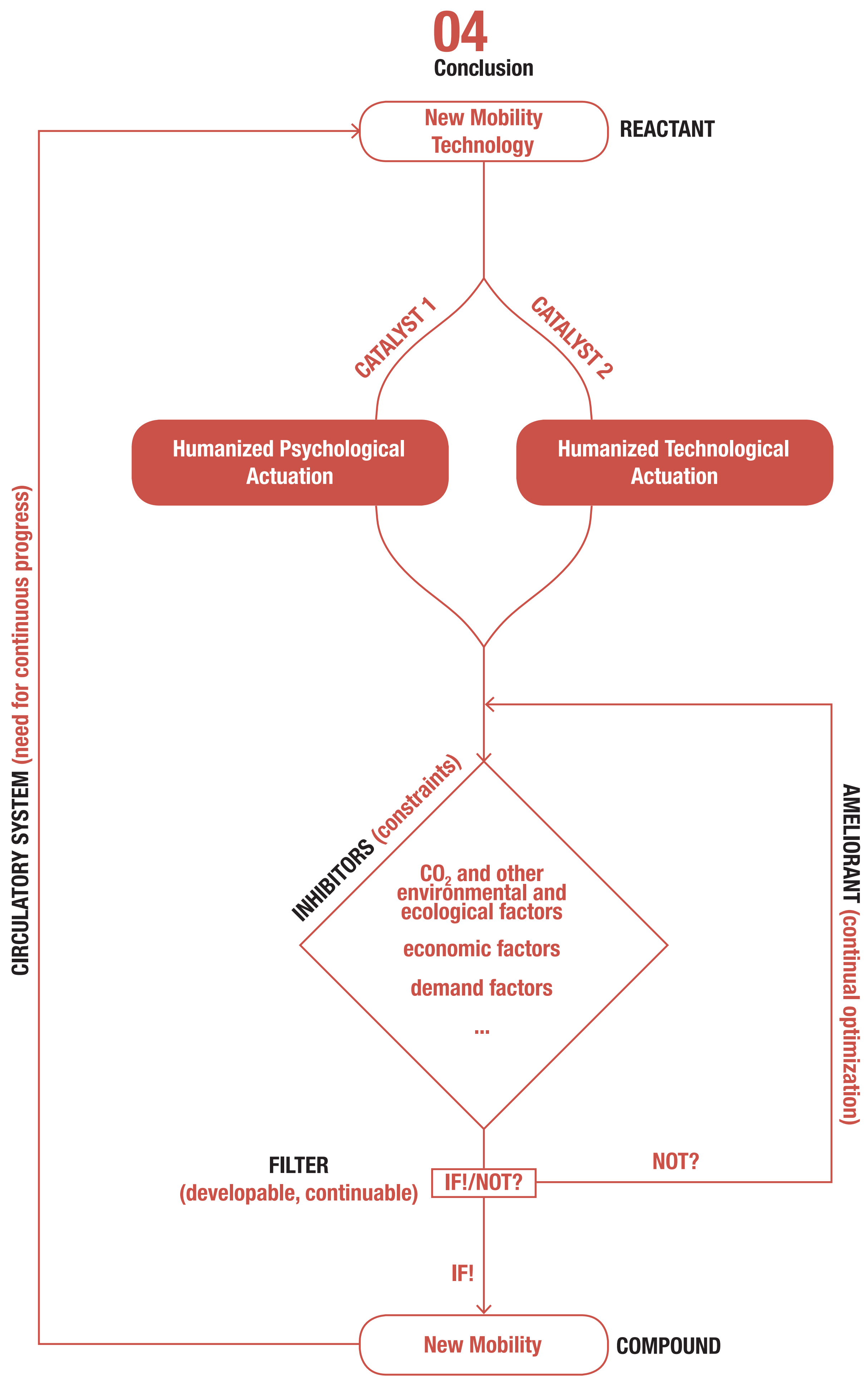


Fig. 1.17. Technology-Mobility's logic tree

PROBLEM STATEMENT

In reality, the frequent traffic improvement is positive: it shows the seriousness of the problem has aroused people's attention; The second is negative: it reflects people's blindness and inefficiency in the following three aspects:

1. How to summarize and sort out new mobility technologies,
2. How to select new mobility technologies,
3. How to use new mobility technology.

If there is no clear implementation outline or appropriate reference plan to guide these three questions, the main problem statements are:

1. If the expectation after the transformation cannot be clearly imagined, the timeliness of the new scheme will be lost, and the expected mobility cannot meet the demand.

2. In order to adapt to new mobility, frequent renovation of streets and buildings, firstly, waste of material resources, human resources, and time resources; secondly, frequent changes in people's living habits will lead to resistance and affect the implementation of reasonable plans in the future.

3. If human's contribution to mobility cannot be unified and sorted out, poor information in rural areas in second-tier, third-tier and fourth-tier cities will lead to various difficulties and inefficiencies in research, such as repeated research and blind selection. We expect to have an atlas, which can be improved and improved by generations together, and also facilitate other people who want to improve mobility to choose appropriate solutions quickly and effectively.

2. CASE STUDIES

[On base] Hypeloop-One Tube, Las Vegas, US
<https://hyperloop-one.com/media-gallery>

Sidewalk Labs is designing a district in Toronto's Eastern Waterfront to tackle the challenges of urban growth, working in partnership with the tri-government agency Waterfront Toronto and the local community. This joint effort, called Sidewalk Toronto, aims to make Toronto the global hub for urban innovation. Sidewalk Labs is asked to present the Master Innovation and Development Plan (MIDP) for the Sidewalk Toronto project as a comprehensive proposal for how to realize that potential.[1] By reading the Sidewalk lab's urban plan 'MIDP VOLUMN2' and studying Toronto's urban situation report, in conclusion, Toronto was facing the following four main mobility challenges:

- **Worse health**
- **Accident**
- **Traffic jam**
- **Bad accessibility**

A 2015 study by Statistics Canada looked at the prevalence of obesity among urban and suburban Ontario residents. The conclusion: "Residents of highly walkable areas engaged in more utilitarian walking and had a lower prevalence of obesity than did adults in low-walkability areas."(Fig. 2.1) A large number of employed labor forces in Toronto prefer to use a car, truck or van to get to work instead of walking, riding or public transit. Although worse health is not a direct mobility challenge, it mainly caused by bad walkability. In this case, we regard it as a mobility challenge.

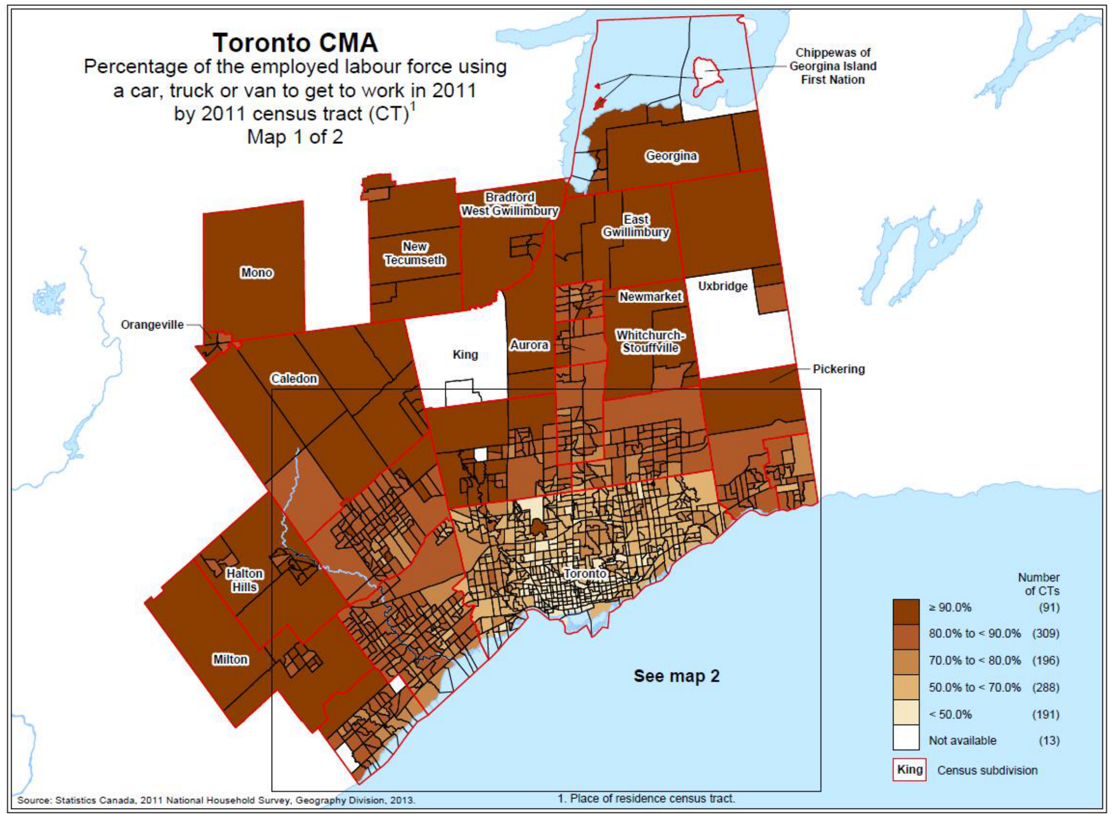


Fig. 2.1. The employed labour force vehicle usage percentage in Toronto (2011), Statistics Canada <https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/99-012-x2011003_1-eng.cfm>

1 Sidewalk Labs Toronto. (2019). *Over view.* Retrieved from https://storage.googleapis.com/sidewalk-toronto-ca/wp-content/uploads/2019/06/23135500/MIDP_Volume0.pdf

TORONTO

• Solution 1: All-weather Ground Floors

On the lower floors, these adaptable structures can house a variety of short-term, long-term, and seasonal tenants, allowing for a livelier mix of shops, services, community gathering spaces, and other destinations all within walking distance. Some of this "stoa" space would be designed with retractable awnings to invite foot traffic in all weather.[1]

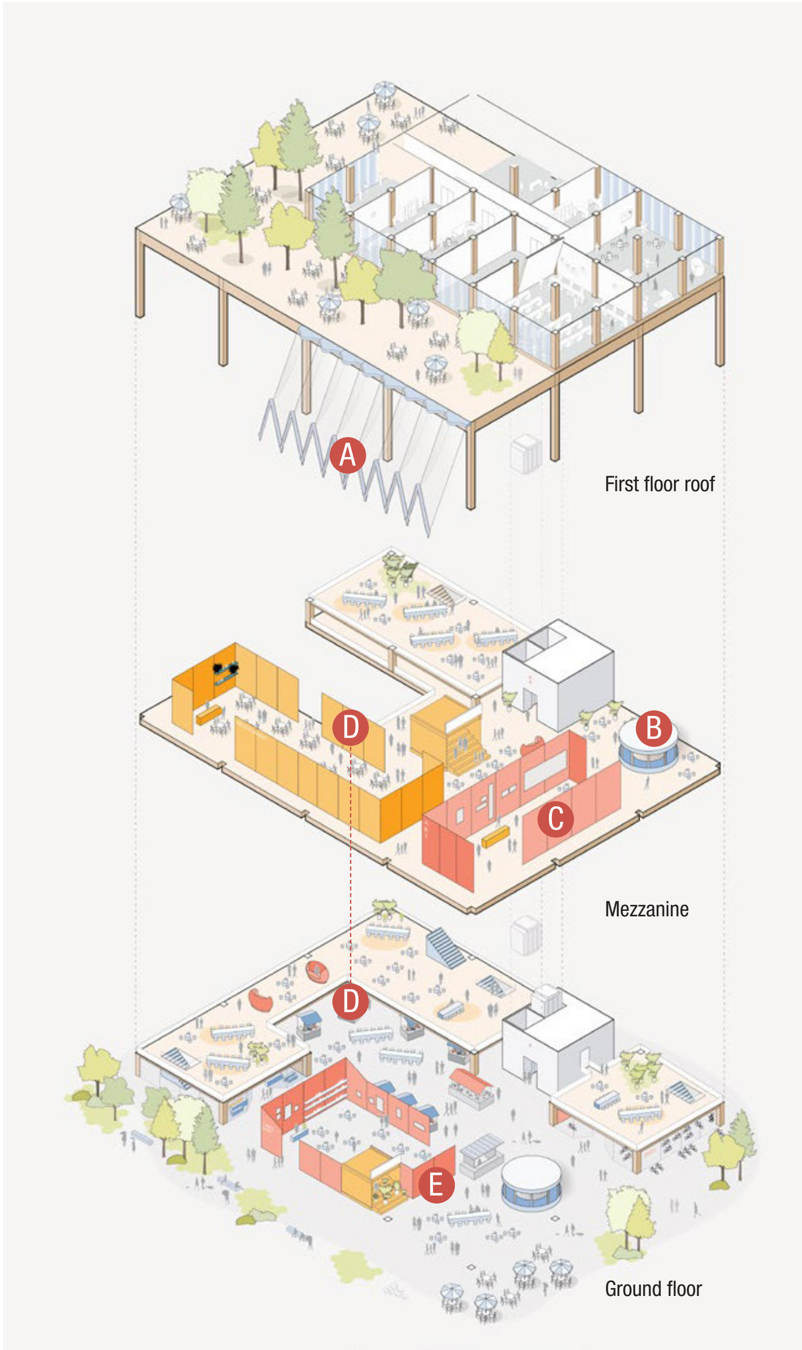


Fig. 2.2. All-weather ground floors scenarios in Toronto, Sidewalk Labs

A: Weather-mitigation structures are used to mitigate travel disturbances and extend the building's street space,
B: Stoa is a temporary structure that can be used as a dynamic retail outlet, event pavilion and so on,
C: A flexible partition system reduces the cost of building renovation, is more sustainable, and can be expanded to meet the growth of consumer demand,
D:Double height Spaces provide spacious Spaces across the mezzanine for midsize shops or art studios,
E: The Seamless anna-outdoor zone blurs the boundaries of street.

1 Sidewalk Labs. (2019). *Plan SmartCity Quayside Toronto.* Sidewalk Toronto. Retrieved from https://www.sidewalktoronto.ca/innovations/mobility

TORONTO

• **Solution 2: Social Infrastructure**
To improve walkable access to essential services, Sidewalk Labs plans to provide space in Quayside for an elementary school co-located with a child care facility, health services co-located with supportive care programs, and community space for neighborhood groups. In Quayside, the whole neighborhood would be walkable within 15 minutes. When applied at the full scale of the IDEA District, Sidewalk Labs plans to encourage a vibrant mixture of homes, jobs, shops, and public spaces on every block would lead to 9% of all trips being made by walking.[1]

• **Solution 3: Underpass**
Underground tunnels that had been cut off by the railway will be rebuilt. Give separate pedestrian, bicycle, car, and public transportation systems in line with the city's existing bike and bus networks. Add noise lighting to the walkways to enhance comfort and wayfinding buffers to attract pedestrians, while installing electronic information Windows and digital art exhibits to spice up underpass.

• **Solution 4: Narrow Bridge**
Narrow Bridges designed for pedestrians and cyclists, rather than concentrating all traffic on one or two Bridges. Make waterways part of communication between communities, not an obstacle.

• **Solution 5: 'Green Waves' Bicycle Lane**
Toronto will use Green waves to help cyclists safely maintain higher speeds over longer distances. (Fig. 2.3) The Green waves is a concept pioneered in Copenhagen. That Green waves for cyclists was an idea coming out of a brainstorm started by Klaus Bondam when he worked in the city council. It was born because of the dominance of cars and public transport over traffic signals, and bicycles' inability to keep a constant speed, almost on a par with pedestrians, limited their primary purpose of increasing speed.

Fig. 2.3. Green waves in Toronto

1 Sidewalk Labs. (2019). *Plan SmartCity Quayside Toronto*. Sidewalk Toronto. Retrieved from https://www.sidewalktoronto.ca/innovations/mobility

• **Solution 6: Bike-share**
To facilitate individual cycling, Sidewalk labs recommends that all buildings create at least one cycling space for residents of every two buildings and every four employees. Studies show that a sweaty commute can deter many would-be bike commuters, so Sidewalk Labs plans to help provide on-site showers by striking deals with fitness centers or dedicated bike centers. Dockless vehicle sharing to provide this option, and to prevent the clutter of bicycles parked in public areas, sidewalk lab plans to designate parking lots for dockless vehicles.

• **Solution 7: Heated Pavement**
The paving of such pavements relies on modularity to allow easier access to heating systems and reduce maintenance costs. The great advantage of this technique is that it doesn't require much plumbing to run. To save energy, the heated road is connected to a real-time weather forecast system that automatically energizes three or four hours before a storm. The maximum temperature on the road will be between two and four degrees Celsius, which will melt the snow and keep you comfortable.[1]As long as the road is dry and there is no danger of smooth ice forming, the system shuts down automatically. At Quayside, Sidewalk Labs in Toronto plans to deploy 1,200 square meters of heated sidewalks and pedestrian areas and 1,590 square meters of heated bike paths.[2]

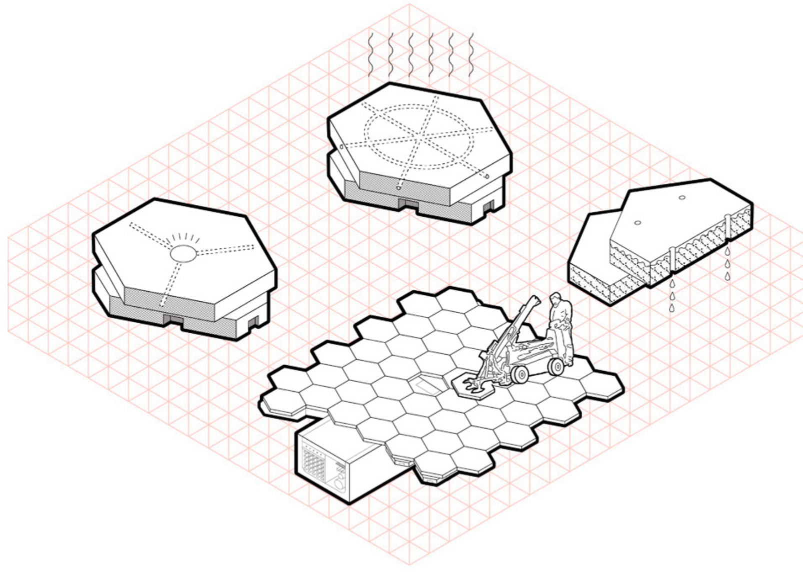


Fig. 2.4. Modularized heated pavement invented by Sidewalk Labs Toronto

1 Sidewalk Labs. (2019). *Plan SmartCity Quayside Toronto*. Sidewalk Toronto. Retrieved from https://www.sidewalktoronto.ca/innovations/mobility

2 Rodriguez, J., & CTVnews. (2019). *Sidewalk Labs T.O. plan has heated walkways, roads that light up based on traffic*. Retrieved from https://www.ctvnews.ca/sci-tech/sidewalk-labs-t-o-plan-has-heated-walkways-roads-that-light-up-based-on-traffic-1.4480613

• Solution 8: Self-driving and Car-share

Labs plans to reduce the number of parking Spaces by 48 percent, freeing up the urban space between the driveway and the two buildings.

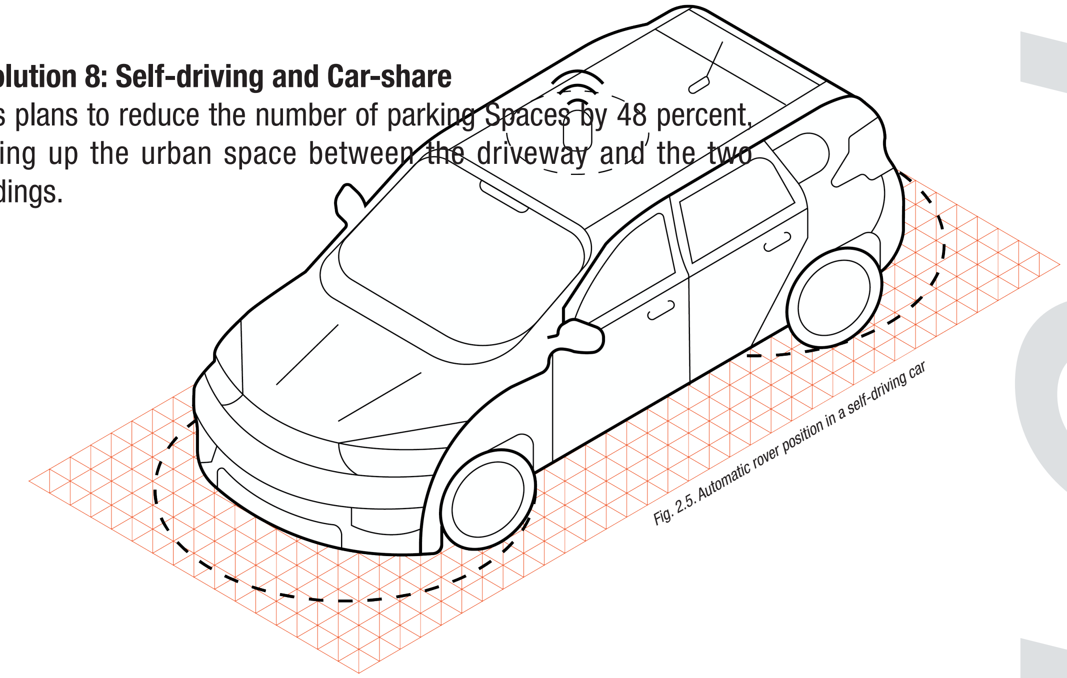


Fig. 2.5. Automatic rover position in a self-driving car

• Solution 9: Underground Logistics Hub

Smart containers filled with parcels, storage, or borrowing items would be placed on self-driving delivery dollies and delivered to their final destinations via underground tunnels. Smart containers could be dropped off without fear of theft: they are trackable and unlockable only by way of a digital code-shared solely with a recipient. In Quayside, the entire logistics hub would be capable of accommodating over 18,000 daily parcels, with nearly all activity occurring underground. A 24-hour underground freight system would greatly reduce air pollution from trucking while keeping it easy for customers to receive or send goods.[1]

And design a "smart container" for the last mile of shipping. Traditional vehicles and ferries can also load smart containers for coordinated transport, though autonomous vehicles will inevitably replace them in the future, further reducing human involvement。These durable containers would be stackable, enabling them to function as lockers and to be placed easily onto delivery vehicles. They would also be embedded with location-based capabilities to track movements.[2]

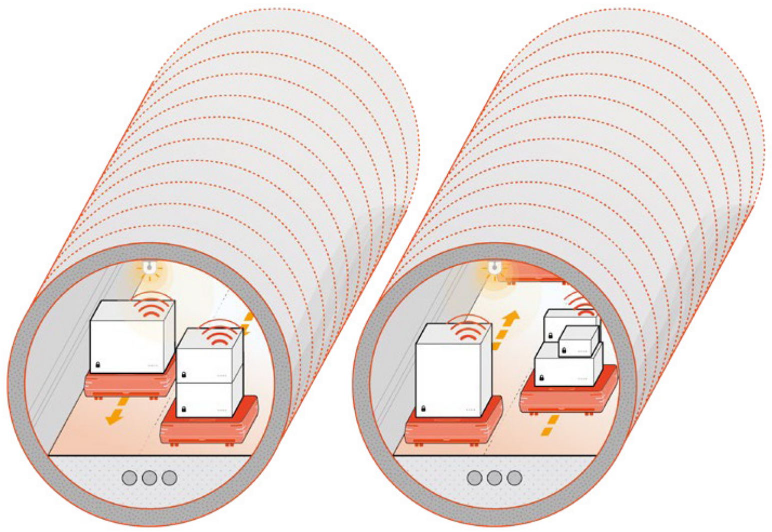


Fig. 2.6. Connect underground delivery tunnels designed by Sidewalk Labs Toronto

1 Rothbard, S. (2019, November 4). *Innovation in Freight Transportation: Sidewalk Toronto.* Retrieved from http://smartfreightcentre.ca/wp-content/uploads/2019/11/2.2_SandraRothbard_SidewalkLabs.pdf

2 Sidewalk Labs. (2019). *Plan SmartCity Quayside Toronto*. Sidewalk Toronto. Retrieved from https://www.sidewalktoronto.ca/innovations/mobility

• Appendix

Fig. 2.7. Quayside area as an experimental site by Sidewalk Labs in Toronto

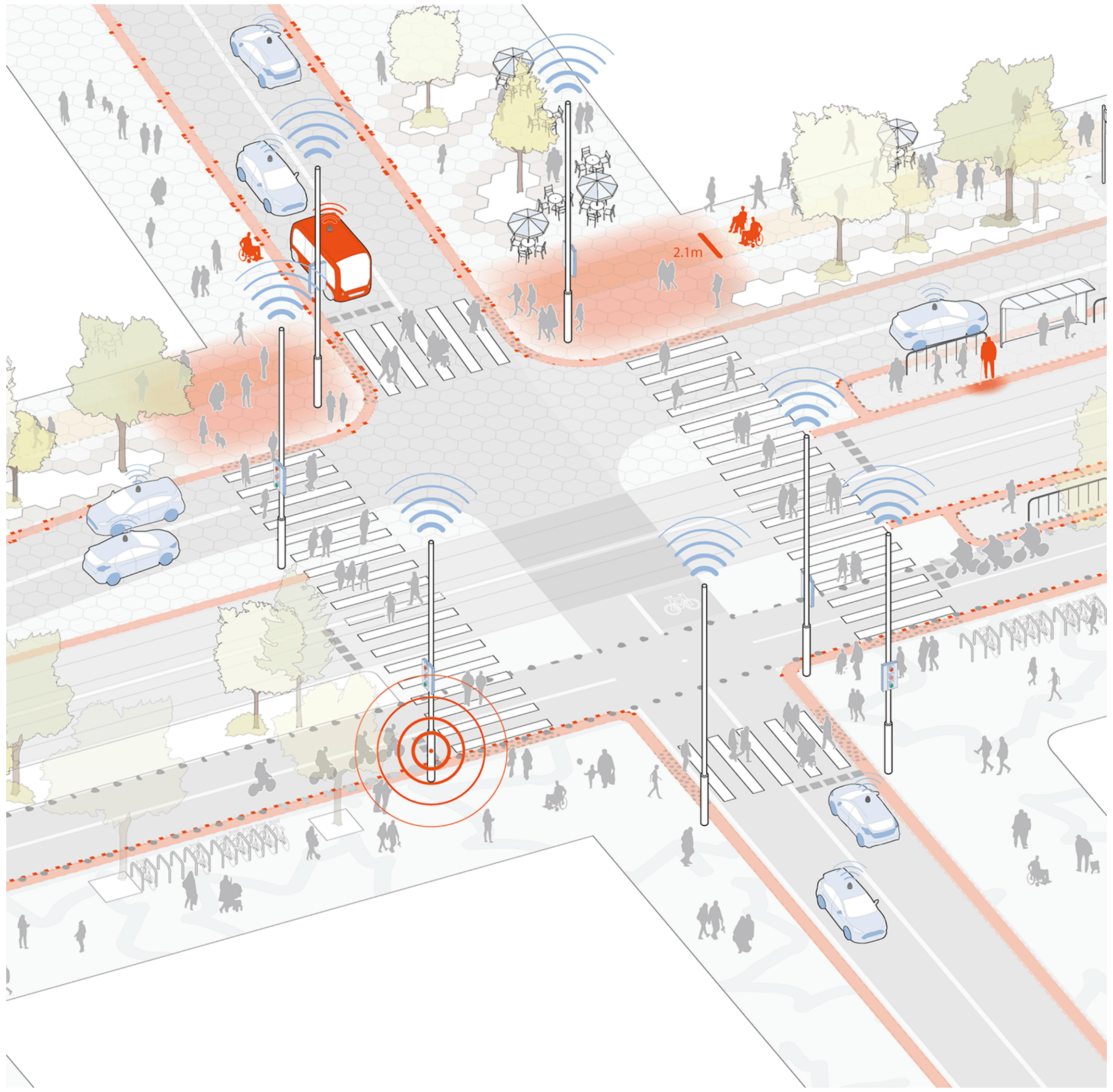


Fig. 2.8. Future street scenarios imagined by Sidewalk Labs Toronto

PROBLEM	GOALS	TOPICS	SOLUTION 1	2	3	4	5	6	7	8	9
Worse health	Reduce vehicle usage	Walkability	■	■	■	■			■		
Accident	Warm up the frozen pavement	Climate (Cold)							■	■	
	Protected ride lane	Lane set					■				
	Speed control	Indicator					■		■	■	
Traffic jam	Convenience of bike to buildings	Lane set	■					■		■	
	Update parcels transportation	Exchanging goods									■
Bad accessibility	Connect isolated streets caused by rails	Lane set			■						
	River	Natural Barrier				■					

Fig. 2.9. The urban mobility problems that Toronto are facing and the role of 9 solutions

(Fig. 2.9)Solutions 1,2,3,4 are strategies. Solutions 5,6,7,8,9 are technical innovations that are in the topic. Solution 5,7,8 (green wave indicator, heated pavement and self-driving) belong to an entire autonomous traffic system. Solution 6,8 (bike-share and car-share) include software innovation. Through this analysis, we can find strategies corresponding to the underlying problem, which can be used as a general reference option for the modularization of urban mobility construction. For example, for choosing solutions to deal with the 'cold climate', now we have 2 options, 'solution7' and 'solution 8'.

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• Solution 1: Smart Garbage Bin

The municipality of Copenhagen went over its waste collection budget by 100 million DKK (€13.3 million) during the years from 2013 to 2016.[1]

So the Copenhagen government adopted the smart garbage bin designed by Nordsense company. A mini sensor is installed under the bin's cap, measuring the distance between the inlet and the garbage to monitor the volume of the filler. Otherwise, whether solid or liquid can be identified. The length and width of the smallest POD are similar to that of a credit card, with a depth of only 3cm. Coupled with their black color, it allows the sensors to be very discreet when installed. Despite the small size, battery life is over seven years.[2]

One-third of complaints submitted to the mobile application to provide feedback from the citizens to the municipality of the city of Copenhagen was about overfilled bins. At the beginning of 2016, the first 100 Nordsense Pods were installed In street bins In different areas of the city with various activity levels.[3] Drivers can check bins that need to be collected and repaired on the mobile end, which greatly reduces unnecessary traffic congestion caused by garbage transportation. It is an invisible but effective new technology to improve mobility.

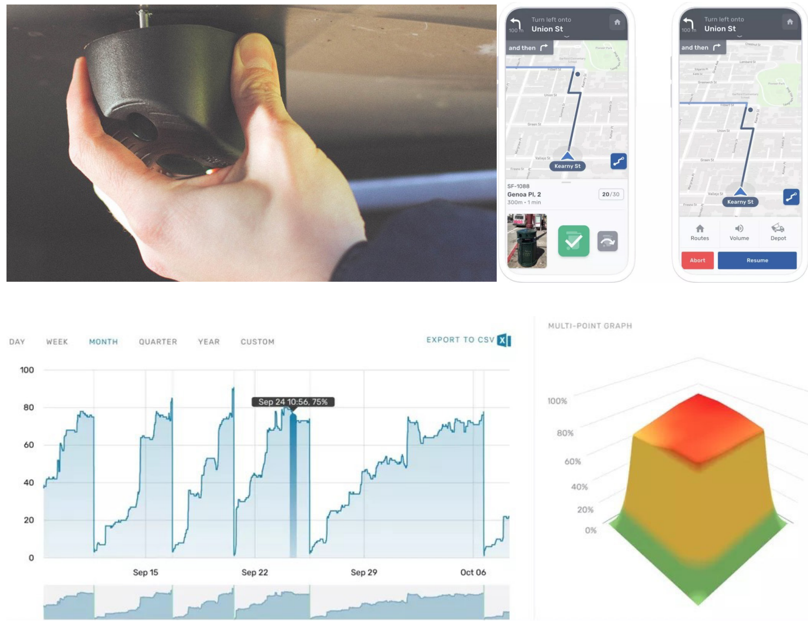

Fig. 2.10. Demonstration of installation, use, and detection of Smart garbage bin <https://nordsense.com/overview/>

1 Politiken. (2016, November 7). *København har tabt 100 millioner kroner på at samle skrald ind.* Retrieved February 15, 2020, from http://goo.gl/KmvrIrCastro Lundin, A., Ozkil, A. G., & Schuldt-Jensen, J. (2017).

2 Nordsense. (n.d.). *Smart bin waste sensor | Fill level monitor by Nordsense*. Retrieved February 15, 2020, from https://nordsense.com/ns-navigator/ns-pod/

3 Smart Cities: *A Case Study in Waste Monitoring and Management. Proceedings of the 50th Hawaii International Conference on System Sciences (2017)*. https://doi.org/10.24251/hicss.2017.167

• Solution 2: Autonomous Minibus by AVENUE Project[1]

AVENUE integrated some new mobility concepts and proposed a disruptive public transportation based on door-to-door services and the nascent concept of the 'Mobility Cloud'[2].(Fig. 2.11) With autonomous minibus as the core, This system enables multimodal public transportation blending traditional public transport with the sharing economy. AVENUE's largest test site in Copenhagen is located in the **Nordhavn district** (just 4km from the center of the city).

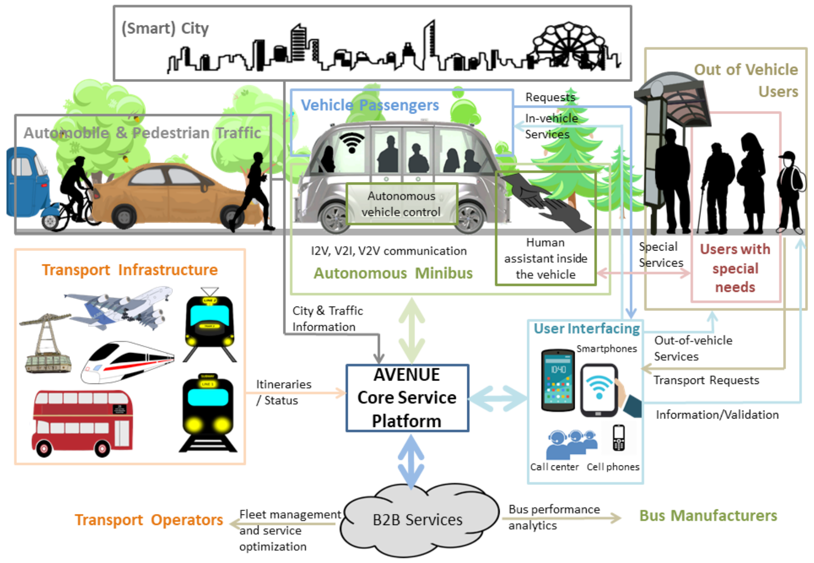

Fig. 2.11. 'Mobility Cloud' autonomous system created by AVENUE <https://h2020-avenue.eu/summery/#toggle-id-5>

The autonomous minibus technology AVENUE's reconstruction plan of the Nordhavn was provided by NAVYA, models 'Autonom shuttles'(Fig. 2.12): two-way drive, single occupancy includes 15 people (11 seats, 4 stances)[3]

Fig. 2.12. Minibus model used in Nordhavn, Copenhagen <https://h2020-avenue.eu/summery/>

1 *AVENUE project* is an EU-funded project under Horizon 2020 (grant agreement No. 769033). The project started on May 1, 2018 and will last 48 months (4 years), which aims to design and carry out full-scale demonstrations of urban transport automation by deploying.

2 AVENUE. (n.d.). *What is AVENUE Project?* Retrieved February 15, 2020, from https://h2020-avenue.eu/summery/#toggle-id-5

3 NAVYA. (2019, December 4). *Navette autonome, intelligente et électrique : Autonom Shuttle.* Retrieved February 15, 2020, from https://navya.tech/shuttle/

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AVENUE and NAVYA provide the technology of autonomous minibus, but how to implement it according to local conditions requires more detailed planning. In Copenhagen's Nordhavn district, a new mobility transformation project has been started to transform the port into a "sustainable city".The project is the result of an international competition launched in 2008, driven by CPH City & Port Development, and will be completed within 50 years.[1]

Fig. 2.13. Integrates with the surrounding districts.
<https://www.cobe.dk/place/nordhavn#nordhavn>

Fig. 2.14. Connected to surrounding districts by metro loop.
<https://www.cobe.dk/place/nordhavn#nordhavn>

Fig. 2.15.Connected to the city's public transport network by bicycle corridor.
<https://www.cobe.dk/place/nordhavn#nordhavn>

Fig. 2.16. Green Spaces spread all over the island pieces.
<https://www.cobe.dk/place/nordhavn#nordhavn>

Fig. 2.17. Minibus lane connects island pieces to reduce inconvenient private travels across the river. It's only a 5-minute walk from the 7 minibus stops to the corner of their piece. In conclusion, Urban metro loop-Districts metro loop-minibus loop-riding loop/walking
<https://www.cobe.dk/place/nordhavn#nordhavn>

Fig. 2.18. Along with the green strips, new canals will be dug to enhance access and proximity to the water.
<https://www.cobe.dk/place/nordhavn#nordhavn>

1 Eco_DesignWebMagazine. (2018, September 5). *Nordhavn a Copenhagen: un distretto sostenibile affacciato sul porto*. Retrieved February 15, 2020, from https://anteritalia.org/nordhavn-copenhagen-un-distretto-sostenibile-affacciato-sul-porto/

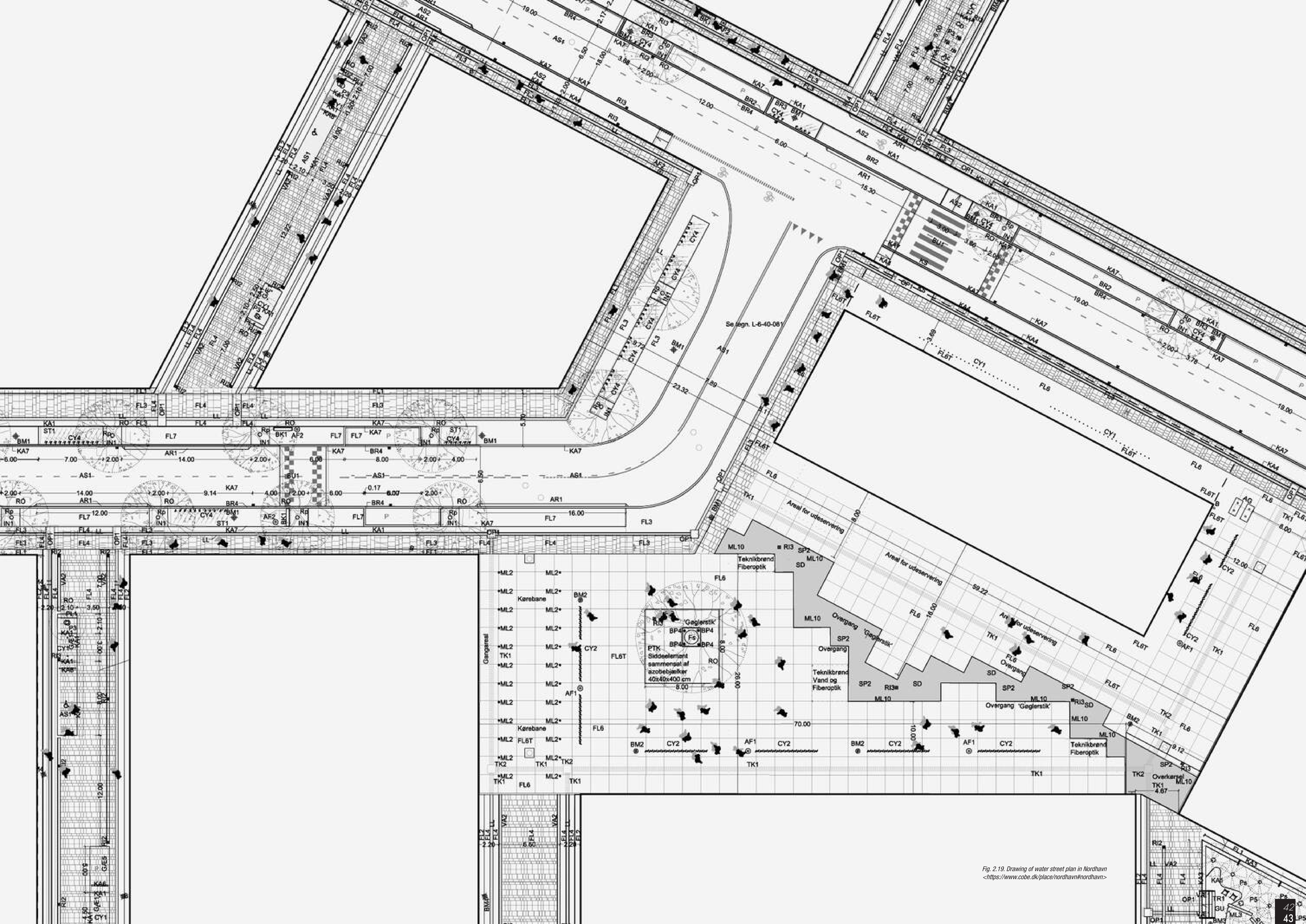

Fig. 2.19. Drawing of water street plan in Nordhavn
<https://www.cobe.dk/place/nordhavn#nordhavn>

• **Solution 3: Cargo Bike**

Bicycles are always important in Copenhagen as a solution to air pollution and pollution:49% of all trips to work or education are by bike, And more than a third of all driven trips in and around the city is by bike. [1]

A study of Copenhagen made by Stefan Gossling from Lund University and Andy s. Choi from the University of Queensland in2014 concludes that cars have a greater negative impact on the pa than bicycles. The study shows how one kilometer by car costs euro 0.15, Whereas society earns euro 0.16 on every kilometer cycled[2]. According to the results of their research, the social cost of car travel is six times the social cost of bicycle travel.

As a result of the habit of bicycle travel, the cargo load capacity of an ordinary bicycle has become a limitation, so the birth and popularity of cargo bike is a natural thing. According to Copenhagenize, a group that started a data campaign in 2015(Fig. 2.20), cargo bikes accounted for 6%of all bikes and 26%of families with two or more kids own a cargo bike as of 2015.

Fig. 2.20. Andersen, Mikael Colville. (2008). Fruit sale cargo bike, in Nahavn, Copenhagen [Photograph]. Retrieved from https://www.flickr.com/photos/16nine/2679539144/in/photostream/

Fig. 2.21. Andersen, Mikael Colville. (2008). Tranportational integration of bicycles on S-train in Copenhagen [Photograph]. Retrieved from https://www.flickr.com/photos/16nine/2679539144/in/photostream/

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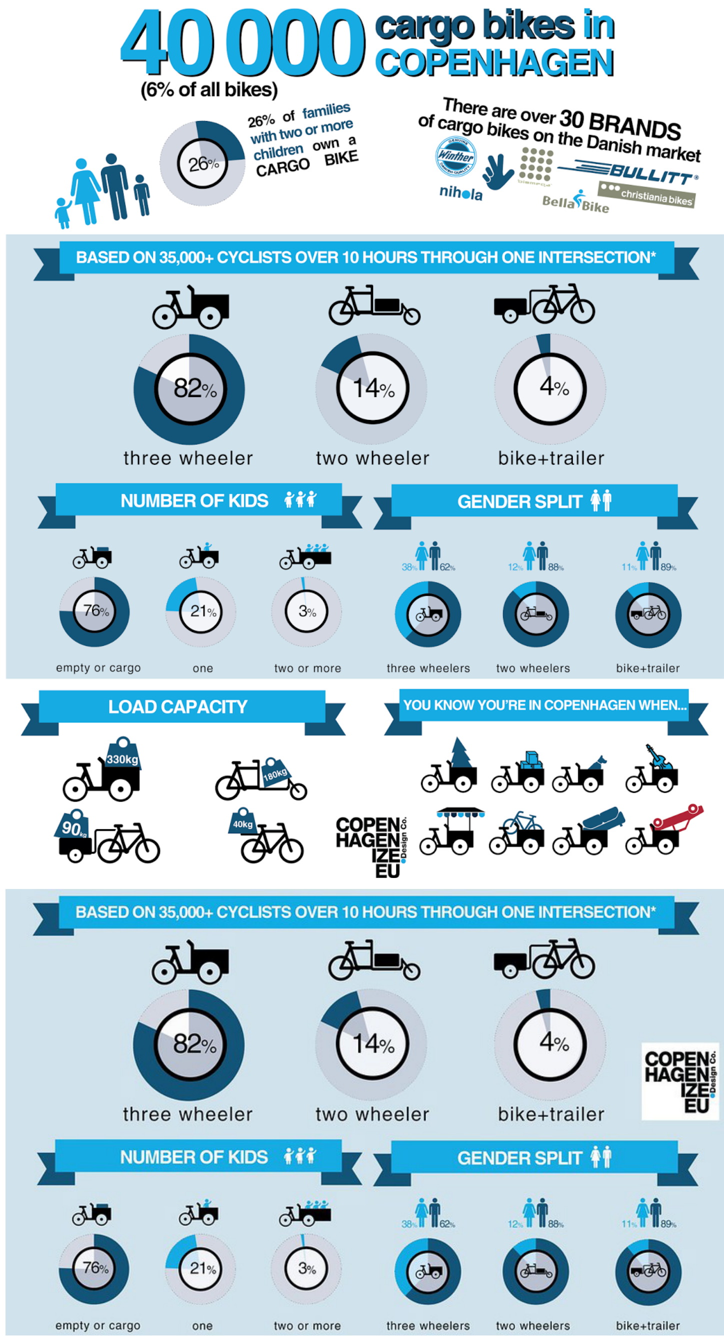

Fig. 2.22. Cargo bike data in Copenhagen <http://www.copenhagenize.com/2015/10/cargo-bike-nation-copenhagen.html>

1, 2 Mehmet, S. (2019, October). City snapshot: what does mobility look like in Copenhagen? Retrieved February 2020, from https://www.intelligenttransport.com/transport-articles/90308/city-snapshot-what-does-mobility-look-like-in-copenhagen/
Andersen, M. C. (2015, October). *Cargo Bike Nation - Copenhagen.* Retrieved February 2020, from http://www.copenhagenize.com/2015/10/cargo-bike-nation-copenhagen.html

• Solution 4: RFID Tags

Nowadays, many applications of magnetic sensors in mobility are only used to identify cars at intersections to control traffic in more smart. Due to a large number of bicycle trips, the identification of bicycles by the transportation system needs to be more accurate and universal.

Copenhagen, in collaboration with the Danish Technical Institute, will implant RFID chips in bicycles to solve the problem that smart transportation systems cannot recognize cyclists. The RFID is a workaround to the weight issue, It's a small tag that clips onto the bike's front wheel. So when a rider passes one of the sensors, it triggers a response to change the light to green as long as it's safe. As an added feature, it can also be used to track bikes in case they are stolen.[1]

Fig. 2.23. RFID tags installation
<http://www.copenhagenize.com/2015/10/cargo-bike-nation-copenhagen.html>

• Solution 5: Automated Driverless GOA4 Transport System

Grade-of-Automation 4 (GoA4) Is the highest level of the train automation level. There is still service personnel on the train, but they are only responsible for the cleaning, ticketing, catering, and other services on the train, not any operation related to running and safety. (Fig. 2.24)

In Copenhagen, the original first-delivered train approaches the retirement age in 2026.[2]Therefore, the government hopes to take this opportunity to restructure the transportation system and use the most advanced and fast means of transportation. The future Copenhagen metro is a typical GoA4 grade transportation system. Under the plan, the new Copenhagen railway network will become the world's fastest driverless public transport system.

1 THANGHAM , CHRIS V. . (2008, November). *RFID Technology Deters Bicycle Thefts in Denmark*. Retrieved February 2020, from http://www.digitaljournal.com/article/262180#ixzz64PZ96BnZ

2 DSB. (n.d.). Future-rail-network. Retrieved February 2020, from https://www.dsb.dk/en/future-rail-network/

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Grade of Automation (GoA)	Type of train operation	Setting train in motion	Stopping train	Door closure	Operation in event of disruption	Exampl
GoA 0	Driver without ATP	Driver	Driver	Driver	Driver	On-stree trams
GoA 1	Driver with ATP	Driver	Driver	Driver	Driver	Tyne anc Wear Metro
GoA 2	ATP and ATO with driver	Automatic	Automatic	Driver	Driver	Paris Métro Line 3
GoA 3	DTO	Automatic	Automatic	Train attendant	Train attendant	Docklan Light Railway
GoA 4	UTO	Automatic	Automatic	Automatic	Automatic	Dubai Metro

ATP automatic train protection, *ATO* automatic train operation, *DTO* driverless train

Fig. 2.24. GoA trains automation range
Wang, Y., Zhang, M., Ma, J., & Zhou, X. (2016, December). Survey on Driverless Train Operation for Urban Rail Transit Systems. Urban Rail Transit, 2(3–4). Retrieved from https://link.springer.com/article/10.1007/s40864-016-0047-8v

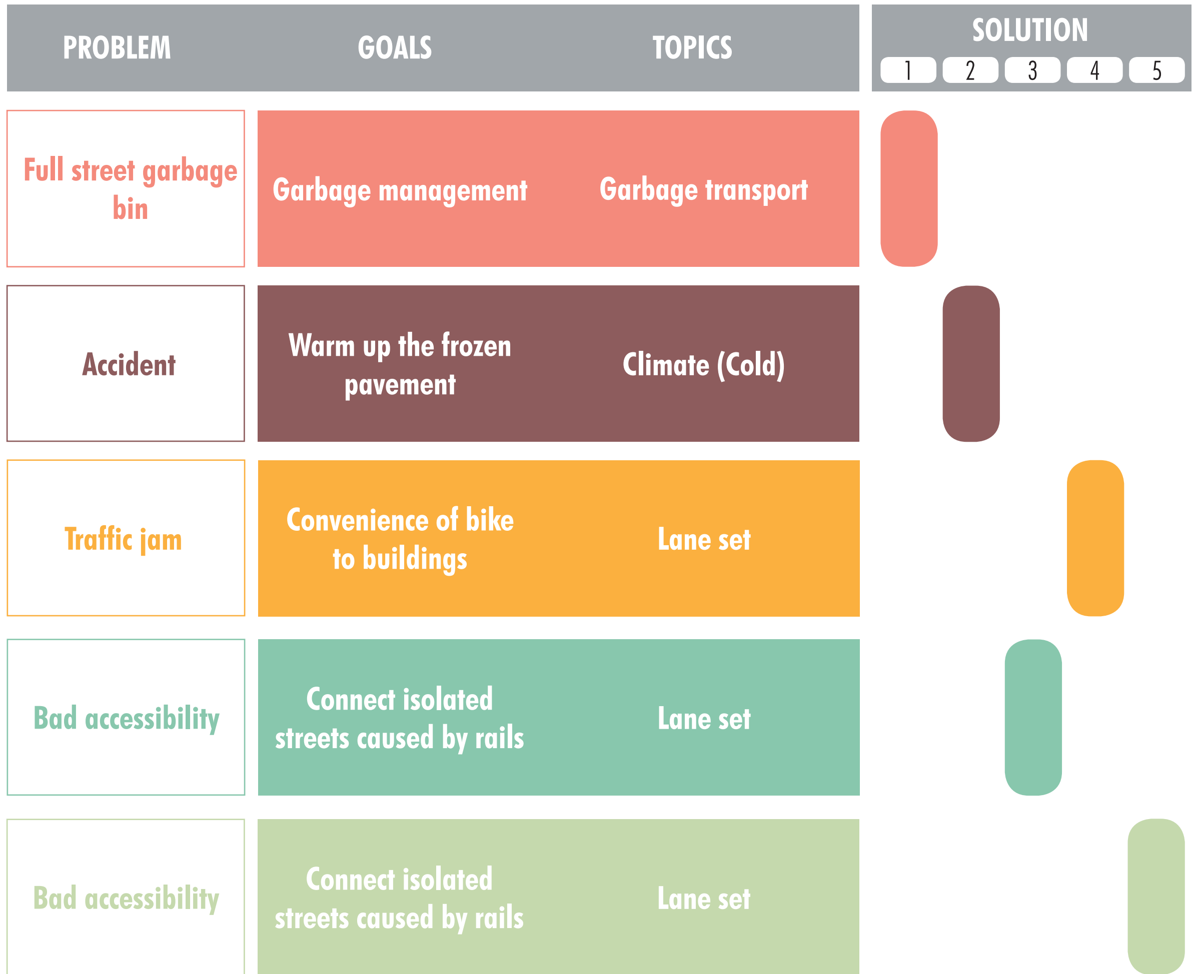


Fig. 2.25. The urban mobility problems that Copenhagen are facing and the role of 5 solutions

• Situation 1: Auto ferry

As cities grow, Trondheim As a coastal city needs more cross-links across rivers and canals. However, the construction cost of the bridge is high and will become an obstacle for the ferry.

Trondheim's auto ferry project is responsible for solving this problem from a technical point of view - providing new, driverless water taxis to meet the travel needs of people in the city. The main responsibility for the Autoferry project so far has been the Department of Electronic Systems, Department of Technical Cybernetics and Department of Marine Engineering at NTNU(Norwegian University of Science and Technology). They have built and tested a prototype of a driverless electric ferry.[1] 'The driverless ferries can become a new tool in the city's toolbox', says Egil Eide(Associate professor, department of electronic systems, NTNU).

Fig. 2.26. Dragland, K. (n.d.). Autonomous pilot ferry for concept testing and to study behaviour of the other boat traffic. [Photograph]. Retrieved from https://www.ntnu.edu/autoferry

Fig. 2.27. Reactor (Finland). (n.d.). The next generation of driverless ferry looks [Illustration]. Retrieved from https://www.reaktor.com

1 Skoglund, A. U. (2019, February). *Førerløse ferger kan erstatte gangbruer.* Retrieved February 2020, from https://gemini.no/2018/06/forerlose-ferger-kan-erstatte-gangbruer/

• Situation 2: Bicycle Lift

The Bicycle Lift was invented by Bicycle enthusiast and The owner of The company in The Design, Management AS Jarle Wanvik. Trondheim is the first city in the world with a lift specifically designed for cyclists.[1] The bicycle lift, developed in Trondheim, is designed to help cyclists overcome mountain terrain.

Fig. 2.28. Bicycle lift in Brubakken, Trondheim <https://www.trondheim.com/trampe-bicycle-lift>

Fig. 2.29. Bicycle lift with skateboards and strollers <https://www.boredpanda.com/bicycle-escalator-cyclocable-trondheim-norway>

During the last 20 years, more than 20 million NOK (€ 2,5 million) was invested in a bicycle road network and bicycle transport infrastructure in Trondheim. The bicycle lift trampe is one of the most important infrastructure project. Since 1993, it's pushed more than 220 000 cyclists up the very steep hill Brubakken in the historical heritage part of the city center.[2]

The bicycle lift has now been commercialized as the Cyclocable® by the french ropeway and funicular company POMA SA. The main difference between the old lift and the Cyclocable ® is the retractable pedal. [3]Whenever the cyclists' feet leave the pedals, they come slowly back to the starting point. Without passengers, it doesn't run like an escalator all the time. Instead, it's on standby to prevent collisions with pedestrians and vehicles, which may bring accidents. This is a typical example of how new technology in mobility solves natural barriers.

1 Trondheim official government website. (n.d.). *Trampe Bicycle Lift*. Retrieved February 2020, from https://www.trondheim.com/trampe-bicycle-lift

2, 3 Eltis. (2014, August). The Trampe bicycle lift in Trondheim (Norway) | Eltis. Retrieved February 2020, from https://www.eltis.org/discover/case-studies/trampe-bicycle-lift-trondheim-norway

• Solution 3: E-Bus

Since August 2019, 35 electric buses have been put into operation on Trondheim's roads.[1] Trondheim get Norway 's most environmentally friendly bus fleet. In their blueprint, Starting in 2020, all major bus manufacturers will have battery-electric buses in their portfolio, and by 2030 a large proportion of the city buses will be battery-electric as their most effective measures to deal with climate change and traffic congestion.

Fig. 2.30. Illustration of a Volvo 7900 electric bus at pantograph charging station in Trondheim <https://www.boredpanda.com/bicycle-escalator-cyclocable-trondheim-norway>

Fig. 2.31. On average, a bus can replace 50 cars.At rush hour, a bus about 16 meters long with a capacity of 74 passengers can stand in line instead of a bus 270 meters long <https://www.tide.no/i-tide/miljoe-og-teknologi/trondheim-faar-norges-mest-miljoevennlige-bussflaate/>

TRONDHEIM

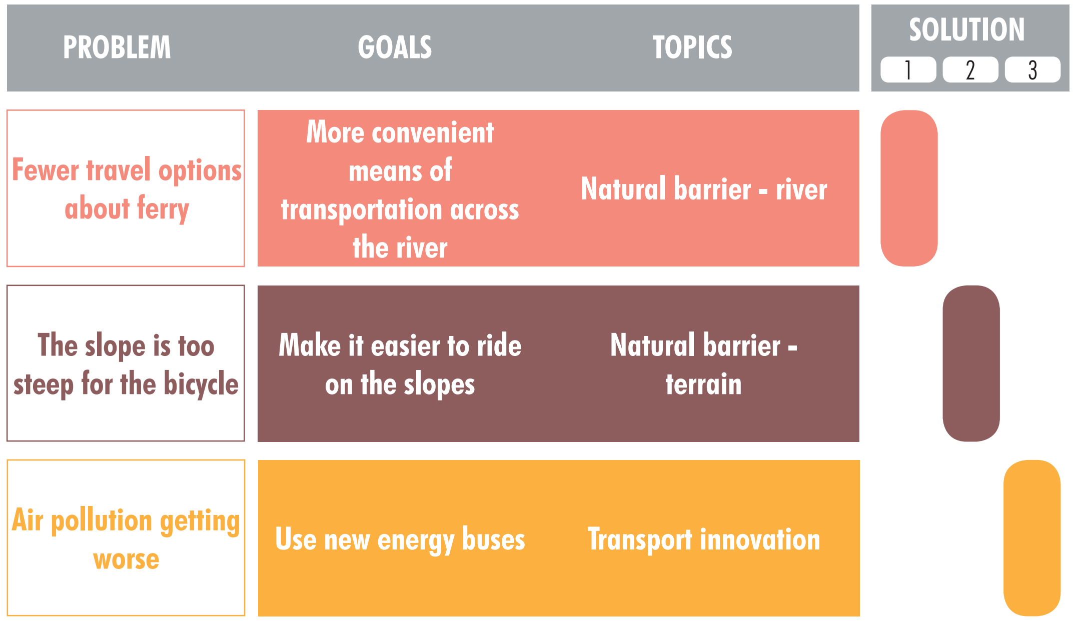


Fig. 2.32.The urban mobility problems that Trondheim are facing and the role of 3 solutions

1 Tide Buss AS. (n.d.). *Trondheim får Norges mest miljøvennlige bussflåte*. Retrieved February 2020, from https://www.tide.no/i-tide/miljoe-og-teknologi/trondheim-faar-norges-mest-miljoevennlige-bussflaate/

TORINO

Since 2010 Torino then adopted new policy documents such as the Torino Action Plan for Energy in 2008, the Sustainable Urban Mobility Plan in 2010, the Master Plan SMILE (Smart Mobility, Inclusion, Life&Health, Energy) and the Bike Plan in 2013, focusing on improving the quality of air, reducing CO2 emission, boosting public transport and sharing mobility, promoting biking, etc.

Nevertheless, according to a new report from Italian environmental authority Legambiente, the reality remains grim:

"Il 2019 anno nero per la qualità dell'aria: 26 i centri urbani fuorilegge sia per polveri sottili (PM10) sia per l'ozono (O3). Prima Torino con 147 giornate fuorilegge (86 per il PM10 e 61 per l'ozono), seguita da Lodi e Pavia. Dal 2010 al 2019 il 28% delle città monitorate da Legambiente ha superato ogni anno i limiti giornalieri di PM10. Torino prima in classifica 7 volte su 10 con un totale di 1086 giorni di inquinamento in città."[1] Thus, poor air quality remains the most obvious problem in Torino mobility. But the reasons for this are different.

A growing part of the population is "multimodal" because residents use more than 5 modes of transport in each week (for example, private car, bicycle, underground, tram, the taxi or various means of sharing transport such as electric scooter sharing or car-sharing). It is 28% of the national average with much higher percentages in cities (up to 60% in Milan).[2] Public transport is already more electric than private cars but still needs to be implemented.

The contents of the report can be summarized in the following four points:

1. The high emission of old fuel cars is still not updated, which is one of the reasons why air pollution cannot be solved,

2. Although there are many traffic restrictions in Torino, including the control of diesel tax rate, the actual air purification effect is not obvious,

3. To meet the Paris agreement's future emissions expectations, only electric vehicles can be achieved, not improvements to gas-powered vehicles,

4. Premature deaths from air pollution in Italy could be reduced by 27% if EU air standards are met.

TORINO

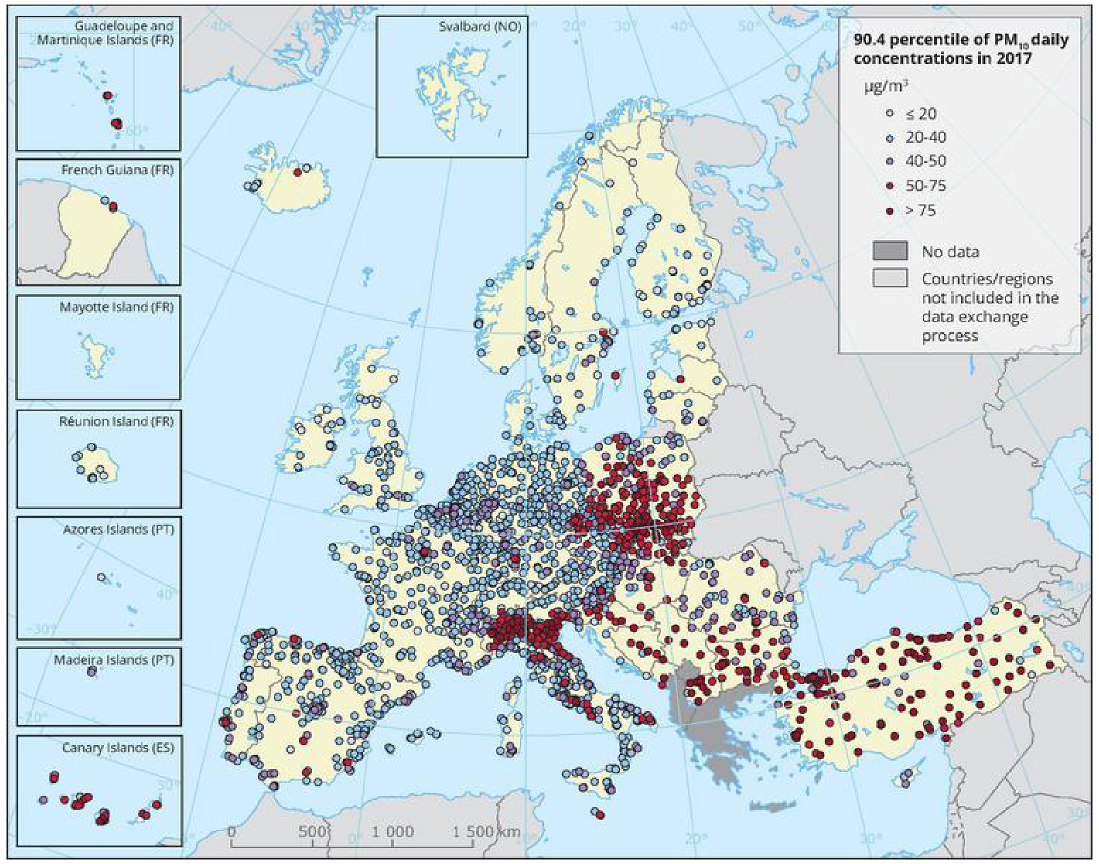


Fig. 2.33. PM10 concentration trends in 2017

Inquinamento atmosferico: le città che hanno superato almeno uno dei limiti giornalieri previsti per il Pm10 o per l'ozono nel 2019

Torino	**147**	**Treviso**	**102**	Trento	46
Lodi	**135**	**Brescia**	**94**	Chieti scalo	45
Pavia	**130**	**Parma**	**87**	Verbania	45
Piacenza	**128**	**Ravenna**	**79**	Lucca	44
Alessandria	**121**	**Rimini**	**78**	Genova	43
Vicenza	**116**	**Lecco**	**73**	Vercelli	41
Rovigo	**115**	**Bergamo**	**72**	Cuneo	39
Mantova	**114**	Frosinone*	68	Grosseto	37
Verona	**114**	Varese	65	Napoli*	36
Cremona	**112**	**Forlì**	**63**	Aosta	34
Milano	**109**	Como	61	Pescara	34
Monza	**109**	Bologna	59	Savona	31
Venezia	**109**	Biella	55	Udine	31
Modena	**108**	Caserta	52	Firenze	30
Reggio Emilia	**108**	Enna	50	Novara	29
Padova	**105**	Potenza	50	Pordenone	29
Asti	**104**	Terni	47	Macerata	28
Ferrara	**103**	Avellino	46	Roma	27

Fig. 2.34. Days of Italian cities (partial) exceeded the PM10 and ozone limit over the course of 2019

1 Legambiente. (2020, January). *Emergenza smog: i nuovi dati di Mal'aria il report di Legambiente sull'inquinamento atmosferico in città*. Retrieved February 2020, from https://www.legambiente.it/emergenza-smog-i-nuovi-dati-di-malaria-il-report-di-legambiente-sullinquinamento-atmosferico-in-citta/

2, 3 l'ufficio scientifico di Legambiente, Poggio, A., Laurenti, M., Santis, S. D., & Izzi, A. (2020). Mal'Aria di città 2020. Retrieved from https://www.legambiente.it/wp-content/uploads/2020/01/Malaria-di-citta-2020.pdf

• Solution 1: Auto-sliding Pavilion - Mobjects, Granstudio

Mobjects designed by Granstudio[1] is a kind of new mobility mode that carries forward the seamless urban mobility. Auto-sliding pavilion——Mobjects, pedestrian can fluently hop-on and hop-off when the distance gets too far to walk, but too short to use vehicle. They created this new form of mobility that has an open and positive interaction with pedestrian public space, also when it stands still.[2]

Fig. 2.35. Mojects on the street scenario
<https://www.granstudio.com/mobjects>

This kind of auto-sliding pavilion uses solar energy as its source of kinetic energy and move at a slower speed through the streets of the city center. It will be a recreational mode/place located in cycling and walking.(Fig. 2.36) At the same time, it reduces the demand for cars in urban areas, while catering to the aging trend of travel conditions.

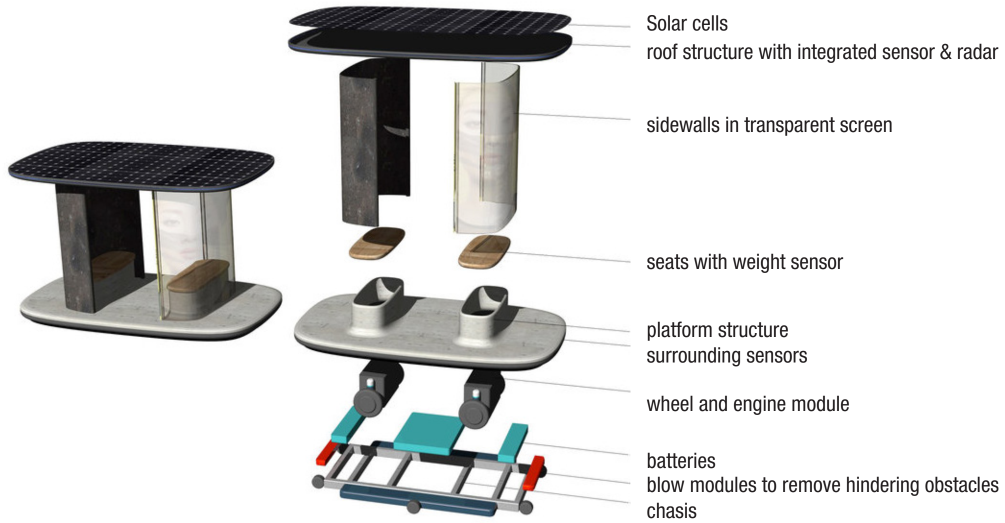


Fig. 2.36. Structural explosion diagram of auto-sliding pavillon
<https://www.granstudio.com/mobjects>

1 Granstudio is an innovative car design & mobility research studio in Torino
2 Mojects. (n.d.). Revolutionising Urban Mobility. Retrieved from https://www.granstudio.com/mobjects

• Solution 2: Modular Air taxi - Pop.Up, Italdesign

People never give up on taking vehicles to the sky. During the 87th Geneva International Motor Show, Italdesign(Torino) and Airbus world-premiered Pop.Up, the first modular, fully electric, Zero-emission concept vehicle system designed to solve traffic congestion in crowded megacities.[1]

How does it work?

The capsule measures 2.6 meters long, 1.4 meters high, and 1.5 meters wide. The capsule turns itself to a car by coupling to the ground module, which features a carbon-fiber chassis and is battery powered. When running on a traffic-clogged urban street, the capsule disconnects from the ground module and is carried by a 5 by 4.4-meter air module propelled by eight counter-rotating rotors. With this structure, Pop.Up becomes an self-piloted air vehicle, taking advantage of city above to get from A to B efficiently avoiding urban traffic jam. After the last service ends, the air and ground modules with the capsule autonomously return to dedicated recharge stations to wait for their next customers.[2]

This kind of modular air taxi is a typical product of multi-mode transportation. By the way, in terms of urban streets and buildings, we must imagine and design in advance to meet this inevitable trend and accelerate the application of mobility to new technologies.

Fig. 2.37. Concept rendering of Pop.Up
<https://www.italdesign.it/project/popup/>

1, 2 Italdesign. (2017, March). Italdesign-Airbus-PopUp. Retrieved February 2020, from https://www.italdesign.it/project/popup/

• Solution 3: Indicator in the metro - Metropolitana, Italdesign
InTO aims to offer metro's passengers an immediate and simple service to improve their experience onboard. Above the doors allowing access onboard the carriages at the Re Umberto pilot Metro station some LEDs have had been installed; When the train arrives at the station, the LEDs turn on indicating the occupation percentage of each coach: green if it 's free, yellow if it' s half - occupied, orange when it 's fully crowded. The algorithm InTO is on offer a service to citizens guaranteeing The right to their privacy: The images provided by the security cameras are not saved, they are used only to count the number of the passengers on board.[1] New York, London, and Paris have also started using the indicators. Such indicators can be used not only on subways but also on other public transport. It is the same idea as Copenhagen's Green waves, which is to improve transport efficiency by humanizing it.

Fig. 2.38. Thi, V.A. P. (2019). Metropolitana in Re Umberto metro station, Torino [Photograph]. Retrieved from https://static-www.quotidianopiemontese.it/wp-content/2018/03/23205158/metropolitana-torino-qp-768x431.jpg

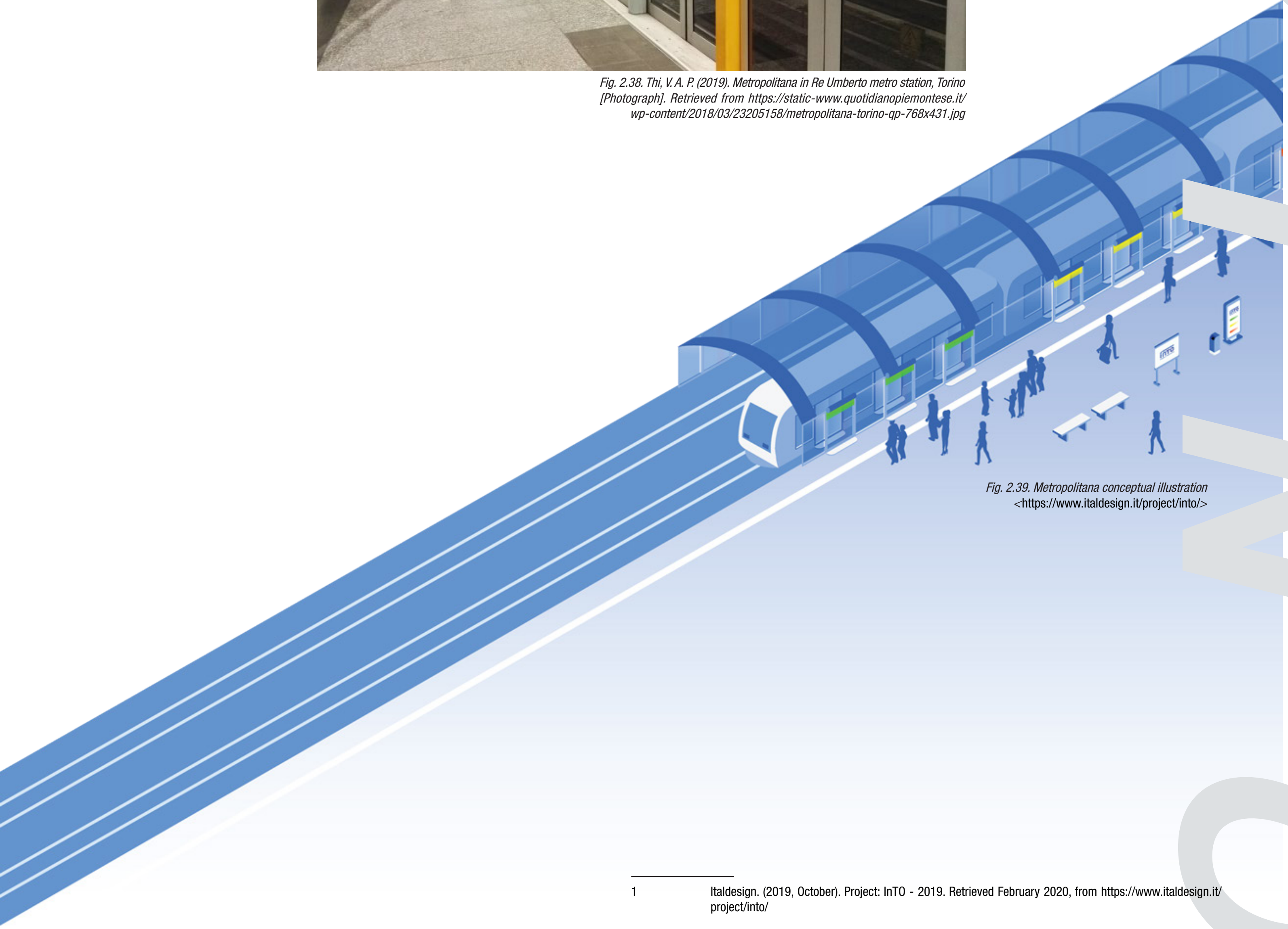


Fig. 2.39. Metropolitana conceptual illustration <https://www.italdesign.it/project/into/>

PROBLEM	GOALS	TOPICS	SOLUTION 1 2 3
Few travel chioces	New transport mode for taking place walking on street	Walkability	
Traffic jam	Reduce ground traffic congestion	Transport innovation	
The transfer time is too long	Proper allocation of passengers	Indicator	

Fig. 2.40. The urban mobility problems that Torino are facing and the role of 3 solutions

1 Italdesign. (2019, October). Project: InTO - 2019. Retrieved February 2020, from https://www.italdesign.it/project/into/

• Solution 1: Drone Deployment system

In China, the economic losses caused by natural disasters and accidents amount to hundreds of billions every year. There is generally too complex terrain in the affected rural areas. In contrast, the intelligent aircraft is more responsive, which has less affected by the natural environment and terrain, and has a better perspective. Especially in the face of major infectious diseases, it is possible to avoid human contact.

In December 2016, the world's first drone command and control center was built at EHang headquarters in Guangzhou, China, for aircraft scheduling, monitoring, warning, recording and controlling. The plan will be promoted in three steps: First, they will promote the launch of the EHang manned autonomous pilot aircraft, pilot flights and flight routes in 11 municipal districts of Guangzhou. Second, the construction of the Guangzhou government drone command and dispatching management platform, actively promote the application of government drone including centralized real-time monitoring, command and dispatching, cluster networking, etc. Third, deepen and expand drone logistics distribution to help Guangzhou establish a new transportation mode of drone distribution.[1]

Fig. 2.41 & Fig. 2.42. Application of drone for relief materials transmission against the new coronavirus epidemic, China <http://www.81.cn/gnxw/2020-02/16/content_9743834.htm>

GUANGZHOU

Fig. 2.43. Drone command center <http://www.ehang.com/cn/news/496.html>

Command center deploys the drone to reach the scene of traffic accidents for investigation and gives real-time feedback on whether the staff needs to be transferred, to reduce traffic congestion may be caused by redundant resource allocation for minor accidents. Traffic management can directly update traffic information on the spot, but this part may be replaced by artificial intelligence based on big data in the future.

Fig. 2.44. Monitoring and tracking system [video snapshot]<http://www.ehang.com/cn/video/show/220.html>

Monitor and track the movement of relief supplies and the real-time status of drones. Data include cargo weight, remaining mileage, electric quantity, etc.

Fig. 2.45. Temporary dispatching system [video snapshot]<http://www.ehang.com/cn/video/show/220.html>

Multiple drones dispatching can change the functions of different drones in time. When a major accident occurs on the ground, the cargo transport drones can modify the route to conduct field detection first.

1 Huangpu new era(黄 埔 新 时 代). (2019, December 27). The drone in our district is on the stock market(我区培育出无人机上市第一股). Retrieved February 2020, from http://www.hp.gov.cn/xwzx/zwyw/content/post_5549945.html

• **Solution 2: Drone delivery system - Super species & EHang**

Food Delivery Process

Fig. 2.46. Food Delivery Process-1 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

1. Customers order their food on mobile applications.

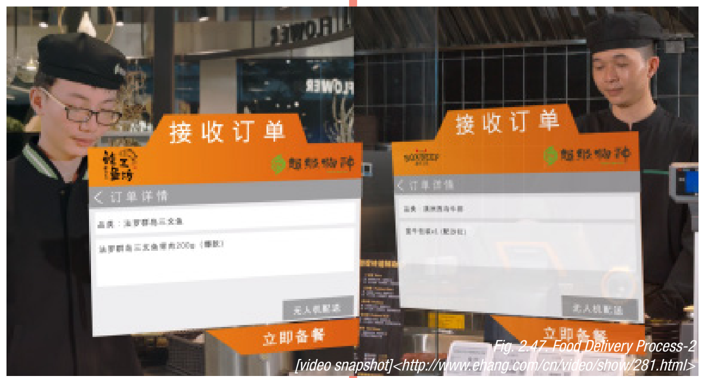


Fig. 2.47. Food Delivery Process-2 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

2. Merchants receive the order and make food.

Fig. 2.48. Food Delivery Process-3 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

3. Merchants put dishes into the drone and scan the QR code on the aircraft for binding, which is used for customers to check the flight progress on the mobile phone.[1]

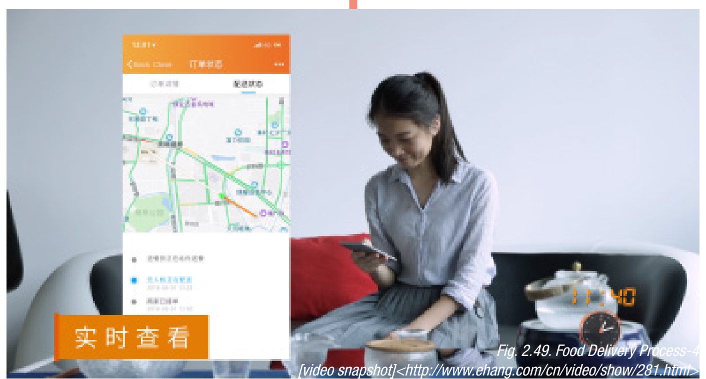


Fig. 2.49. Food Delivery Process-4 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

4. Independent monitoring by both customers and merchants.

1 EHang. (n.d.). EHang Falcon drone delivery solution. Retrieved from https://www.ehang.com/cn/video/show/220.html

5.Take food


Fig. 2.51. Food Delivery Process-5.2 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

5.2. Direct access to the landing platform of the compound.


Fig. 2.50. Food Delivery Process-5.1 [video snapshot]<http://www.ehang.com/cn/video/show/281.html>

5.1. Landed on a mobile landing platform located in the community, and then manually transported.

It is estimated that delivery by a drone can save 40%-60% of delivery time, expand routes and form an air logistics network, and reduce the distribution cost of a large-scale operation by 50%.[1] The picture shows the stores in the unit community and the direct distribution within the short-range community of individuals. This method is more suitable for inter-company distribution, to reduce the damage caused by improper drone operation by ordinary individuals. For the cross-community, the plan states that the drone is delivered to the end of the community, and the community rider at the station completes the final 100 meters of delivery. While avoiding traffic congestion, distribution in the community is carried out manually to facilitate delivery to residents' doorsteps and reduce the distance for residents to pick up meals. If all of them are delivered from drone stores to individuals, they must be equipped with a large number of landing points, resulting in the waste of space within the community. Through this scheme, the design of the restaurant landing point and community landing point are considered.

1 EHang. (n.d.). EHang Falcon drone delivery solution. Retrieved from https://www.ehang.com/cn/video/show/220.html

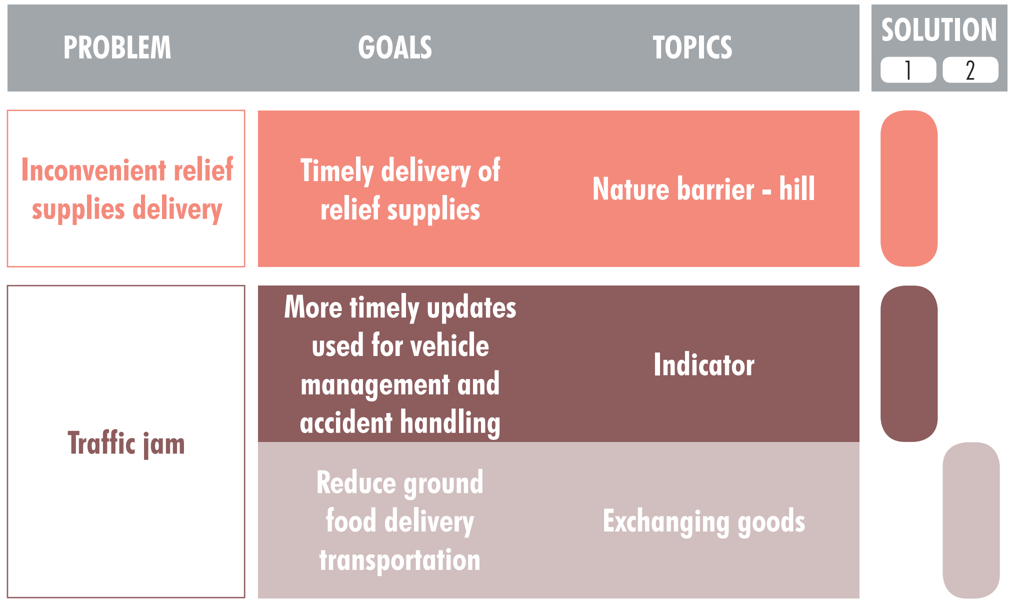


Fig. 2.52. The urban mobility problems that Guangzhou are facing and the role of 2 solutions

GUANGZHOU

ADDITION CASES

• Solution 1: Cora Air taxi - Christchurch, New Zealand

New Zealand is located in an earthquake zone, where historically frequent earthquakes have caused mountains to rise, especially on the west coast, where the coastline is very rugged. Terrain and disaster have always made air relief an important demand for local mobility.

Kitty Hawk company is partnering with Boeing to help further develop the Cora, a two-seat vehicle it hopes will be the cornerstone of future flying taxi service. The vehicle customers would hail with an app like Uber or Lyft, being flown by an autopilot system, with support and oversight provided by a human pilot situated remotely.[1] Kitty Hawk's VTOL Cora has been undergoing stringent testing in New Zealand for over a year now. Having achieved over 700 flights since March 2018, the all-electric air taxi operates at heights of 500 to 3,000 feet above the ground, can travel at speeds of up to 110 mph and currently has a flying range of about 62 miles.[2]

Fig. 2.53. Lord, R. (2018). Kitty Hawk Cora air taxi [Photograph]. Retrieved from https://imoveaustralia.com/news-articles/personal-public-mobility/kitty-hawk-cora-flight-new-zealand/

• Solution 2: Uber Air Taxi- Los Angeles, US

Different from Cora air taxis in New Zealand, the primary purpose of the research on air taxis in the United States is not to solve the terrain impact, but the increasingly serious traffic congestion in the United States. Various mobile travel companies are actively studying the feasibility of air traffic.

Uber wants to perform its test flights in 2020, and it plans to launch some version of an air taxi service in 2023, starting in Dallas, Texas, and Los Angeles, California.[3] They offer air taxis with different models and performance to meet the flight requirements of different spans.

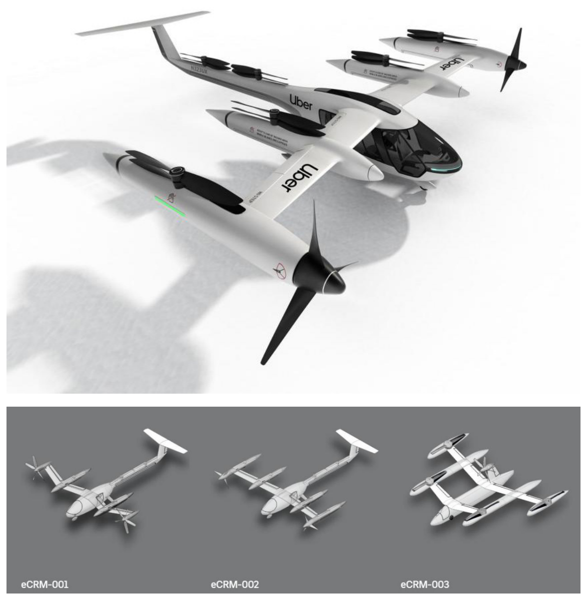


Fig. 2.54. Uber air taxi's rendering and models <https://www.uber.com/it/it/elevate/uberair/>

1, 2 Fitzgerald, S. (2018, March). *Kitty Hawk Cora air taxi takes flight in New Zealand.* Retrieved February 2020, from https://imoveaustralia.com/news-articles/personal-public-mobility/kitty-hawk-cora-flight-new-zealand/

3 Uber. (n.d.). *Uber Air / Uber Elevate*. Retrieved February 2020, from https://www.uber.com/it/it/elevate/uberair/

• Solution 3: Solar Power Path - Krommenie, Netherland

The 70-meter-long solar power cycling path between Krommenie and Wormerveer costs €3 million to construct. Its construction costs have been quickly recouped by the electricity it provides. It is composed of solar panels that provide electricity for three houses nearby. In 2016, the road was built and expanded to 100 meters long. The government aims to deploy solar panels on 20% of all roads in the Netherland, enough to supply the entire infrastructure, from traffic lights to electric vehicles to electric bikes, with power. However, It also has some disadvantages. Due to the flat orientation of the panels, their efficiency is 30% lower than that of solar panels on house roofs. The coating also needs to be sufficiently non-slip for tires and smooth enough for dirt not to stick on the panels.[1]

The first solar power path is located only on the bike path. The main reasons are load-bearing, antifouling and sunlight reflection cannot be solved at that moment. Now they constructed one new solar power road. The new road is about 70 meters long, which is made of concrete slabs in which photovoltaic panels have been integrated, in turn, protected by a thick layer of transparent glass capable of supporting both bikes and heavier vehicles. So far, around 150,000 cyclists have ridden this track-road, from Krommenie to Wormerveer.[2] According to SolaRoad, in the Netherlandish climate, 12 meters of the road could provide 3,500 kilowatt-hours of electricity, which is enough to power an ordinary local household for 1 year. [3]

Fig. 2.55. Solar power bicycle path in Krommenie <https://ecoliving.it/blogs/news-notizie-ecologia/34227205>

1 Berger-Schauer, Christoph. (2017, December 11). 5 Bike Infrastructure Solutions to Make Cycling Easier. Retrieved February 2020, from https://www.bikecitizens.net/bike-infrastructure-even-more-cycle-comfort/

2 Scuri, E. (2015, June). *SolaRoad, in Olanda la prima pista ciclabile al mondo che produce energia pulita.* Retrieved February 2020, from https://ecoliving.it/blogs/news-notizie-ecologia/34227205

3 SolaRoad. (n.d.). *SolaRoad kit.* Retrieved February 2020, from https://www.solaroad.nl/solaroad-kit/

• Solution 4: Hyperloop - Los Angeles, US

In 1909, rocketry pioneer Robert Goddard proposed a vacuum train concept similar to the Hyperloop. In 1972, the RAND Corp. extended this into a supersonic underground railway.[1]

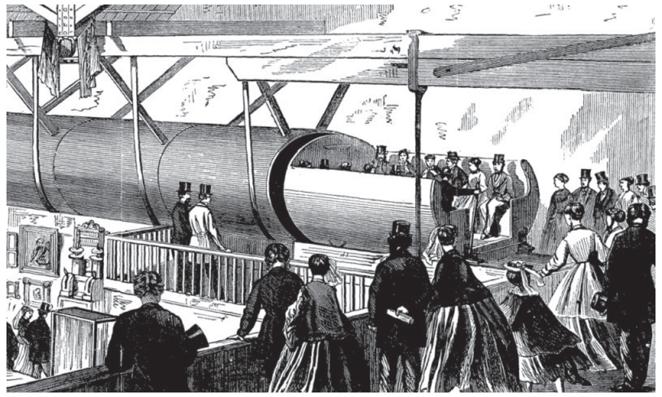


Fig. 2.56. Experimental train system invented by Alfred Ely Beach in 1867 Andrews, E. (2018, September). The Strange Tale of New York's Forgotten Subway. Retrieved from https://www.history.com/news/the-strange-tale-of-new-yorks-forgotten-subway

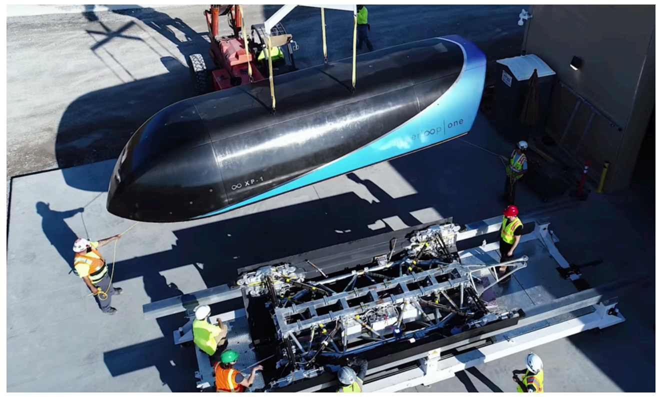


Fig. 2.57. Hosseini, K. (2018). Fuselage and levitating chassis in the process of being seamlessly integrated [Photograph]. Retrieved from https://hyperloop-one.com/blog/story-radical-hardware

Fig. 2.58. Upbin, B. (2016). Burj Khalifa Hyperportal, View from Main Entrance, Dubai [Photograph]. Retrieved from https://hyperloop-one.com/blog/pictures-new-designs-hyperloop-one-system-uae

Hyperloop is considered the fifth mode of transportation, and it's also known as a big bet because of its high cost. Under the social background of pursuing freedom of mobility, it is an extreme way to meet most needs——combining multiple transportations such as airplane, vehicle, and subway. The vehicle of 27 seats levitates in a near-vacuum environment into a tube, propelled at a speed around 1000-1200 km/h for distances of more than 500 km. As an airplane, it can connect directly cities by a direct line, even better operating with more renewable energy consumption and increased efficiency. The vehicle traction system is conceptually similar to maglev, with a coupling of an aircraft compressor. [2] Not only in terms of cost but also in terms of coverage and replacement of the existing transportation system. Without proper mobility accessories, such as coherent city streets and proper building spacing, the implementation of the technology will be constantly delayed.

Hyperloop One engineering and product teams worked with the architects and designers at BIG to come up with these, the first conceptual renderings of a Hyperloop One system in the UAE.[3] (Fig. 2.58)As a transition point between multimodal transportation and Hyperloop, they tried to integrate into the urban landscape and increase the penetration of sunlight. The circular construction and omni-directional access also fit the concept of free mobility.

Fig. 2.59. Upbin, B. (2016a). Burj Khalifa Hyperportal Control Center, Dubai [Photograph]. Retrieved from https://hyperloop-one.com/blog/pictures-new-designs-hyperloop-one-system-uae

1 Diamandis, P. H., & Kotler, S. (2020). *The Future Is Faster Than You Think: How Converging Technologies Are Transforming Business, Industries, and Our Lives (Exponential Technology Series)*. New York, United States: Simon & Schuster.

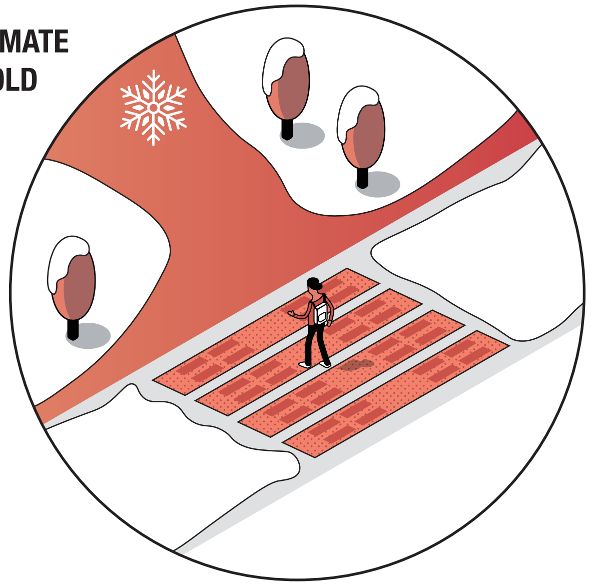
2 Riviera, M. (2018). *High-speed trains comparison to Hyperloop: energy and sustainability Hyperloop safety analysis and integrations to reach the NOAH concept*. Retrieved from https://webthesis.biblio.polito.it/9231/

3 Upbin, B. (2016c, October). *New Designs for System in the UAE*. Retrieved February 2020, from https://hyperloop-one.com/blog/pictures-new-designs-hyperloop-one-system-uae

3. METHODOLOGY

ATLAS
(Fig. 3.1-3.30.)

CLIMATE -COLD



HEATED PAVEMENT
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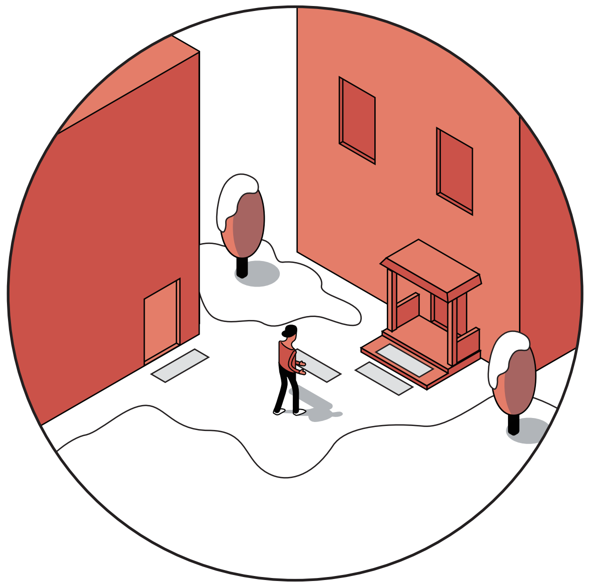
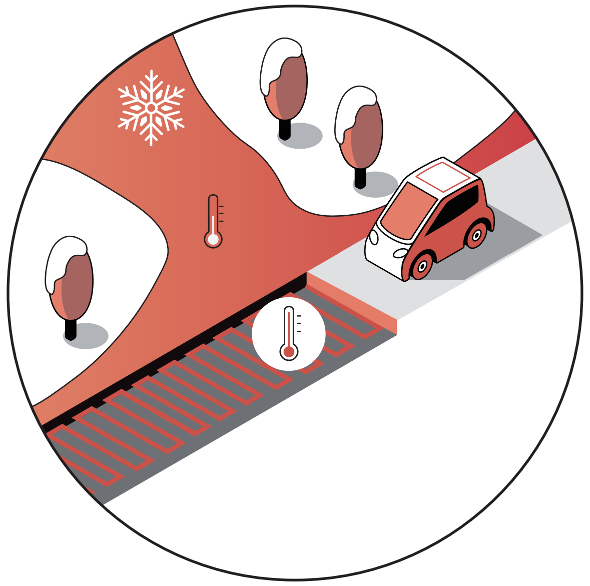
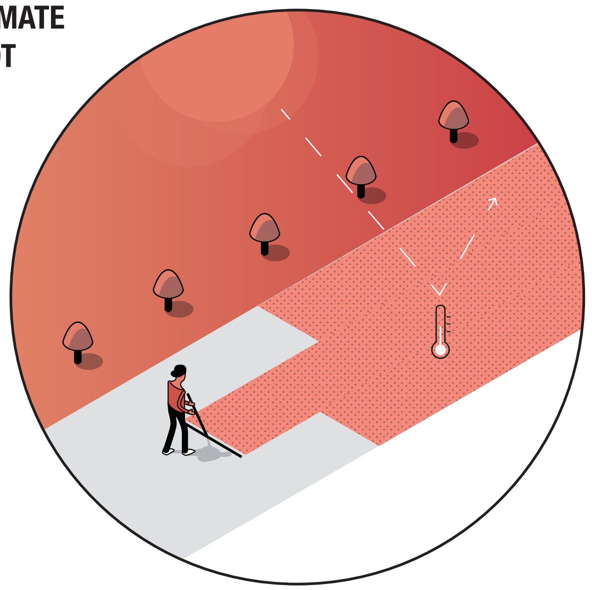


FLEXIBLE HEATED BOARD
<MURRAY>



STREET SNOWMELT SYSTEM
<HOLLAND, MICHIGAN>

CLIMATE -HOT



COOL COATING PAVEMENT
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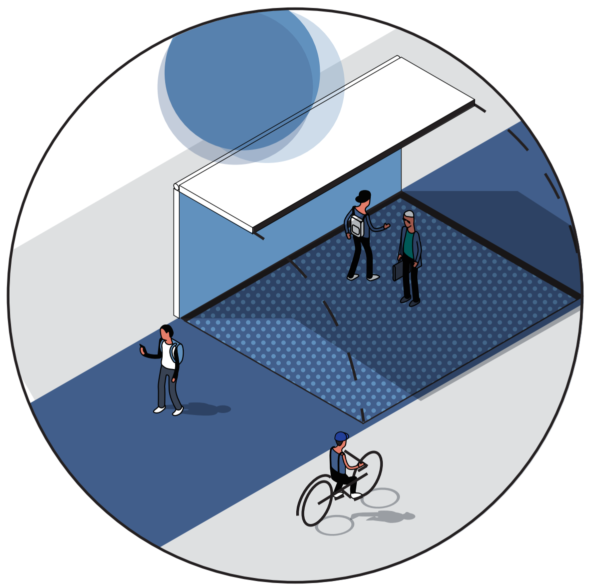
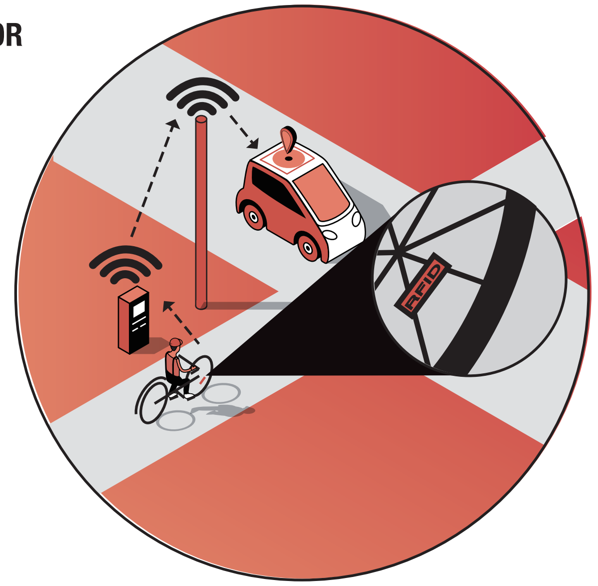
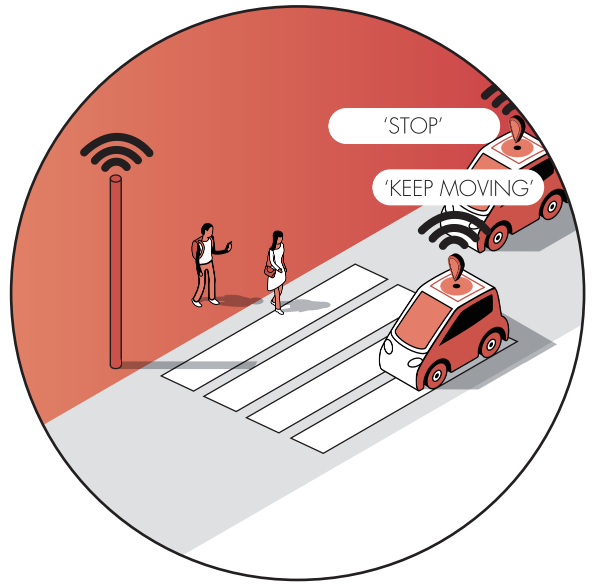


ADJUSTABLE PAVEMENT

INDICATOR



RFID TAGS FOR BICYCLES
<COPENHAGEN>



AUTONOMOUS TRAFFIC SYSTEM
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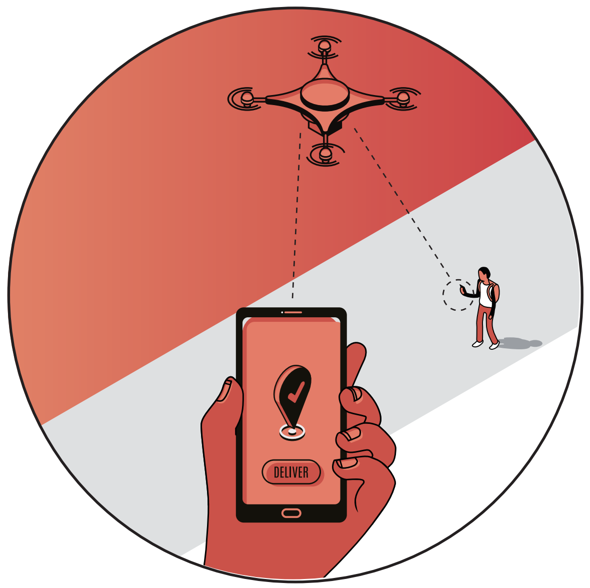

DRONE DELIVERY SYSTEM
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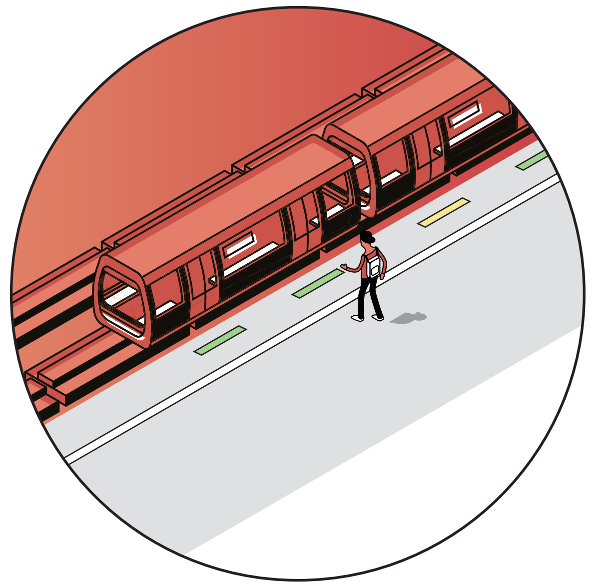
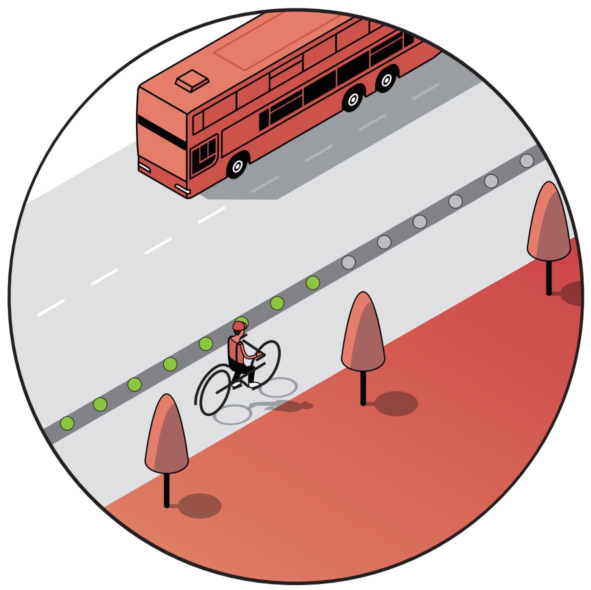
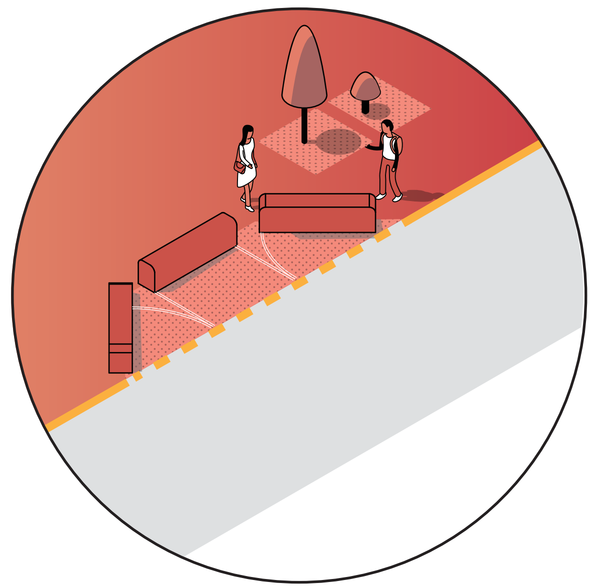


CARRIAGE INDICATOR
<TORINO>

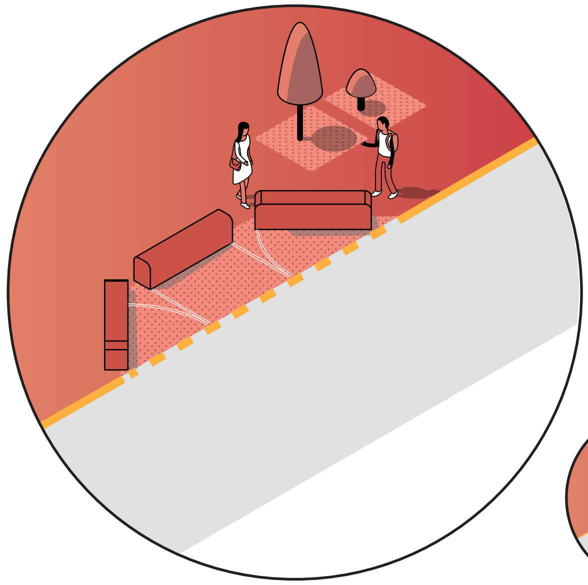


GREEN WAVES
<TORONTO>



POP-UP ROADBLOCK
<TORONTO>

LANE SET



POP-UP ROADBLOCK
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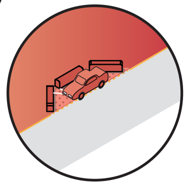
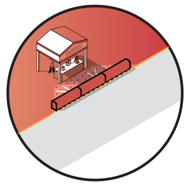


9:00 AM



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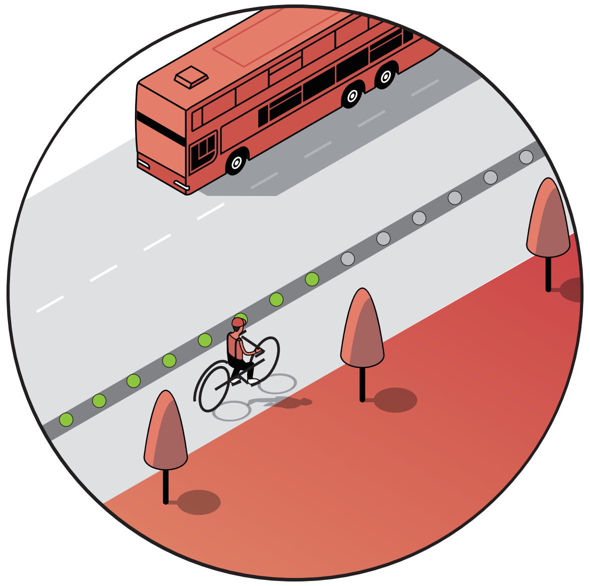

GREEN WAVES
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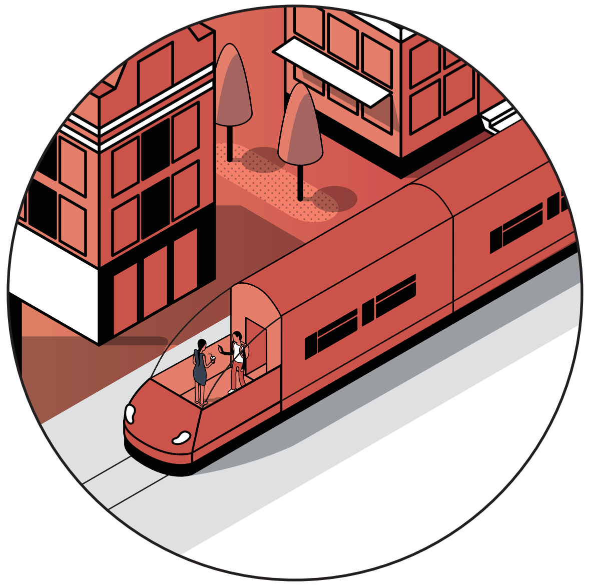
TRANSPORT INNOVATION



GOA4 TRANSPORT SYSTEM
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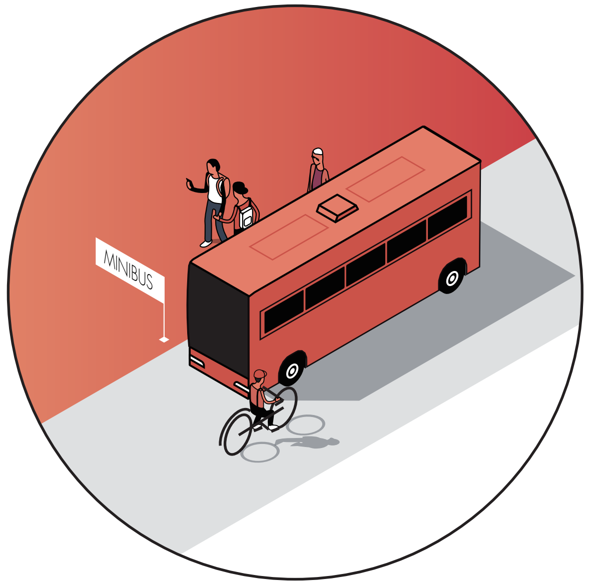
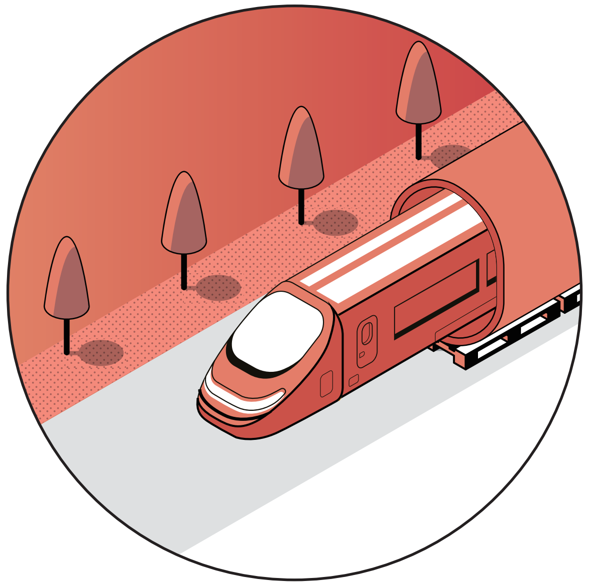
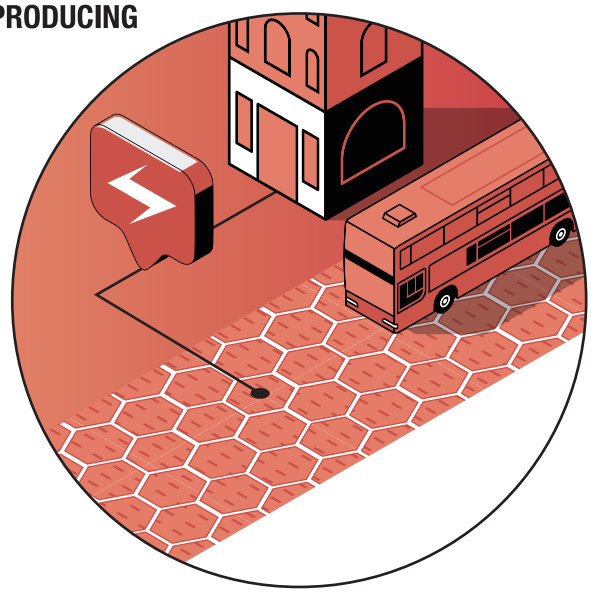


AUTONOMOUS MINIBUS
<COPENHAGEN>



HYPERLOOP
<LOS ANGELES>

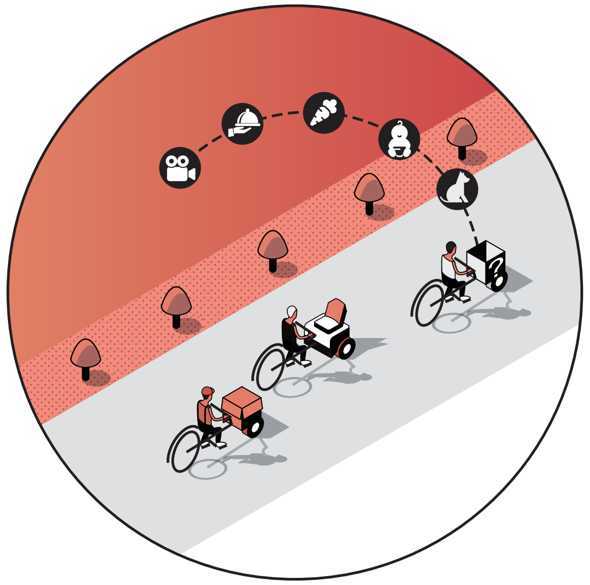
ENERGY PRODUCING



SOLAR POWER PAVE
<KROMMENIE>

EXCHANGING GOODS

UNDERGROUND LOGISTICS HUB
<TORONTO>



CARGO BIKE
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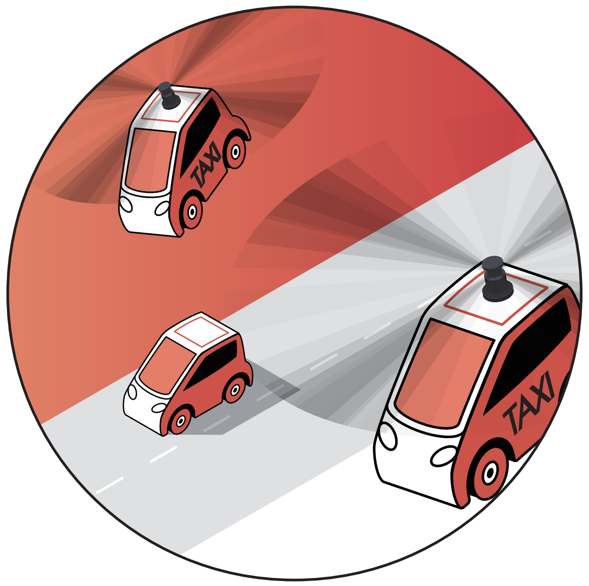
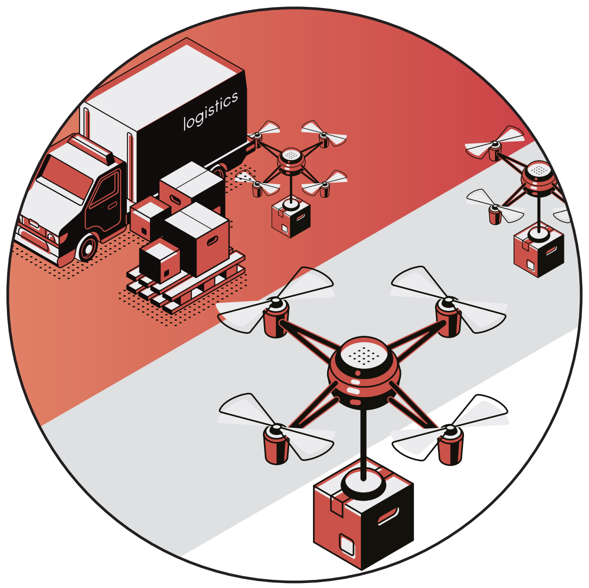
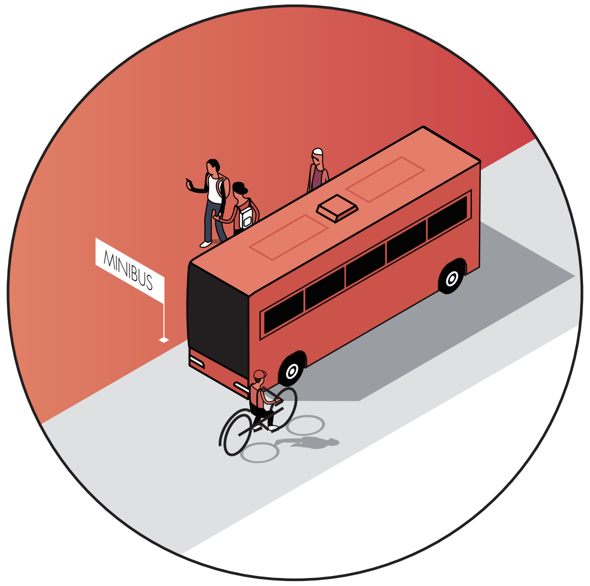


AIR TAXI
<CHRISTCHURCH>



DRONE DELIVERY
<GUANGZHOU>

NATURE BARRIER



AUTONOMOUS MINIBUS
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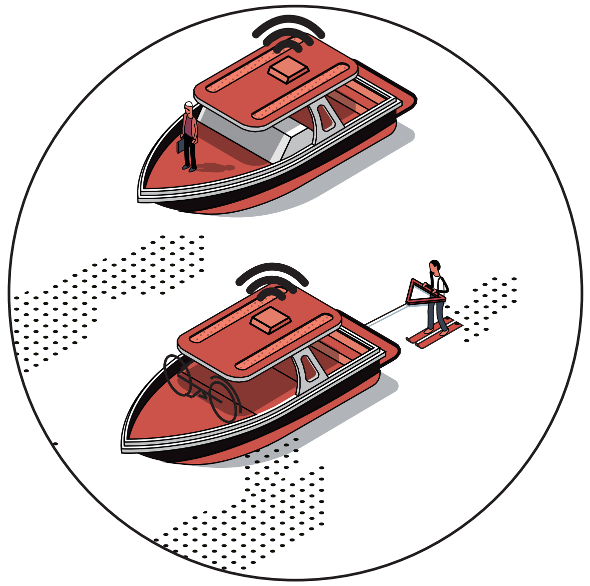

AUTOFERRY
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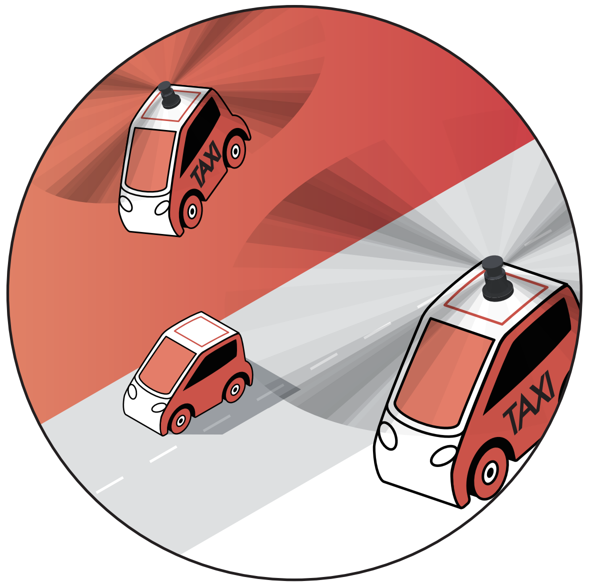
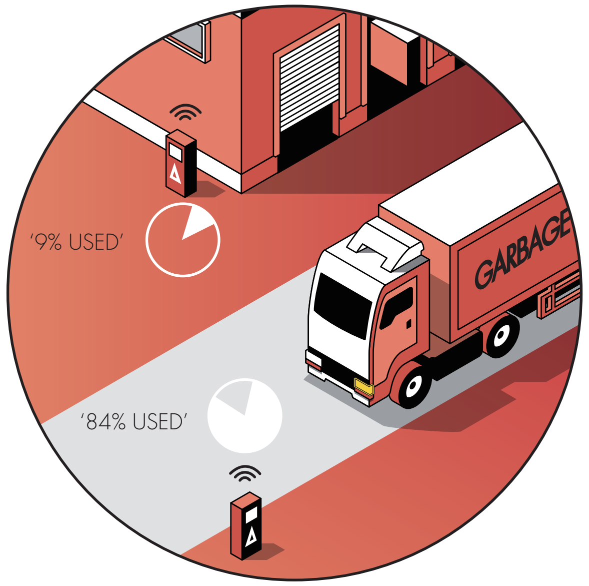


AIR TAXI
<CHRISTCHURCH>

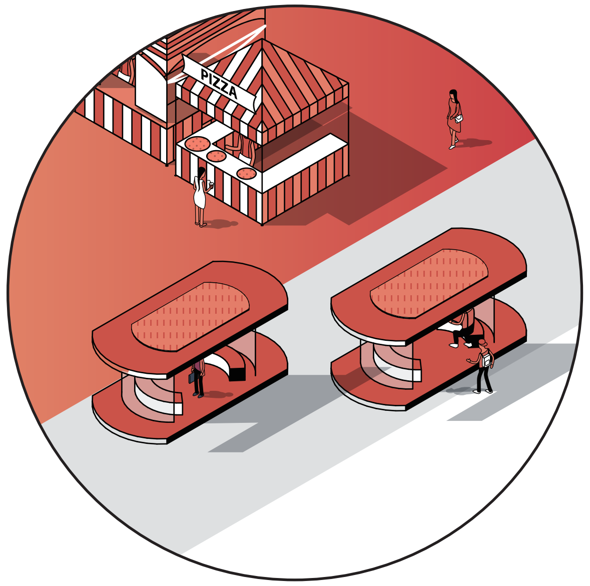
GARBAGE TRANSPORT



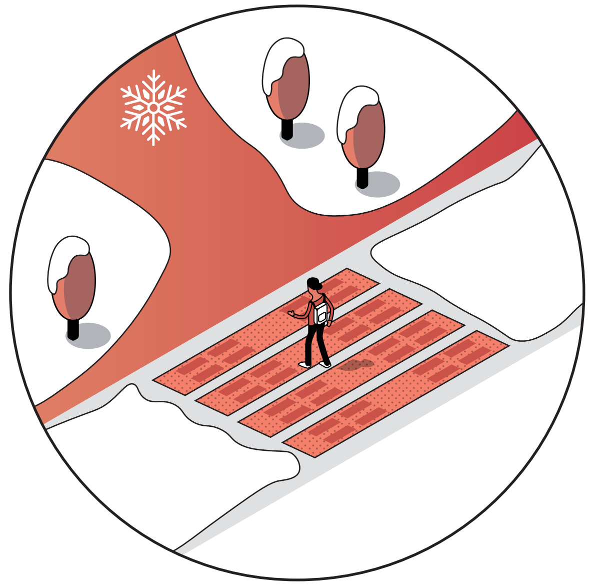
SMART GARBAGE BIN
<COPENHAGEN>

UNDERGROUND SORTING SYSTEM

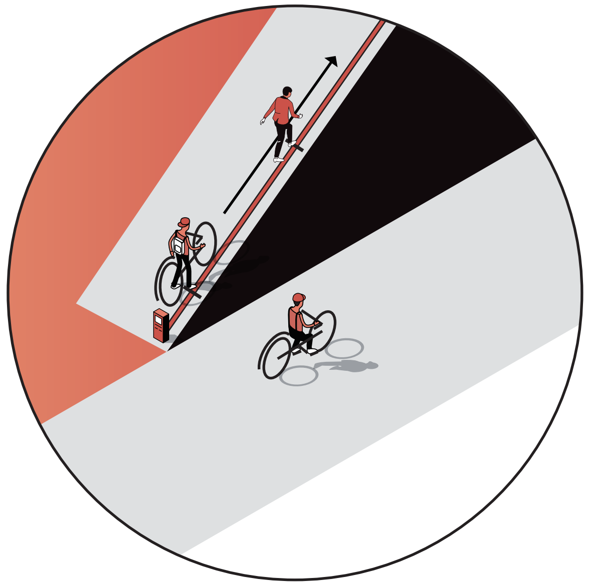
WALKABILITY



AUTO-SLIDING PAVILION
<TORINO>



HEATED PAVEMENT
<TORONTO>



BICYCLE LIFT
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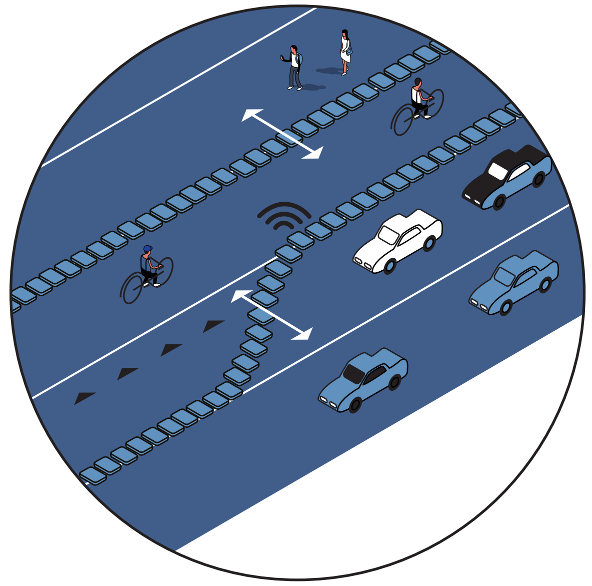


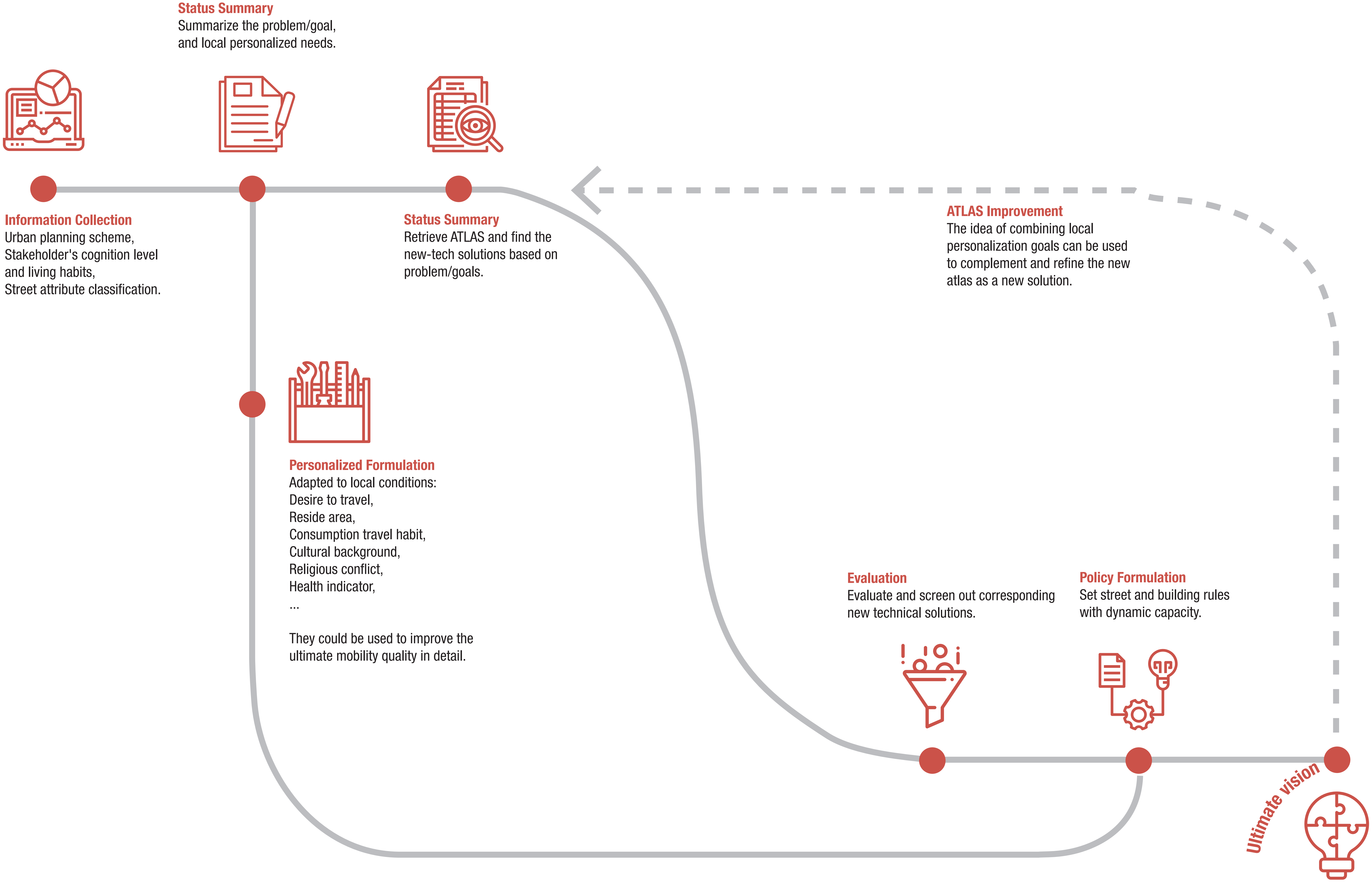
MOVABLE STREET

Integrated by case study

Imagined by authour

METHODOLOGY

Solution Process(Fig. 3.31)



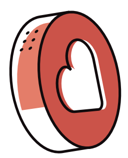
Assessment Evidence

How to determine the solution of new technology, and how to evaluate whether it is suitable for local mobility and whether it can bring the expected effect?
In terms of the basic concept, sustainability is the first principle. Secondly, we should main consider the following factors:

1. Has the potential for dynamic change. Because of this, we need to consider the requirements deeply and carry out elaboration and design at the same time before filtering the solution.

Chasing shiny new technology is not the same as delivering good public services. We start with design. We need technology, but you need to design first.——Mike Bracken (He was named UK Chief Digital Officer of the year in 2014 and awarded a CBE.)

2. Avoid “redundant technical benefits”. For example, when it comes to solving the problem of cargo transportation, flying car can also be one of the solutions, but its first function is to solve the travel problem. On the premise of not facing the same serious travel problem, I call it the“ redundant technical benefits”.



3. Meet stakeholders' and designers' expectations for mobility
This depends on whether the new idea matches up with the information gathered.We can look to Copenhagen for information on what kind of stakeholders to collect.Before the implementation of driverless minibus in the "avenue" renovation project in Copenhagen, a questionnaire was conducted on the Internet (see the next two pages of Appendix). The final scheme in line with this expectation ensures the fault tolerance of the implementer.

We can clearly find that the differences between this questionnaire and the ordinary questionnaire are:
- The driverless side of the problem has a very subjective promotional intent, as opposed to other specific problems where there are more options and disorder;
- Lead the respondents to imagine the scenario in the future, which is more specific than solving the current problemIt focuses on local issues, travel costs and weather factors.

Problems might be faced in the implementation phase

For future cities, the urban areas we now recognize are also villages with a large number of mobility defects. Mobility is a necessary condition for the birth and growth of cities. In many cases, the degree of Mobility determines the upper limit of a city's development. Find a method that is useful in a fixed time, how to avoid design conflicts, instead of demolishing and redesigning city streets, again and again, use a fixed method, and the items and specific implementation methods of the method can be updated. Perhaps there will be a professional branch of architecture or urban planning that will be responsible for choosing plans, imagining and shaping the future.

Rapid modular selection, to adapt to the changing speed of the city. This is not a rude choice, it will be as simple as what to do after a fall -- get up. In practical cases, when Street mobility is faced with problems, modularity determines that decision-makers can use the simplest method to find new technology and improve it.

With the modular choice, we are faced with several problems:

PROBLEM 1. Interval of Improvement

This is determined by the future expectations of the last time it was improved, choosing the ones that are acceptable to city dwellers, rather than saying to people 300 years ago that tomorrow we will start flying to work. The lessons of history tell us that passive evolution or passive progress over a large period in a short time will bring instability, discrimination and even crime to the whole society. However, when only the current problems are solved, residents just start to adapt to a new mobility habit and then change because of the new mobility problem. The short-sighted mobility design will make the development of the city difficult to move forward, facing many embarrassing situations in terms of humanitarian, economic compensation, resource waste, and other aspects. In short, how far we want the future to go.

PROBLEM 2. Personalized Improvement

After the decision-makers have analyzed and selected the options, new rules need to be made, whether for streets, buildings, or traffic regulations. We can't list all the possibilities under different types of cities and cultural environments, all of which need to be supplemented and realized in case after case. There is no fixed way to make a city a city forever——perfectly embedding and optimizing the mobility of a city with an endless stream of new technologies. So I chose the field improvement program——Shenzhen, as a case of modular implementation.

Appendix: (Fig. 3.32)Copenhagen AVENUE Questionnaire Excerpt
Used for information collection before the popularization of autonomous minibus
<https://www.unipark.de/uc/Copenhagen_survey>

• Could you indicate what aspects are important in selecting your preferred means of transport?
Please rank the following items, with rank 1 as most important and rank 7 as least important:

- Punctuality
- Accessibility
- Safety and trust feeling
- Speed / travel time
- Price
- Comfort
- Pleasure and joy
- None is important

→

• Could you please indicare the changes in case of bad weather:
I use this means of transport...

	Less	Equal	More	Not relevant
Own car	○	○	○	○
Motorbike	○	○	○	○
Scooter	○	○	○	○
Bus	○	○	○	○
Train	○	○	○	○
Metro	○	○	○	○
Tram	○	○	○	○
Taxi	○	○	○	○
Car-sharing	○	○	○	○
Bike/e-bike/e-scooter	○	○	○	○
Walking	○	○	○	○

• Which means of transport do you mainly use when commuting between:

	Your home and the place you work/study	Your home and family/friends	Your home and supermarket
Walking	○	○	○
Scooter	○	○	○

• Imagine that your private car could be autonomous but the car would be much more expensive, would you prefer the cheaper autonomous e-minibus, the expensive autonomous private car ot a none autonomous private car?

- ○ Cheaper autonomous e-minibus
- ○ Much more expensive autonomous private vehicle
- ○ A traditional private car
- ○ Would not use any of these options

• To what extend do you agree with the following statements? The idea that autonomous e-minibuses will be introduced everywhere worries me, because...
Please tell us on a scale from 1 to 5, where 1means fully disagree and 5 means fully agree.
With the other points on the scale you can grade your answer.

	1	2	3	4	5	I can't judge
...the systems are not reliable	○	○	○	○	○	○
...the pleasure of driving gets lost	○	○	○	○	○	○
...it is not clear who is liable in the event of an accident	○	○	○	○	○	○
... I have to learn how to use an autonomous e-minibus	○	○	○	○	○	○
...it is not clear how autonomous e-minibus react in unforeseen situations	○	○	○	○	○	○
...the software may be hacked or otherwise misused	○	○	○	○	○	○
...it is not clear how autonomous e-minibuses interact with motorized road users	○	○	○	○	○	○
...jobs get lost	○	○	○	○	○	○
...privacy is not protected	○	○	○	○	○	○
...it is not clear how autonomous e-minibuses interact with non-motorized road users	○	○	○	○	○	○

• Regarding one way transport, how much time do you on average travel between:

	<30 min	30min-1h	1h-2h	>2h	I don't know
Your home and the place you work/study	○	○	○	○	○
Your home and the supermarket	○	○	○	○	○
Your home and family/friends	○	○	○	○	○

4. APPLICATION

WHY CHOOSE SHENZHEN

Fig. 4.1.Shenzhen's map illustration

Logic of City Organization

Futian district is located in the bustling area of Shenzhen, the "factory of the world". Here, the famous Futian port is the bridge between Shenzhen and Hong Kong. According to 2016 figures from the Hong Kong transport department, the port area is home to more than 30 million commuters a year. At the end of 2019, the 2019/2020UABB in Shenzhen made Futian a calling card of Shenzhen. Architects, designers and scholars from various countries are here to provide the latest technological research results and perspectives. Nevertheless, in the heart of such a developed city, there are village blocks. The residents of the village are given not only the unfriendly label of rural people in their consciousness but also face problems in a living environment that would not be encountered in a big city.

This starts with the development of Shenzhen. Under the high-intensity support and preferential policies of the state, it only took 40 years for Shenzhen to become a metropolis from a fishing village. This speed of development has led to the functions of the city blocks being divided from the beginning to facilitate economic exchanges between high-end enterprises within the city and between Shenzhen and neighbouring cities. After the original land was rebuilt, large Numbers of people moved into residential blocks. With the influx of foreign residents and the cheap rent in the village, the density of population and dense residential buildings in the block caused severe mobility problems. As a result, the block is subject to draconian and less humane traffic controls. This made the block a blocked district in the real sense. Rural residents in the block have enormous demands for convenient internal transportation, the connection of urban public transportation, and adequate public living space.

In contrast, in the cities outside the block, a large number of vehicle flows need wider roads, and space is continuously expanding and squeezing to the villages in blocks. This is the profound mobility contradiction between them. Both of them have demands, and neither of them gives in to each other, so it can serve as an essential practice object of "THE INFLUENCE OF NEW MOBILITY TECHNOLOGIES IN THE DEVELOPMENT OF URBAN SCENARIOS".

PROBLEM/GOALS

Gated Village Blocks

All vehicle entrances and exits in a village are obstructed, all vehicles need to be registered (for parking charges) and each sign clearly reads "no empty taxis allowed" to prevent taxis from lingering to look for passengers.It was also written "no parking on the whole road", but due to the excessive demand for parking, the control requirements can only be useless, only the entrance and main road, in order to facilitate the passage of a large number of vehicles have been strictly controlled, no roadside parking phenomenon.

Foreign vehicles are charged for parking. Vehicles can park on both sides of wide roads to ensure reasonable traffic flow in narrow roads and avoid congestion.The parking lot inside the community and the underground parking lot of the office building at the entrance of the village can only be used by relevant personnel.For the general public, apart from the temporary parking Spaces on both sides of the road, there is only one public parking lot in the village.

On December 29, 2018, the development and reform commission of shenzhen municipality introduced the charging standard for residential areas and classified urban villages as residential areas.Fee rate: Owners or tenants of ordinary street-level houses in the village who do not have an internal car park can only purchase monthly parking at 110 RMB.

Unsustainable "Last Mile"

This seemingly "last kilometer" status quo, is not reasonable. Most residents, based on their overall economic situation, are not enough to buy private cars and pay for parking every month, making it possible for the current parking system to continue to struggle despite a few complaints.As wealth levels rise, the conflict will intensify.A large number of private battery cars can be seen everywhere in the streets, which are mainly used for the travel within the block and for the movement of scattered shops in the village.Even though Shared bikes are popular in shenzhen, people in the village only choose electric bikes.One of the key reasons for this phenomenon is the need for transportation. Most of the people who move between the villages are middle-aged and elderly. Bicycles are physically demanding, but they need to carry heavy objects, so they use electric bicycles instead of walking.The second reason is that there is no public transportation system in the whole neighborhood!If you want to travel to other neighborhoods farther away from the city and need to use public transportation, people need to leave the city's main roads between neighborhoods. However, not every boundary of every neighborhood has transit stations for bus systems, so the time spent depends entirely on the location of residents' houses. The last mile can encourage people to walk and exercise, as well as promote healthy living and environmental protection. But it is by no means intended to create movement barriers.

Fig. 4.2. The eastern road fence in Huanggang village.

Fig. 4.3. Piles to keep out cars.

Fig. 4.6. The only special non-motor vehicle parking place in the village during on-site survey.

Fig. 4.7. Temporary parking space beneath the house.

Fig. 4.4. Entrance control in neighboring blocks.

Fig. 4.5. The southwestern road fence in Huanggang village.

Fig. 4.8. Temporary parking space between houses.

Fig. 4.9. The underground passageway outside Huanggang village at night is full of bicycles.

PROBLEM/GOALS

Unfit Curbside Infrastructure

Low housing prices in urban villages have attracted a large number of distinctive authentic food shops and other service industries, enabling them to maintain a medium level of consumption in a big city like shenzhen, thus attracting a large number of diners and passers-by.In the daytime, there are mainly fruit vendors and fresh vendors on the street. In the early morning, the street snack culture is popular and the atmosphere is lively, which attracts people from the surrounding streets to eat snacks.The area used by the mobile vendors is a pedestrian walkway and the motor vehicle side has been occupied by a parking area.

Fig. 4.10. Villagers leave the block to rest on the city streets.

Fig. 4.11. Barricades in the commercial streets of Huanggang village.

Fig. 4.12. On the north side of Huanggang village, electric vehicles and pedestrians can only walk on narrow barrier-free passages.

Restricted Cargo Transport

The density of small shops in urban villages, regardless of their type, requires frequent shipments of goods, inevitably competing with already narrow streets and scarce parking Spaces.It is also a common option for shops along major roads to unload their cargo if they do not have a nearby parking lot. Unload the cargo as quickly as possible, otherwise it will be recorded and fined.

Narrow Street Life

The environment of the street has resulted in the limitation of the rich daily life of the residents.The ground floor of the houses on the edge of the Village is directly connected to the city sidewalk, and there is no public space equipped with residential type, so the residents have to choose the seats set for city pedestrians on the roadside of the boundary road.There should also be reasonable public Spaces and semi-private areas, even at street intersections and at the last kilometer transition point.

Fig. 4.13. At night the vans park at the city's public underpass outside the block.

Fig. 4.14. Residents chat and rest on residential street.

This is due to the development history of village. In the historical evolution, the nature and functions of the various blocks in Shenzhen were temporarily divided by the government, without a long-term cultural evolution process. Migrants from other cities make up 83% of Shenzhen's population, and when nearby neighborhoods are demolished and turned into high-end commercial residential neighborhoods, migrants will be more likely to rent in urban villages that are cheaper with the advantage of location, even if the living environment is poor. Moreover, the planning of village block lags behind, and a large number of residential buildings with only a gap of 1.2 meters appear due to the large residential demand. These residential buildings retain most of the traditional habits of the past, that is, collective living.The ground floor of residential buildings is directly facing the street. In some roads where motor vehicles are forbidden to pass, you can even see the daily life of some residents in the lane. They are also willing to sit on the street to chat and play CARDS with neighbors.

About the origin of the nature of these urban villages, Mary Ann O 'donnell (artist-ethnographer, 302 Art Space Shenzhen) mentioned in an interview (interview by Jacob's team on Eye tracking project), '**Its when the People's Republic of China was established. It was divided into two administrative systems: rural and urban. In urban spaces, all land belonged to the state. In rural areas, all land belonged to the collectives, and the collective was based on village settlements. Shenzhen, of course, had seen a rural area, it was Bao'an Country and then it was elevated to the state of the city. And so rural or urban village actually is not describing the relationship between industrial and rural production but it is instead describing a historical difference between forms of property ownership.**'

And the consciousness of the form of property ownership is not just an ordinary life habit, it means the value orientation of all things around. There is no higher value orientation, there is no right or wrong. In terms of mobility, the life of collective ownership in the past means the complete accessibility in small units, and the transportation mode between different units is weakened, because the life scope is limited. But the innovation of urban mobility is a historical necessity, and the disorder of collective ownership life and the mobility of free growth are vividly seen. And the collective ownership of life is the corresponding state ownership, the development of the city at the beginning of the change, especially on mobility, for those who had only a small unit of life, for the sake of convenient city suddenly split spacious road and completely open space between elements, seem too apathy and rational, but with the change of the concept of generations, late of urbanization, the mobility of the new technology can be used as the warmth and perceptual completely, for the different value orientation of life to improve new suitable mobility solution.

SOLUTION SELECTION

STEP 2
Select suitable TECHNOLOGIES in ATLAS

STEP 1
Summarize the GOALS of mobility in Huanggang village

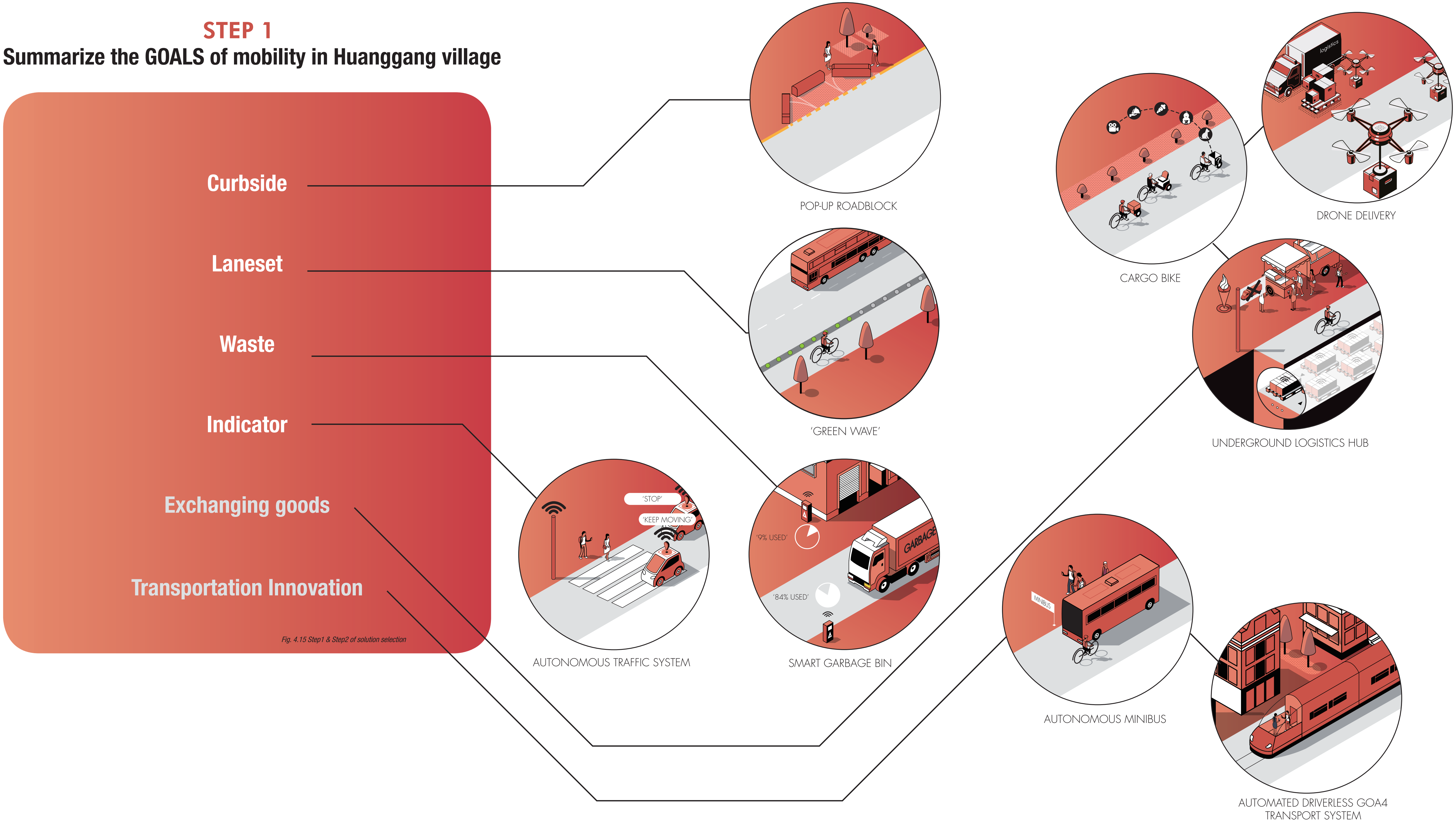


Fig. 4.15 Step1 & Step2 of solution selection

STEP 3

Draw up the RULES of dynamics

DYNAMICS OF THE FUTURE STREET

Flexible Curbside

Retails

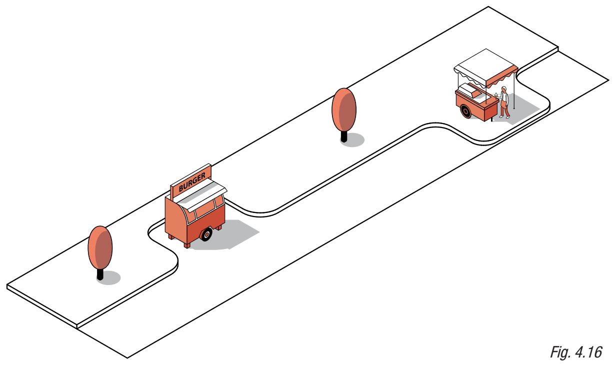


Fig. 4.16

Adapt to local street food habits, extend the function of shops or services, and enrich the function of life on the street, so as to reduce the traffic attribute of the street and improve its living attribute.

Public Seating

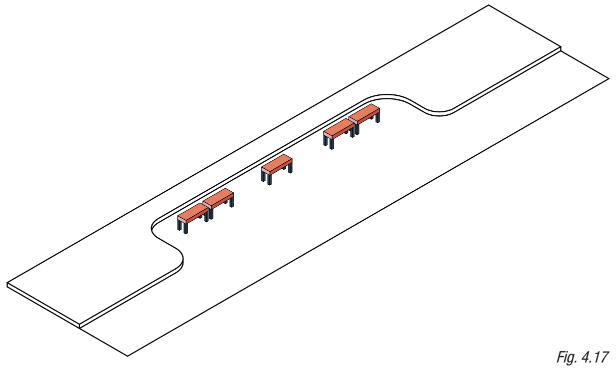


Fig. 4.17

Different from the functions of ordinary street seats, the seats here should serve the residents more, because the extension of the building to the street central axis has already met the needs of passengers.Therefore, the seats of the street should have a certain sense of territory and mental shelter.

Pick-up/Drop-off

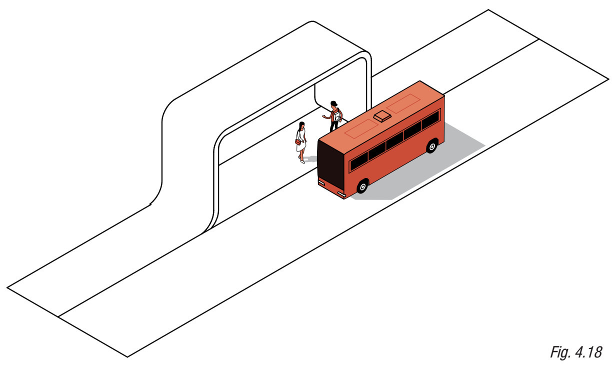


Fig. 4.18

In the future, the pick-up/drop-off area of different transportation's waiting area will be merged into a whole curbside, which will facilitate the selection while retaining the original walking and passing properties, and reduce the need to specifically arrange multiple transform zones.

Temporary Stop

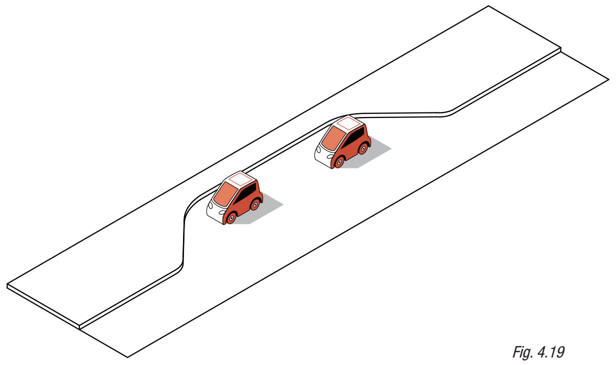


Fig. 4.19

A large number of autonomous vehicle applications will reduce the use of cars by 70%, requiring only temporary roadside stops. Instead of having a lane dedicated to temporary parking, a curbside can be cut reasonably which is sufficient to meet urban users' needs.

Crossing the Street

Today

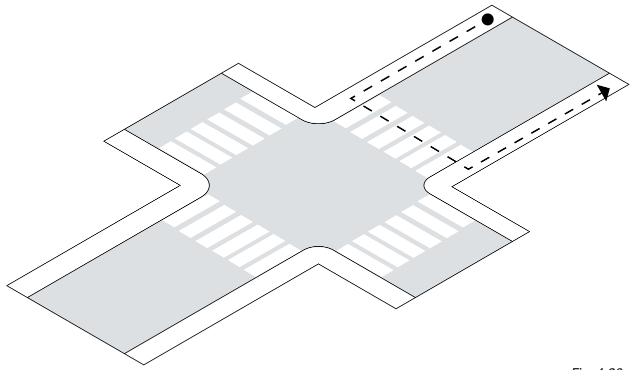


Fig. 4.20

Future

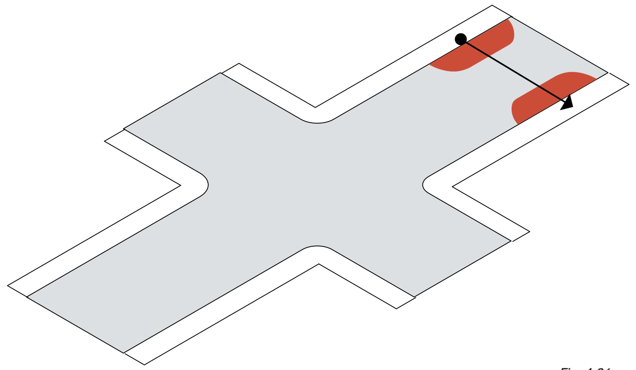


Fig. 4.21

Autonomous system after slowing down brings streets more safety and crossing possibilities, while weakening the stereotype that only intersections represent cross ing streets.

Today

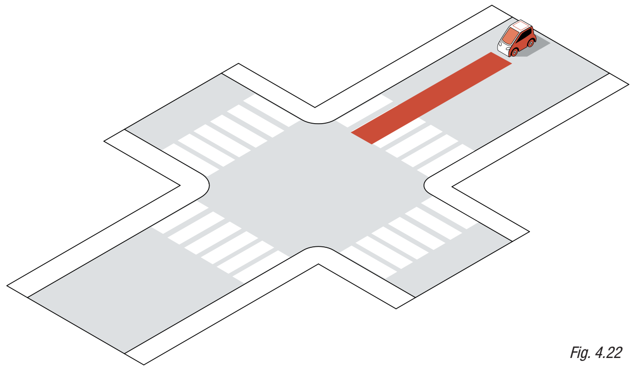


Fig. 4.22

Future

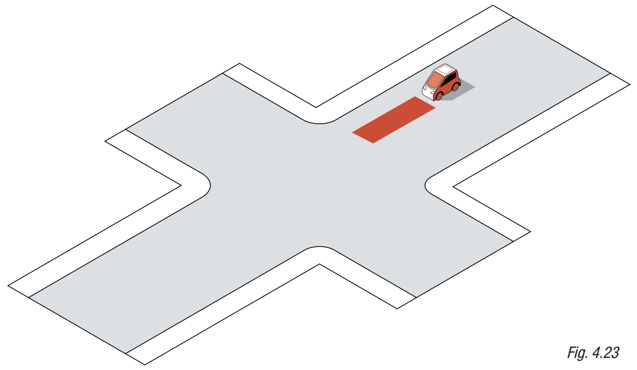


Fig. 4.23

Claimants for faster travel choose the new trains.Regular vehicle lanes will be open to short - distance travelers.The braking distance at the intersection becomes shorter after the speed is reduced, which avoids the potential danger caused by delayed signal with excessive driving speed.

Today

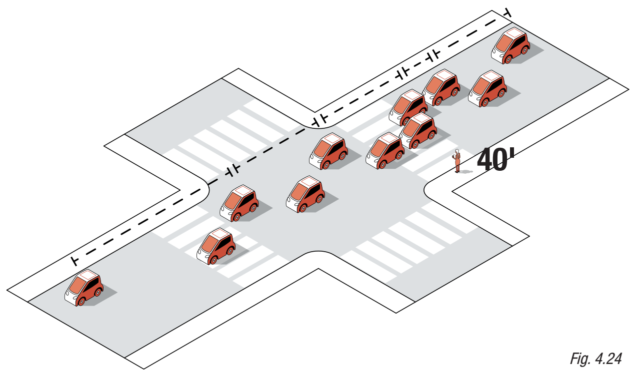


Fig. 4.24

Future

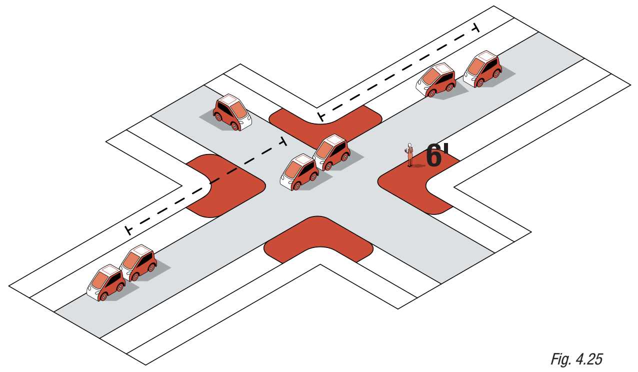


Fig. 4.25

As the lane narrows, the curbside extends to the vehicle lane, which can greatly reduce the waiting time of pedestrians and form a large number of flexible curbside zones, such as parking space.
Autonomous vehicle does not mean that cars can be driven closer together, which would cause long waiting time like past and form a vision barrier. Groups of 2-6 vehicles could be formed, with a wide groups' distance to ensure more opportunities to cross the street.

DYNAMICS OF THE BUILDING

Ground

The ground floor is raised to make the 'ground floor' a real 'ground', which is used to open the crowded alley in village and the street buildings on the outer city streets. In the past, sidewalk served as the segmentation contour of the village, while in the future, the space generated by the building's ground floor can fuzz up the boundary and pedestrians will enter the village unknowingly.The alley, which was only 1 meter wide due to compression by increasing population, has completely disappeared. Scooter and bicycle parked in the alley can be placed here. Building owners can also customize its features, such as separating it with movable partition wal to genarate the commercial area, then participate in the growth of the streets and reshape process.

The street building is allowed to extend to the wider new sidewalk, creating a new semi-interior space.Meeting different sunlight demands and certain shelter in rainy day will become the necessary conditions for 'street life'. If the opening of the ground floor is the integration of "street life" and street building in the horizontal direction, then this extended space can serve as their interaction in the vertical direction.

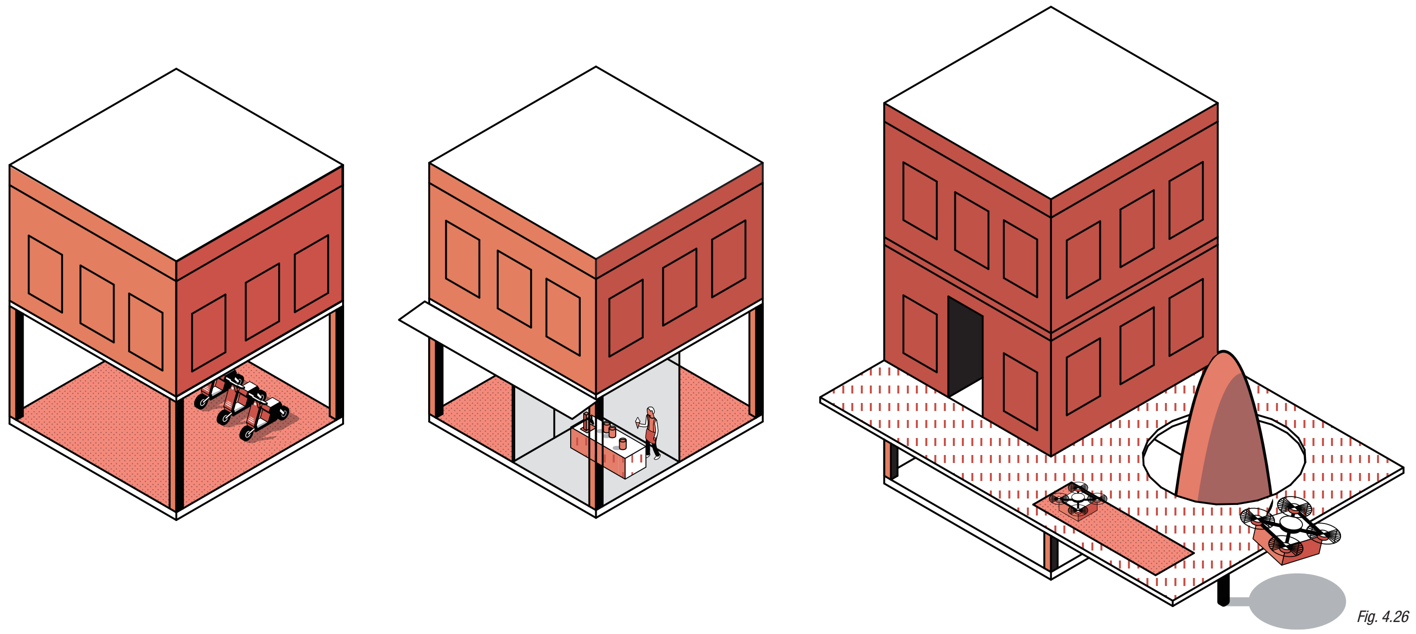
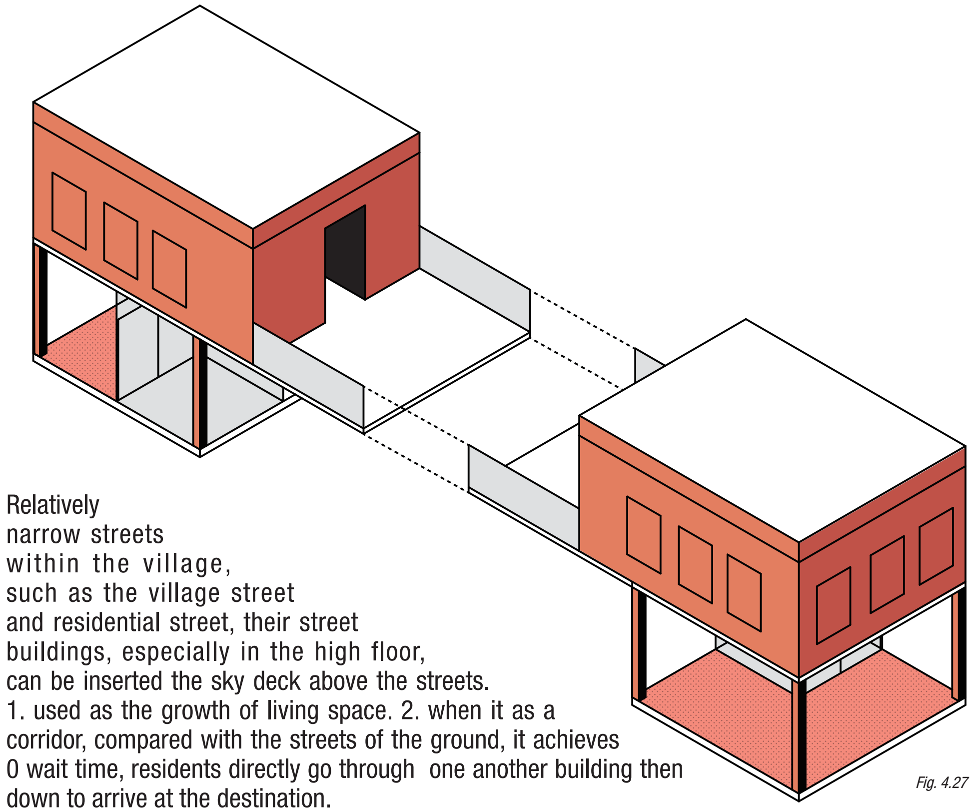


Fig. 4.26

Above Ground



Relatively
narrow streets
within the village,
such as the village street
and residential street, their street
buildings, especially in the high floor,
can be inserted the sky deck above the streets.
1. used as the growth of living space. 2. when it as a
corridor, compared with the streets of the ground, it achieves
0 wait time, residents directly go through one another building then
down to arrive at the destination.

Fig. 4.27

Under Ground

The problems of cargo transportation and garbage collection in the village can be solved through the underground logistics hub at the same time. When the city hub or van transports the goods to the village hub center, through automated distribution they access to the building hub. Information of each box is tracked until arives the corresponding floor. At the same time, this pipeline streamline can be used for garbage collection. Garbage will be unified classification in village hub center. In this way, it greatly reduces the street space occupied by the mobility of goods and garbage in the village.

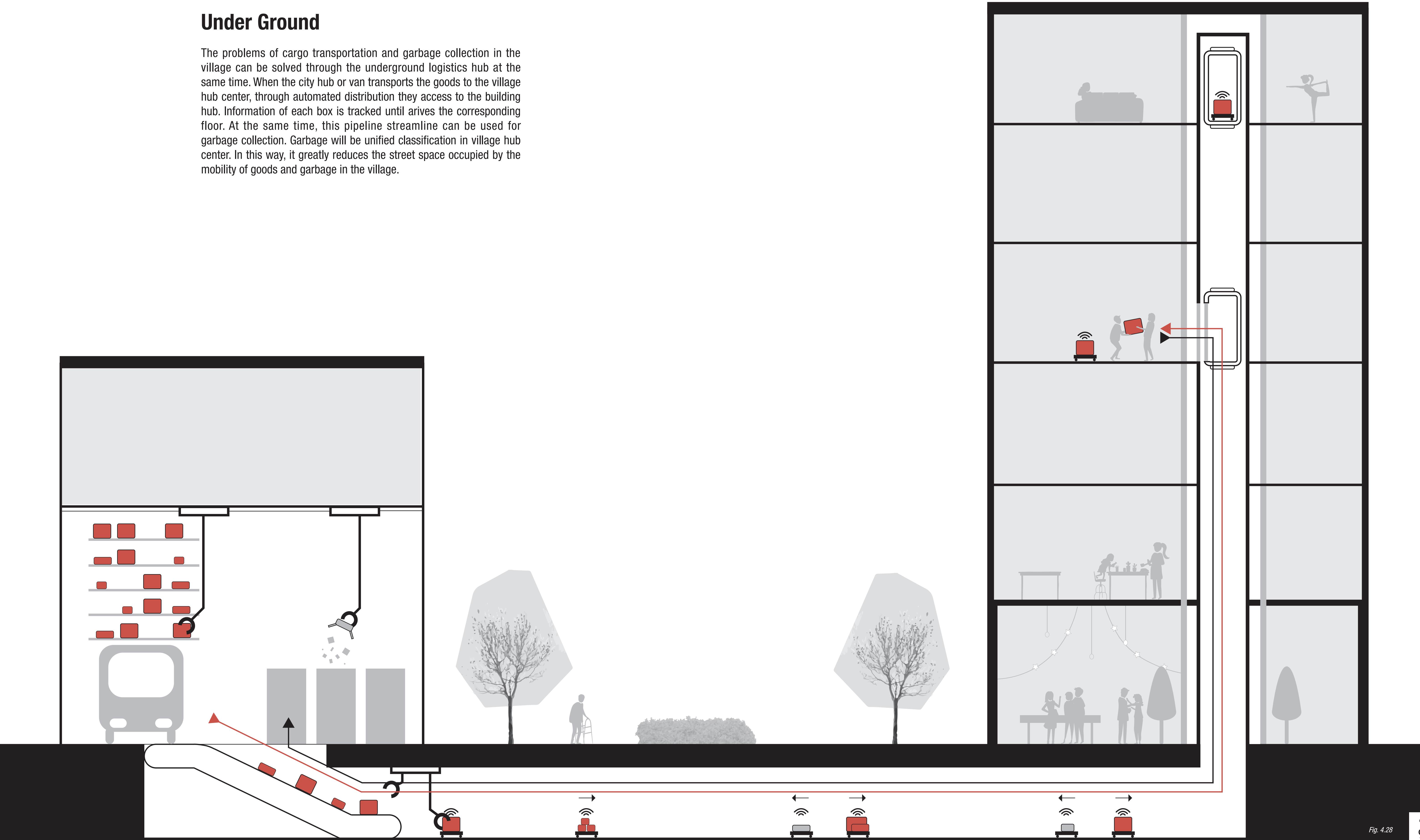


Fig. 4.28

FUTURE STREET
STREET TYPES

Multiway Boulevard

Definition: the road is provided with a central divider, with four or more motor vehicle lanes, all or part of which adopts three-dimensional crossover and controlled access for urban trains to travel at a higher speed.It is the main economic link between cities and between cities and counties.Service: prefer mass, long-distance, rapid transit service in cities. Transportation services include a wide range of travel options, from the most efficient urban trains to walking, as a hub for Multigang traffic.The building space on both sides of the road is dominated by large public commercial or service centers.

Major Transit Street

Definition: the road mainly serves the traffic function, facilitating the passage between adjacent blocks, partly controlling the access, and the slow passage of cars.Service: transport service that favors the medium distance between cities.Transportation services are mainly about sharing cars and riding.The public space on both sides of the road needs to meet the economic and social requirements of the adjacent blocks and remove the existing barriers.Street buildings are mainly built for community services, such as hospitals, bicycle parking in "last mile", community service centers, etc.

Neighborhood Street

Definition: used for blocks residents to avoid urban traffic flow and travel between adjacent blocks in multiple directions to connect internal traffic routes between blocks.Service: prefer fast and convenient short distance transportation.Transportation services are mainly provided by autonomous vehicles and bicycles from Major Transit Street.No business environment is set up.

Village Street

Definition: it is mainly used for the circular traffic flow of minibus within the block to facilitate daily travel and remove the possession of the street by personal travel vehicles.Service: towards the residents and passengers in the block.The service content fully integrates transportation and life, and minibus is used to connect different residential areas within the block as the final destination of public transportation.

Target Passengers

Residents outside block

Residents of nearby block

Residents inside block

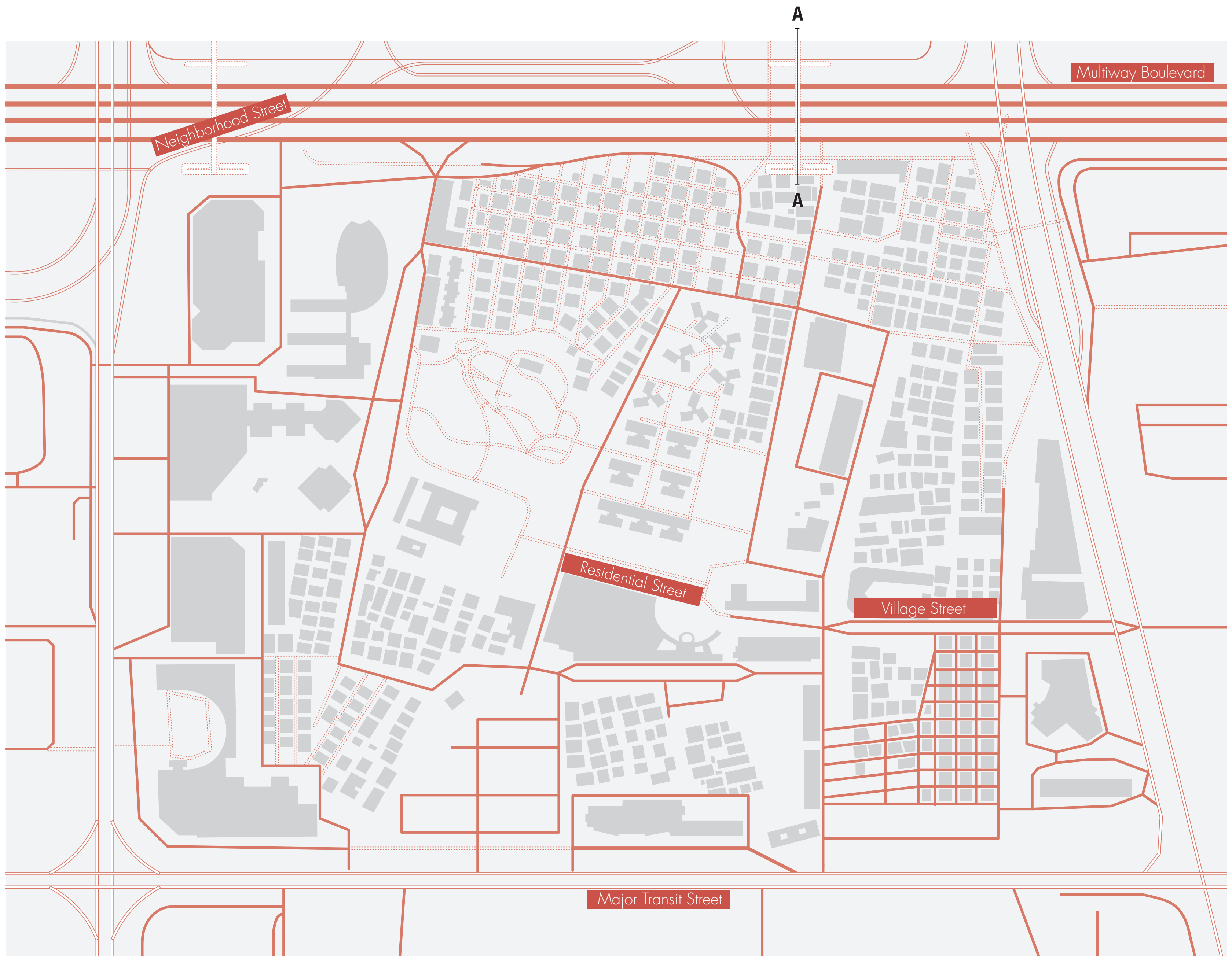


Fig. 4.29 Huanggang masterplan

Residential Street

Definition: originally an extremely narrow walkway, it will be redefined as a public space for residents to walk through through the opening of the building's ground floor. There is no public transportation, and fewer traffic signals are indicated by ground signals.Service: mainly serve local residents, expand living space, as the best benefit of terminal mobility after the optimization and compression of public transportation, the life attribute is greater than the traffic attribute.

MULTIWAY BOULEVARD'S FUTURE SECTION

Today

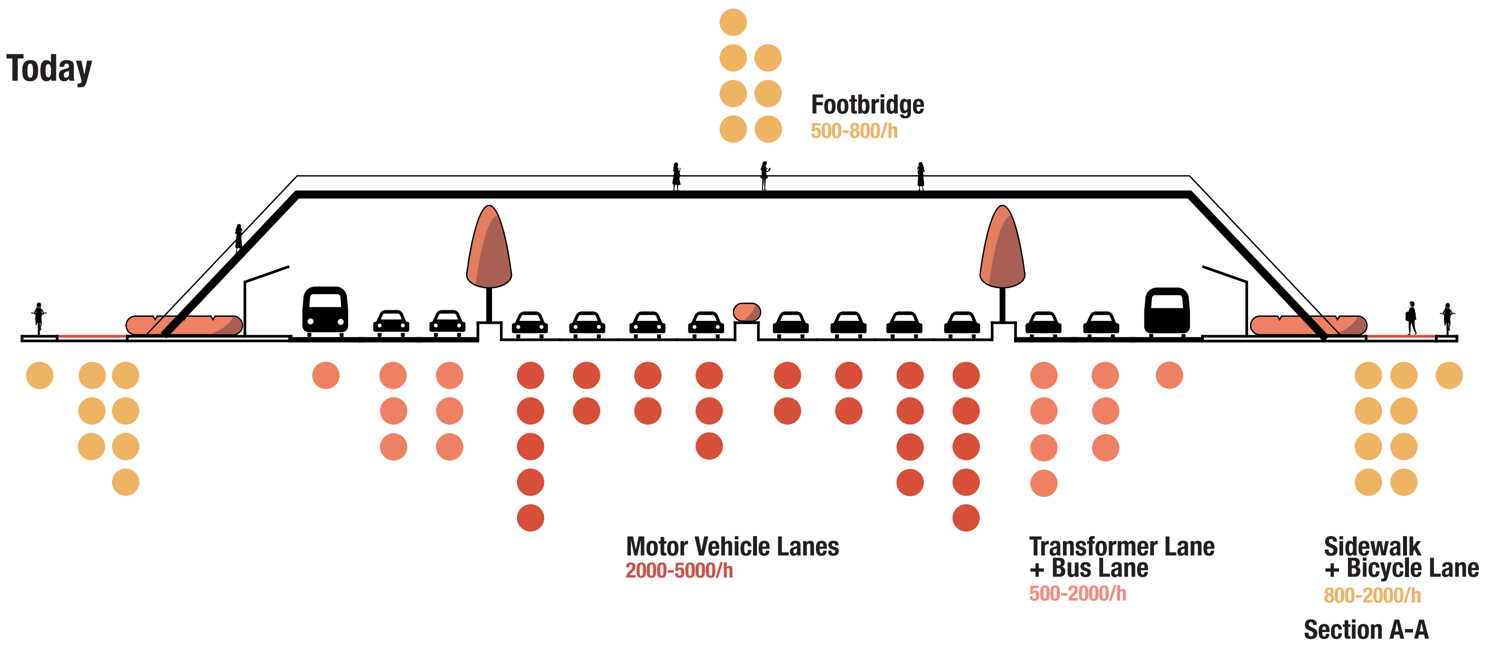


Fig. 4.30 Multiway boulevard's section today.

Future

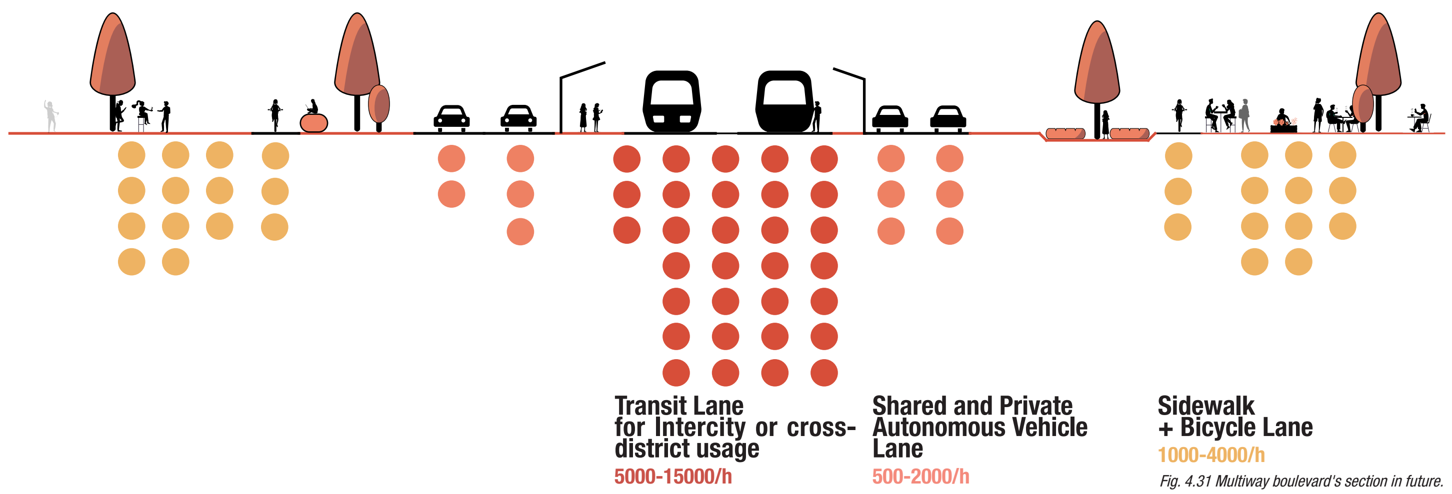


Fig. 4.31 Multiway boulevard's section in future.

VISION OF MULTIWAY BOULEVARD

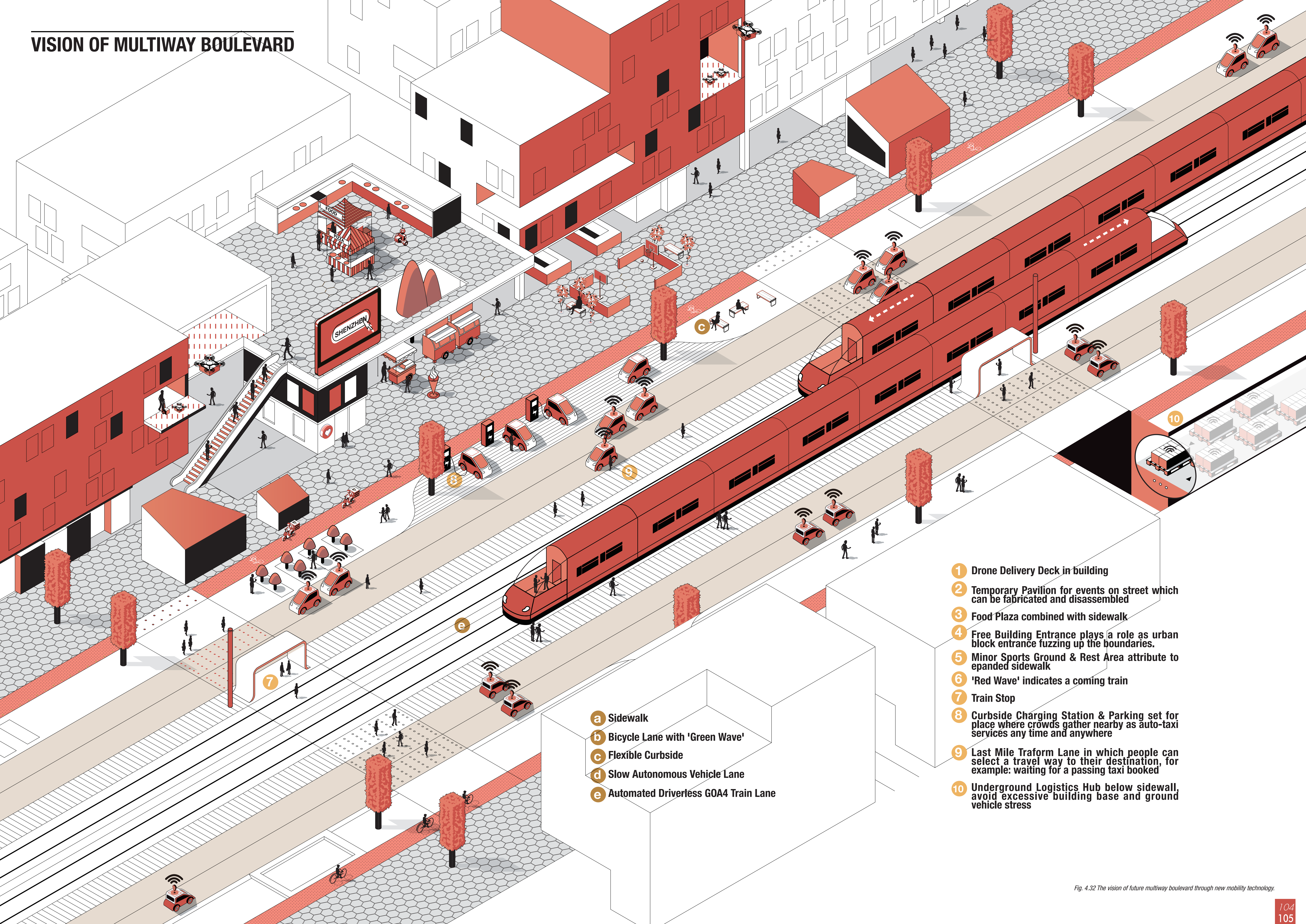
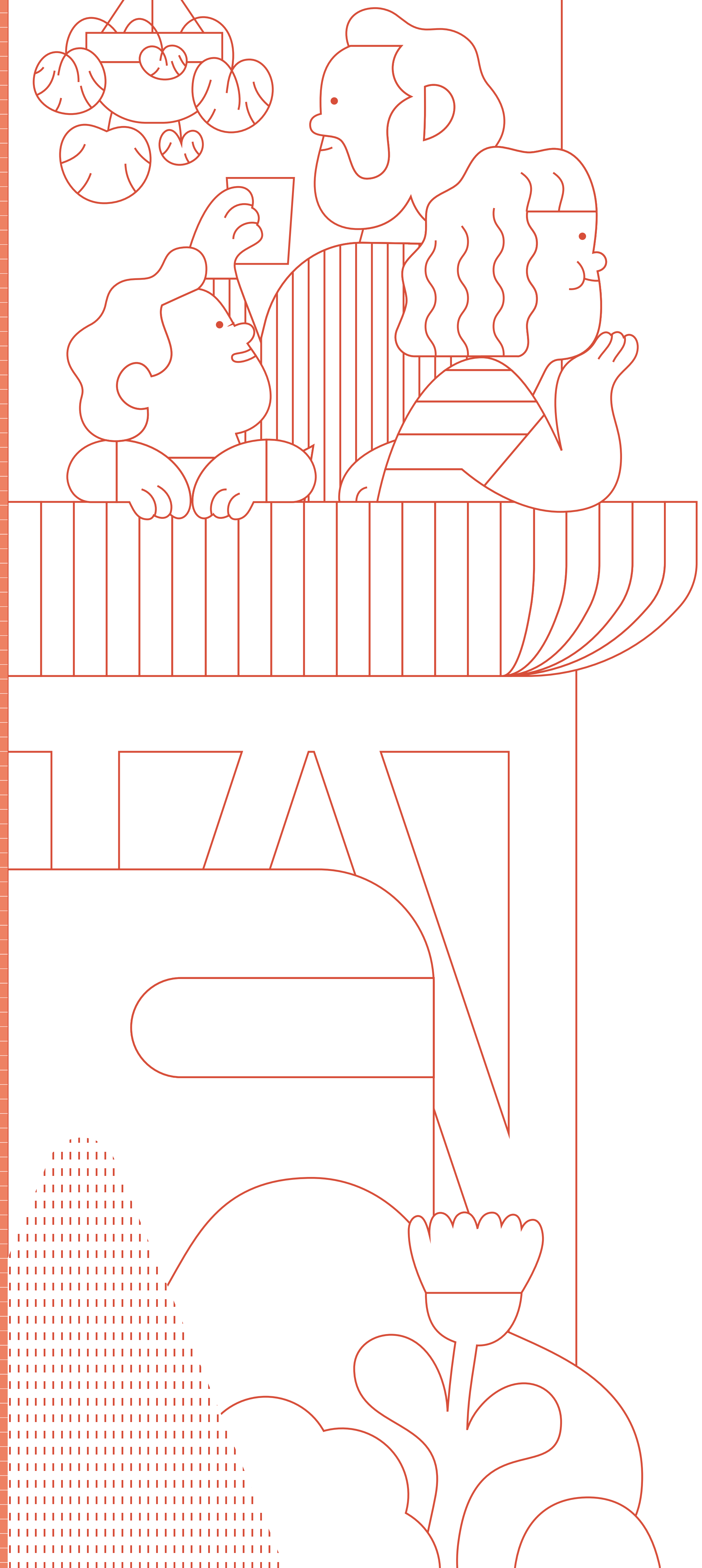


Fig. 4.32 The vision of future multiway boulevard through new mobility technology.

5. CONCLUSION



How will new mobility technology change our life? The depth of this topic stems from this simple self-question. As the subject progressed, I began to reflect on the questions——As the relationship between new technology and urban mobility began to become a little clearer. What about us? How do we deal with new mobility technologies? Moreover, how do we envision cities with new mobility technologies?

The car is no longer a mobility device, however we do not know who will replace it. In the case research of Shenzhen, an urban village with a nearly saturated population is hoping to grab public space from the city streets as a living habitat, while the city's heavy traffic will only widen the roads and demand more land for demolition. The adverse effects of traffic restrictions, population control and evacuation are within people's reach in mental and economical domain. What people cannot afford is the uncertainty about future mobility.

From the perspective of another stakeholder analysis, through the case study, the more advanced transport innovation is, the less technical information will be disclosed, and most of the attention of hot spots will come from their advertising investment, but stay in the concept and rendering stage. Solving traffic congestion may have become a natural excuse for financing new technology; they ignore whether the new technology is redundant. Gimmicks cannot solve the real mobility problem. In the past few years, autonomous vehicles have yet to achieve the goal of the single complete intervention, while at Trondheim, the simple technology of the bicycle lift has sent millions of people uphill and solved one of the most intractable mobility problems in the region.

As we all know, the problem of urban mobility is not just a point-to-point displacement problem, but what are the problems that cannot be generalized? No answers. The problem may change or disappear over time, as the amount of CO2 released by manufacturing and disposing of autonomous electric vehicles is much higher than that of fuel-powered vehicles, and electronic waste is potentially more harmful to the environment.

In different countries, new technologies were viewed very differently because of different cultural backgrounds and values. Companies are racing to design autonomous vehicles that can run faster and even fly higher, but in a 2017 survey of autonomous vehicles buying trends, people over 65 showed the highest acceptance of autonomous vehicles in Japan (80%) and were willing to pay more for them. So it is hard to imagine autonomous vehicles in Japan as a means of promoting accessible social care beyond the electric wheelchairs. Therefore, I try to summarize and count how cities from different continents can imagine their city vision with the new mobility technology, focusing on the differences and effects between their information collection, technology distribution and field implementation. In this way, we try to summarize the mobility problems we are facing and corresponding feasible solutions in the same time dimension.

Furthermore, I tried to adopt a modular approach, trying to simplify the process of choosing new technologies, so that urban planners or future us can reflect and categorize. Also, as Mike Bracken says, “Chasing shiny new technology is not the same as delivering excellent public services. We start with design. We need technology, but you need to design first.”

The purpose of this paper is not to provide a solution, but to try to express the hope of imagining the future city vision by providing a kind of dialectical thinking. The new technology has absolute timeliness, and it cannot be "deferred gratification" because it will soon be replaced. Therefore, even if we find the mobility suitable for ourselves in the fastest way at this moment, we cannot predict how long it continues.

In this moment, what urgent we have to deal with is, how to use this technology with transient timeliness and unpredictable effects to evaluate and detect not only urban mobility, but also the operational efficiency of the future society? Whether it is more urban experience, or whether it is the emergence of "ultimate technologies" that will reassure us, remains to be explored.

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