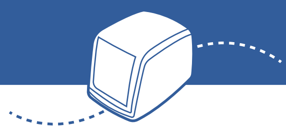
Research on Driverless Vehicle Slow Transportation Service System Design in Large-scale Residential Community Based on Kano Model



Candidate: **ZHENG Rensi**

Student Number: **894623**

School: **School of Design**

Major: **Product Service System Design**

Supervisor: **Davide Fassi**

Co-supervisor: **Sun Xiaohua**

ABSTRACT

With the development of modern transportation, the speed of travel has gradually become the goal of development. However, as a necessary way to start and finish a trip, slow transportation, though with a slow speed, still occupies a considerable proportion in traffic mode. In some specific situations, such as large-scale residential community, the slow transportation environment becomes the main traffic environment in the area due to its special safety considerations as a residential community. Therefore, improving the traffic quality of the slow transportation environment is an important way to improve the daily travel life of large-scale residential community. On the other hand, with the improvement of automobile technology, the technology of driverless vehicles has gradually matured. It has begun to be applied and practiced in multiple scenes with the advantages of less driving attention of user and more precise driving control. In recent years, driverless vehicle services have gradually entered the public's field of vision, such as driverless taxis and driverless buses. Driverless vehicle technology is also recognized and practiced in the associated slow transportation environment.

Based on the specific situation of slow transportation environment in large-scale residential community, this paper summarizes the problems and user pain points in the existing environment through literature review and current situation analysis. On this basis, this paper uses the Kano model to develop different levels of design guidance for services in this environment. At the level of service system frame, this paper uses the Kano model to summarize and prioritize the user needs, and proposes to build a more targeted design hierarchy and expand the three-dimensional dimensions of the Kano model to further build a slow transportation service system in large-scale residential community. At the level of service touchpoint, under the guidance of the user-centered design principle of the Kano model, this paper proposes the interaction design principle for the slow transportation service of driverless vehicles in large-scale residential community, and applies it to the specific service touchpoint design.

Finally, the author uses the extended model to put out the design practice of slow transportation environment in large-scale residential community, including the construction of the driverless vehicle service system in this situation, the corresponding driverless vehicle concept design and driverless vehicle multi-terminal interface design. Different design levels further reorganize and optimize the ordering and combination between different sub-services.

In the further research direction, the author proposes to use the smart community as the macro background to develop the slow transportation service in large-scale residential community, link the property service and home service in the community, and jointly build a community service network covering all aspects of residents' daily life.

Key Words: Kano model, slow transportation, driverless vehicle, large-scale residential community, service design

Contents

Chapter 1 Introduction

1.1 Research Background

With the development of modern transportation, travel speed has gradually become the goal pursued by development. In recent years, the development of ground and air traffic at home and abroad has greatly improved the speed and efficiency of people's travel. However, as a necessary way to start and end the trip, slow transportation, although slower, still occupies a significant proportion of the travel modes. The advent of the post-automobile era has increased this proportion to a certain extent. As people's demand for health and leisure has increased, slow transportation has begun to be presented in more different forms [1].

Among the current modes of slow transportation, the more common modes of transportation are walking, cycling, and mopeds. For a short-distance transportation, the form of slow transportation can basically meet the travel needs of users. In similar scenarios, such as short-distance travel, users will choose non-motorized modes such as walking, cycling or mopeds to complete the trip. For long-distance transportation, the main body of traffic is mainly fast and high-speed traffic, but when the starting point and the end point are reached, slow transportation is still the main way to connect fast, high-speed transportation with the starting point and the end point. In a similar scenario, a user needs to complete a trip of about 15 kilometers. The user chooses to walk to the nearest subway station, then take the subway to the subway station near the end point, and finally walk to reach the destination. Therefore, the efficiency of slow transportation will directly affect the quality of traffic for users. Improving the user experience during slow transportation can greatly improve the overall quality of user travel.

1.2 Research Status

1.2.1 Improvement of slow transportation infrastructure

The slow transportation infrastructure is the basic condition for the operation of the slow transportation system. Therefore, the development of the slow transportation infrastructure is an important part of improving the slow transportation system.

The development of slow-transportation infrastructure abroad is relatively complete. Independent slow-transportation channels are set up in cities to ease transportation pressure. Slow-travel channels are set up in leisure places such as scenic spots to provide residents or tourists with places for recreation and exercise.

In the case of urban slow transportation, Copenhagen, Denmark was once a city full of vehicles. Nowadays, with the increasing emphasis on the concept of slow transportation and green travel, Copenhagen has established an independent pedestrian slow transportation street area in the old city. Motor vehicle entering. This pedestrian zone connects important commercial centers and cultural landscapes in the urban area, providing residents and tourists with a slow leisure space, while also promoting the prosperity of the local commercial area. In some areas prone to mixed motor and non-motor vehicles, the Copenhagen government has constructed independent slow viaducts to improve the full functionality of slow transportation in the city.

In the case of leisurely slow transportation, the "White Bicycle Project" in Amsterdam, the Netherlands is a very typical case. As an internationally renowned bicycle capital, Amsterdam has set up a "White Bicycle Program", which provides white bicycles for free use in the Amsterdam Forest Park, and designs a 42-km slow transportation bicycle lane. Way to explore freely in the park, as shown in Figure 1.1. Slow transportation bicycle lanes travel through the Amsterdam Forest Park. Through a slow tour, visitors can fully experience the immersion experience in the forest park at a slow pace and improve the tourist user experience.

The focus of domestic transportation system development is still on the development of fast and high-speed transportation, and the construction of slow transportation infrastructure is still in its initial stage. However, as the development of fast and high-speed transportation matures, slow transportation, as a connection and supplementary role of fast and high-speed transportation, is gradually receiving attention. At the same time, with the improvement of the domestic people's material living standards, people are gradually pursuing the abundance of spiritual life, and more spiritual activities such as leisure and entertainment have been mentioned. Therefore, slow transportation, as an important vehiclerier for residents' exercise and leisure, is gradually being strongly advocated, and various regions have begun to develop related slow transportation infrastructure. The important role of traffic and non-traffic functions of slow transportation is also valued by different functional places in China, such as urban streets, industrial parks, school parks, and residential areas.

Figure 1.1 The White Bicycle Plan, Amsterdam

（From：http://360.mafengwo.cn/travels/info.php?id=7884793）

In the reflections on improving the urban slow transportation system, it is mentioned that to develop and improve the urban slow transportation system, the first and very important thing is to improve the design and planning of urban transport infrastructure [8]. In specific suggestions for improvement, Du Li et al. Believe that slow transportation is an important form of transportation. Therefore, when planning and constructing slow transportation, it cannot be designed as a subsidiary component of the transportation system. Consider and design slow transportation as a subsystem in the entire transportation system that is as important as fast and high-speed motor vehicle transportation systems.

The concept of Transportation Calming, which has been developed for a long time in Western countries, believes that the number and transportation of street vehicles should be actively reduced, and slower people should be given priority but not dedicated road rights to improve the slower environment and protect cities The area's slow transportation is vibrant. The urban tranquil walking system of a city is composed of tranquil trails and peaceful crossings [7]. Quiet trails refer to streets that promote community vitality and commercial and cultural prosperity by improving the slow transportation environment, and peaceful crossings refer to crossing facilities that ensure pedestrians can safely cross trunk roads and branch roads [5]. With the combination of tranquil trails and peaceful street crossings, it is possible to optimize and improve the existing slow-transportation environment through the construction of slow-transportation infrastructure to the greatest extent, and improve the slow transportation user experience.

Shanghai uses this quiet walk system concept to plan and construct 399km quiet trails and 206 peaceful crossing streets in the central urban area, while planning 30 river crossing facilities. This case optimizes the current status of some roads in the existing Shanghai city. By planning 13% of the central city roads and 1/4 of the planned main road mileage, it can make nearly half of the residents integrate into the pedestrian-first slow transportation very well. system. At the same time, the slow transportation environment created by open walkways in public spaces has also improved the spontaneous and social activities of the streets, and the vitality of the streets has also been improved.

1.2.2 Application of slow transportation vehicles

The current mode of slow transportation is mainly walking, cycling and various forms of mopeds. While considering strengthening the construction and improvement of pedestrian slow lanes, the research and development of various slow transportation forms of people-vehiclerying transportation has also received increasing attention. Compared with the pedestrian mode, the human transportation means can vehiclery more complex transportation tasks and maintain a more stable transportation speed under the environment of slow transportation. The use of non-motorized vehicles such as bicycles and mopeds in slow transportation environments has become more common, and more forward-looking vehicles have been gradually introduced into slow transportation environments in various traffic scenarios.

In June 2018, the Jingdong driverless express vehicle was put into use in Xibeiwang, Haidian District, Beijing. The Xibeiwang area of Beijing is a residential and office-intensive area, and there is a large demand for delivery and delivery. The delivery of Jingdong driverless express vehicles here is also the first time that Jingdong has put driverless delivery services into an actual open environment. . Prior to this, JD.com 's driverless vehicles had been tested for up to a year in Renmin University of China where the transportation environment was relatively closed. The Jingdong driverless vehicle can be put into use, which can increase the delivery frequency of express logistics and solve related problems such as night delivery. At the same time, the freedom of driverless vehicle distribution also provides users with more scheduled distribution and scheduled fixed-point distribution services. Such courier services have not been well realized in the existing manual distribution process.

In addition to transporting goods, driverless vehicle technology has also begun to be applied to more complex transportation environments such as vehiclerying people. In a 2014 study by Özkan Yalçın et al., The structural design of an driverless vehicle named AKAY02 was proposed. The driverless vehicle is used in a specific slow transportation environment in a campus environment, which is a relatively closed traffic environment. The driverless vehicle can autonomously perform path calculation and planning through related algorithms, and detect surrounding static and dynamic obstacles through its own detection equipment, and complete autonomous avoidance [36].

The domestic UISEE technology company cooperates with CapitaLand in the parking lot of Raffles City to help users retrieve the vehicle. The user can call the driverless terminal at the terminal and take the driverless vehicle to reach his own parking space; at the same time in Guangzhou Baiyun Airport, UISEE invested a driverless vehicle to provide a ferry service between the terminal and the parking lot.

Relevant technologies such as driverless vehicles have gradually been applied to various functions of the slow transportation environment. Among the above-mentioned express transportation, some of the manned services have entered the stage of field testing and fixed-range operations. Similarly, driverless vehicles technology has also been tested and used in more slow transportation environments, such as inspection services in closed environments. Many functions in the slow transportation environment have been gradually realized by driverless vehicle technology, but these functions have not yet formed a service system with a good user experience.

1.3 The goal and purpose of research

This topic aims to study the relevant principles and design practices of the application of driverless vehicle technology in the slow transportation environment under the Kano model. The following aspects will be studied to analyze the current development of driverless vehicle technology and the possibility of its application to daily life. Taking large-scale residential areas in the suburbs as an example, the current situation of slow transportation in large-scale residential areas will be analyzed. Necessity of the situation and development, introducing driverless vehicles as a feasible means of transportation in this situation, and summarizing the problems and services that driverless vehicles can solve in this situation; build a complete The framework of driverless vehicle service system based on slow transportation in large residential areas, and the possible applications and future trends of driverless vehicle service based on various other scenarios.

The research of this topic has the following theoretical significance:

1. This project takes the large residential area as the specific situation, explores and analyzes the applicable scenarios of driverless vehicles, and provides an applicable theoretical basis for this emerging mode of transportation;

2. This subject applies the Kano model to the design of driverless slow-transportation service systems in large residential areas. In the process, the extension and expansion of the Kano model for specific situations are studied and discussed.

This topic has three practical applications:

1. By studying the possibility of combining driverless vehicles with actual scenarios, construct a framework for driverless vehicle service systems, and use the Kano model to provide more complete product and service support for driverless vehicle design and development.

2. By introducing a driverless vehicle service system, it provides new ideas and possible solutions and methods for solving the traffic pain points in large residential areas.

3. Through the introduction of driverless vehicles as a means of slow transportation, give play to the advantages of driverless vehicles, and provide new references and basis for community and urban transportation planners.

1.4 Main research contents

The research object of this subject is the application and implementation of the driverless vehicle service system under the Kano model in a slow transportation environment, and based on a specific scenario-a large residential area in the suburbs, that is, the specific function presentation and Service Content.

The research content of this topic includes the following four points:

1. The feasibility of an driverless vehicle service system constructed with driverless vehicles as contacts and vehicleriers;

2. The applicability of the driverless vehicle service for this particular situation in large residential areas, and the targeted functions and problem solving methods it can provide;

3. Extension and extension of the Kano model for driverless slow transportation services in large residential areas.

4. The specific application of driverless vehicle service in the context of a smart community, and the possibility of linkage with other functional services.

The main content of this article is as follows:

Chapter 1 This article introduces the research background related to the subject, the current research status of slow transportation environment and the application of driverless vehicles, and describes the purpose and significance of the research, and briefly introduces the main research content and research methods.

Chapter 2 This article introduces the concept of slow transportation and the current development status, analyzes the current status of slow transportation in large residential areas, points out the current problems and pain points, and proposes specific service scenarios for the application of driverless vehicles to large slow residential transportation environments.

Chapter 3 Introduce the Kano demand model as the basic theoretical guidance for the research of driverless vehicle service system, and on this basis, expand more levels of theoretical guidance to form a three-dimensional Kano theory extension suitable for driverless vehicle service design to guide the improvement in specific slow travel System framework for driverless vehicle service in the environment.

Chapter 4 Utilize the constructed 3D Kano demand model to practically design the existing slow-transportation environment in a specific large residential area, produce corresponding design results, and further explore the design and development direction of future autonomous vehicle services.

Chapter 5 Finally, the author further summarizes and explores the different function combinations in the context of smart communities, the possibility of linkage with slow transportation functions, and analyzes the higher-level service framework of smart communities in the future.

Chapter 2 Overview of Slow Transportation Services for Large Residential Community

2.1 Overview of Slow Transportation

2.1.1 Slow Transportation Concept

Slow transportation is a form of transportation relative to fast and high-speed transportation. Some scholars also believe that slow transportation is non-motorized transportation [1]. In general, slow transportation is a mode of transportation where the speed is not more than 20km / h. Slow transportation includes walking, cycling, and other forms of mobility, and bicycle and other forms of mobility are collectively referred to as non-motorized transportation.

Slow transportation is classified according to its function and purpose, and can be divided into traffic-purpose slow transportation and non-traffic-purpose slow transportation. Slow transportation is the main mode of short-distance travel. It is a travel mode with the purpose of reaching a certain place. Non-traffic-purpose slow transportation is a mode of travel that has no strong purpose such as leisure exercise, including various public activities, exercise and fitness, leisure sightseeing, and business.

For daily travel, in many cases slow travel does not exist alone. Slow travel is usually combined with other forms of transportation. In combined forms of transportation, slow transportation often serves as the main mode of starting and ending arrivals, while fast or high-speed transportation serves as the main part of the transportation process. Better optimizing the combination can make users travel more flexible and complete the transportation process more smoothly.

2.1.2 Slow transportation system

The slow transportation system refers to the slow transportation system composed of various slow transportation modes in the city. It is an indispensable and important part of the urban transportation system. It acts as a capillary in the urban transportation system to clear the city's rapid or high-speed transportation. The small details ensure the smooth flow of the overall transportation.

The slow transportation system is in the slow part of the entire city's transportation system, and is not the main body vehiclerying urban traffic load. The main function of the slow transportation system is to solve the "last mile" problem of urban transportation systems with fast or high-speed transportation as the main body, to gather people to the main urban transportation system and to evacuate people from the main transportation system to the destination. Therefore, although the slow transportation system cannot enhance the transportation efficiency of the transportation subject through the increase of speed, the slow transportation system makes the main transportation smoother through its own regulation and guidance. At the same time, the slow transportation system not only cooperates with the main urban transportation system to complete the purposeful transportation such as commuting, but also provides more recreational functions such as leisure and exercise, which is an essential part of the urban transportation system.

The slow transportation system is composed of three components, namely the slow transportation space, the main body of the slow transportation, and the slow transportation behavior.

The slow transportation space refers to the space or place where slow transportation occurs. For traffic-purpose slow transportation, slow transportation space generally refers to urban roads, including road spaces of different grades; for non-traffic purpose transportation, slow transportation spaces are mostly recreational spaces, such as green trails, tree-lined trails, etc.

The subject of slow transportation refers to the main role of slow behavior in the slow transportation space. Generally speaking, the main role of slow transportation is a traffic-purpose or non-traffic-purpose crowd. In some cases, the main body may also be inanimate objects such as goods, which complete the transportation of goods under slow transportation.

Slow transportation behavior refers to activities that occur under a specific purpose in a slow transportation environment. The slow transportation behavior in a slow-transportation environment is generally a short-distance trip with a strong purpose. It can connect with various other transportation systems in the city, such as urban commuting. The slow transportation behavior in the transportation environment is generally all kinds of recreational activities such as leisure, exercise, shopping, etc. Slow transportation is just a means to achieve activities to help users achieve entertainment purposes.

2.1.3 Slow Transportation Classification

At present, there are mainly three types of slow transportation in China: walking transportation, bicycle transportation, and various types of moped transportation.

Pedestrian transportation is the most basic mode of transportation for urban residents. Generally, it does not require the help of other means of transportation, and has great flexibility. Using pedestrian transportation can achieve complete point-to-point travel tasks and can be completely home-to-house. The speed is generally 1m / s, the step distance is 60-75cm, and the average speed is 4-5km / h. In a complete pedestrian transportation environment, the safety is very high, and the collision phenomenon due to excessive speed will not occur. The disadvantage of pedestrian transportation is that it is slower and the reachable distance is shorter, which cannot meet the transportation needs of longer distances. And the way of walking is completely dependent on the physical condition of the pedestrians. For residents with physical inconveniences, walking is not the best mode of slow transportation.

Bicycle transportation, that is, the use of human resources to ride an additional means of transportation-bicycles, to complete the transportation. Bicycle transportation is currently the main form of slow transportation in China. Compared with pedestrian transportation, bicycle transportation can reach longer distances. In China, the effective distance of bicycles can reach about 8 kilometers, and the speed is relatively high. 10-20km / h. At the same time, bicycle transportation is also a very efficient exercise and fitness tool. Bicycle exercise has also been vigorously promoted as a national fitness exercise. However, bicycles also need higher safety guarantees. Bicycle transportation in developed countries is more developed. In some developed countries in Europe and the United States, such as France and the Netherlands, very complete bicycle lanes have been built to protect bicycles Cyclists ride safely. The transportation flow of bicycles in China is also very large, but the construction of bicycle lanes and the implementation of other bicycle safety measures are still in their infancy and have not been widely adopted. At the same time, bicycle transportation also has great limitations. The effective movement distance is short, and long-distance transportation cannot be completed. It is not suitable for transportation on steep slopes and in rainy weather.

Moped transportation refers to transportation completed by using fuel, gasoline, or electricity to assist vehicles. Generally, it refers to two-wheeled mopeds, which are mainly divided into two types, fuel mopeds and electric bicycles. Moped transportation is a kind of transportation method that has emerged in China in recent years. Compared with the use of bicycles in the form of human power, mopeds use external fuel or electricity to provide kinetic energy, which reduces a lot of physical burden for the rider, and can guarantee a certain amount of Driving speed is relatively stable. The domestic standards for mopeds stipulate that the maximum speed of the moped should be no more than 20km / h, and the mass (weight) of the whole vehicle should be no more than 40kg. If it exceeds the standard, it is a motor vehicle. Mopeds belong to the scope of non-motorized vehicles and are classified in the same lane as bicycle transportation. However, due to the fast speed and poor safety of mopeds, it is easy to collide with other non-motorized vehicles. In some first- and second-tier cities with heavy transportation pressure in China, in order to prevent transportation accidents of mopeds, fuel mopeds have been explicitly banned. Major cities have successively issued motorcycle bans, while also regulating the speed of electric bicycles and banning mopeds. Human behavior further regulates the slow transportation of mopeds in cities.

2.2 Status of Slow Transportation Development in China and Other Countries

2.2.1 Status of Slow Transportation Development in Developed Countries

In many developed countries, bicycling and walking to work have become a common phenomenon in many cities. The vigorous development of slow transportation can not only reduce the city's vehiclebon emissions and other harmful gas emissions from motor vehicle transportation, but also enhance the physical fitness of the people through slow transportation exercises.

In the case of slow transportation, Tokyo, Japan has the world's largest subway system, and is the most commonly used transportation method for local people. There are many pedestrian crossing facilities and pedestrian walkways near the subway station, as well as comprehensive pedestrian safety measures to help pedestrians to complete the connection to the main urban transportation system smoothly and safely through slow transportation, as shown in Figure 2.1.

It is also a city subway system. Paris, France also has a very developed subway system. In order to ensure the efficient use and connection of urban subways, Paris has arranged public bicycle stations near various subway stations, and a large public bicycle sharing system called Velib Unified regulation. The system was officially launched on July 15, 2007. As of 2016, the system has 1,750 service stations and 23,600 bicycles. By means of bicycle slow transportation, citizens can freely use bicycles to connect to the city bus subway system. In order to ensure the effective implementation of this measure, the Paris government has converted a large number of urban road parking spaces into public bicycle stations. At the same time, it has opened more bicycle lanes on urban roads, built sidewalk guards, and prevented private vehicles from parking in non-motorized lanes. The sidewalk is designed to encourage citizens to use more environmentally friendly bicycle and public transportation, and reduce the use of private vehicles. This measure also reduced the proportion of private vehicle trips from 68% to 60%, and 5% of vehicle users switched to cycling or to public transportation.

Figure 2.1 Slow transportation system around Tokyo Metro, Japan
(From: https://ameblo.jp/mother-book/image-12413012605-14287139994.htm)

In the case of non-traffic-purpose slow transportation, High Line Park in New York, USA is a very successful leisure case in slow transportation. The original site of High Line Park was an elevated railway freight line built in 1930. It was discontinued in 1980 and was retained under the initiative of the non-profit organization "Friends of the High Line Leadership" (FHL). Public slow transportation open space. This elevated railway line that passes through the urban area serves as a valuable historical site in the local area. After the transformation, it has been transformed into an elevated park for citizens to entertain, which not only provides more leisure walking space for citizens, but also creates more and more economic benefits have increased employment opportunities.

2.2.2 Status of Slow Transportation Development in China

Slow transportation has undergone changes in different periods in China. In the 1980s, in the early days of reform and opening up, the number of private vehicles owned by Chinese people was relatively low, and travel was mainly based on cheaper public transportation and bicycle transportation. At that time, China had the largest number of bicycles in the world, and bicycles became an important means of transportation for people to commute.

With the development of China's economic level, people's material levels have gradually improved, and the number of private vehicles has gradually increased. By the 21st century, bicycle use has fallen dramatically. According to a survey by the China Bicycle Association, bicycles accounted for 68% of Beijing's overall traffic in the 1980s, and by 2014 this ratio had fallen to 12%. By the end of 2016, the number of motor vehicles in China had reached 290 million, of which vehicles the number reached 194 million. [52]

However, with the continuous increase in the number of motor vehicles, various problems caused by motor vehicles have followed. Compared with bicycles, private vehicles have a larger body volume and a lower effective use rate. Too many private vehicles in the city cause road congestion. At the same time, excessive exhaust emissions from vehicles have also caused a certain degree of environmental pollution and damage. Therefore, in recent years, many cities have begun to re-encourage slow transportation to rationally supplement public transportation in order to ease transportation pressure and reduce environmental pollution.

In 2017, the Chengdu Municipal Planning Administration began to compile the "Chengdu Slow Transportation System Plan", which aims to plan and construct a relatively independent bicycle slow transportation network, pedestrian transportation network, and characteristic slow routes for urban cultural tourism. According to the Plan, Chengdu plans a unified slow transportation road for 3,900 kilometers of urban roads. For example, set up a continuous slow transportation network around the school to improve the safety of students going to and from school; plan and construct a 798 km bicycle lane to provide independent, safe and comfortable bicycle-only riding space [6]. Similarly, for pedestrian transportation, Chengdu will also build and improve four different types of dedicated roads, including pedestrian-only lanes, priority lanes for learning, pedestrian-specific lanes, and pedestrian-only lanes, to strengthen Chengdu's slow transportation system.

In terms of commercial use, Shanghai Lujiazui Century Corridor was completed in 2014. It connects several major commercial Lujiazui corridors in the sky by slow transportation. After the completion of the two-storey corridor, the total length is about 543 meters, which not only becomes a pedestrian-only air walkway, strengthens regional connections, improves transportation in the Inner-lujiazui area, but also becomes a major tourist attraction, overlooking the entire Lujiazui Financial City. Great platform. In 2016, following the Century Corridor, an underground passage was constructed in the Lujiazui area, connecting 4 super high-rise buildings in the core area of Lujiazui to further strengthen the connection between the buildings in the area. By means of a dedicated slow walk, Make business connections closer.

2.3 Slow transportation environment in large residential area

2.3.1 Overview of large residential areas

A residential area refers to a relatively independent area with a certain population and land size, and concentrated layout of residential buildings, public buildings, green spaces, roads and various other engineering facilities, surrounded by urban streets or natural boundaries [14]. According to the scale, residential areas can be divided into the following categories: residential groups with a scale of 1000-3000 people; residential communities with a scale of 10,000-1.5 million people; residential areas with a scale of about 30,000 people; People's residential areas are called large-scale residential areas, or residential complexes, with an area of more than 50 hectares. The development of large-scale residential areas is at the forefront of urban expansion, and is an important solution to the increasing pressure of urban expansion. It has played a pioneering role in urban expansion to a certain extent [11]. And this type of residential area is generally located in the suburbs, with a large number of commuting residents, and nearby public transportation hubs undertake the main public transportation of this type of community.

2.3.2 Status and Problems of Slow Transportation in Large Residential Areas

Due to the large number of residents living in large residential areas, driving safety is a guarantee factor that the residential area focuses on. Article 67 of China's "Implementation Regulations on Safety Law" stipulates that in residential areas, motor vehicles should drive at a low speed, and the speed must not exceed 15 kilometers per hour. Vehiclee must be taken to avoid pedestrians [10]. It can be seen that, according to laws and regulations, the transportation system in residential areas is a slow transportation system. The closed environment of large residential areas also makes this type of slow transportation system more special. It is a closed slow transportation system that is relatively isolated from the outside transportation system.

Figure 2.2 Transportation hub around Golden Jiangnan Large Residential Area, Wuxi, China

Due to its particularity, the slow transportation environment of large residential areas will also cause some disadvantages. Take the Golden Jiangnan Large

Residential Area in Binhu District, Wuxi City, Jiangsu Province, China as an example, as shown in Figure 2.2, this residential area is located on the north side of Liangxi River in Binhu District, Wuxi City. It is long and narrow, with a length of 2 kilometers in length, an average of about 300 meters in the horizontal direction, and a land area of about 60 hectares, which belongs to the category of large-scale residential areas. There are bus lines around the residential area and two subway stations. The subway can take on more transportation, so it has also become a major transportation hub in this residential area. However, for the residents of this residential area, due to the huge living area of the residential area, it still takes a long distance to reach the nearby subway station, and the average distance is more than 1 km. For this type of travel needs, residents first need to solve the 1 km slow transportation problem. At present, residents mainly use slow transportation vehicles, such as bicycles or mopeds. This type of transportation can solve the "last mile" problem to a certain extent, but at the same time, the parking of vehicles at transportation hubs has also caused a series of congestion problems, which has caused some pressure on local transportation.

Transportation Way	Percentage	
Walking	3.45	
Private Car	3.26	
Cycling	2.02	
Battery Cycling	2.01	
Motorcycling	0.81	
Others	0.61	

Figure 2.3 Survey of traffic mode usage in residential areas

Aiming at the current situation of slow-transportation environment in large residential areas, this paper conducted a questionnaire survey of 118 residents in residential areas, asking respondents to sort the transportation methods used in residential areas by frequency, as shown in Figure 2.3. For walking, followed by private vehicles, the third to fifth places are bicycles, battery vehicles and motorcycles. It can be seen that in the residential area, due to speed restrictions, private vehicles are not the preferred mode of transportation for most residents, but considering the travel needs, the use frequency of private vehicles is still ranked second, and the remaining options are flexible Higher slower transportation.

It can be seen from the above case analysis that the current status of slow transportation in large residential areas in China still has the following problems:

(1) Residents' flexibility for various modes of transportation and the needs of passage in narrow areas cannot be met. The mode of travel by private vehicle can solve most of the travel needs to a certain extent, but if it is only in the residential area, or within a short and medium-distance reach around the residential area, the private vehicle travel needs to complete the pickup, parking, parking Steps such as finding places are not an efficient way to travel. And because the roads in the residential area are slow transportation roads, the roads are relatively narrow, and are not suitable for short-distance travel of motor vehicles such as private vehicles. Similarly, traveling by bicycle or moped also faces the problem of parking confusion. In the current situation where bicycle sharing is more developed, many residents will also choose to share bicycle trips, but the characteristic of shared bicycles is that there is no guarantee that there are idle shared bicycles that users can access at any time.

(2) The lack of a good connection between the slow transportation system in the residential area and the external urban transport system. The population size of large residential areas is generally more than 30,000. There are a large number of residents who need to commute, and they will regularly use public transportation, and a large number of travel needs at the same destination will occur in a short period of time. At present, shared bicycles often used by residents, and the efficiency of travel depends on the effective number of nearby bicycles, which cannot guarantee the stability of travel. As a result, the commute needs of residents in a short period of time cannot be satisfactorily met, and slow transportation in residential areas cannot be well connected with the urban transportation system.

(3) There is no good information interaction between the vehicle and the user. In the environment of large residential areas, slow transportation is the preferred mode of transportation for residents, which is closely related to residents' lives. Slow transportation can be a medium for residents to obtain information and improve the quality of life of residents. However, compared with the human-machine interaction that private vehicles are already developing, the current slow transportation vehicles cannot support the richness that motor vehicles can support due to the hardware support. Human-machine interaction has not been well developed.

2.3.3 Significance of Slow Transportation Research in Large Residential Areas

With the advancement of urbanization in China, more and more large residential areas appear in suburban areas, and these large residential areas, as well as the linkage with public transportation outside the community, basically rely on slow transportation to complete. Therefore, improving the quality of slow transportation can greatly improve the quality of life of residents in large residential areas.

Studying the slow transportation environment in large residential areas has the following significance:

(1) Can improve commuting efficiency in large residential areas. Bring into play the role of slow transportation as capillaries in large residential areas, and effectively improve the efficiency of pedestrian flow and transportation efficiency during commuting hours in large residential areas.

(2) Slow transportation is used as a vehiclerier to help residents improve their quality of life. The slow transportation environment is not only a place for travel purpose activities such as commuting. Similarly, as a transportation mode that is closely related to residents, slow transportation can also give residents more activities in more aspects, such as spiritual aspects such as leisure and entertainment.

2.4 Status of research on driverless vehicles and related services

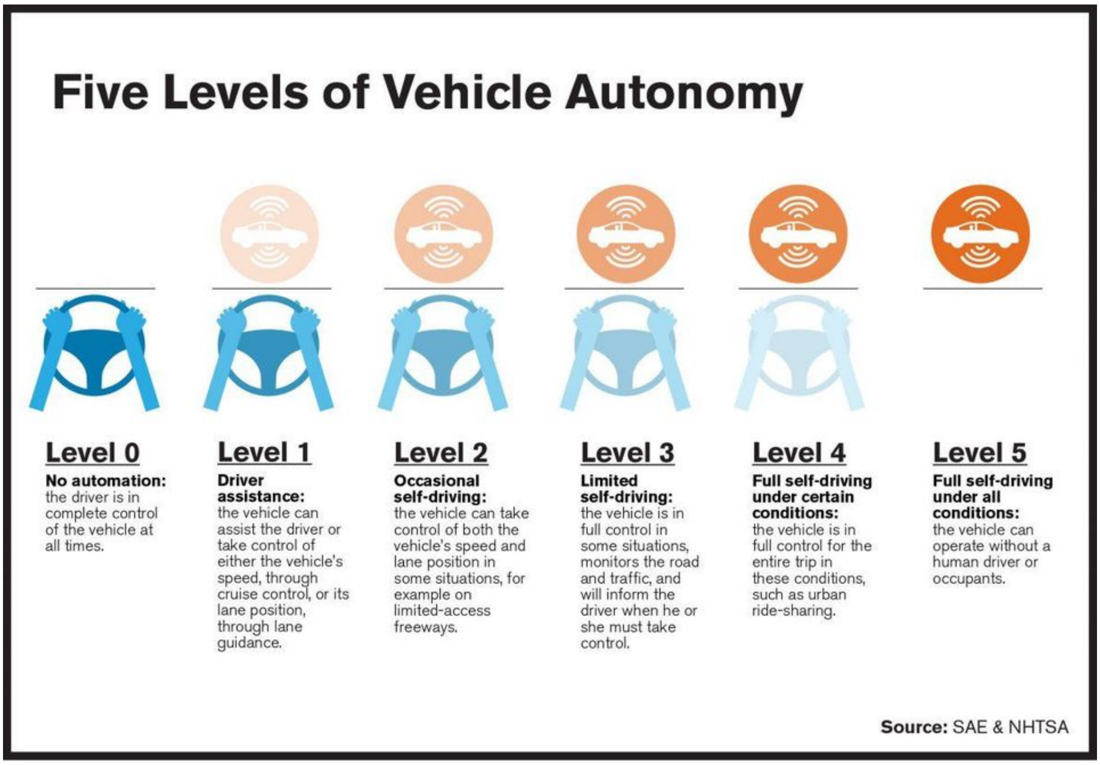
2.4.1 Driverless vehicle overview

Driverless Vehicle is a driverless vehicle, which is a kind of intelligent vehicle. It mainly relies on the intelligent driving equipment mainly based on computer systems in the vehicle to achieve the purpose of driverless driving [16]. The emergence of driverless vehicles was originally due to the needs of military research and development, and gradually turned to commercial and civilian research and development in the late 20th century. The purpose of driverless driving is to replace the manual driving method by computer algorithms, to fundamentally solve the vehicle safety hazards caused by human factors, and to regulate the operation of many vehicles in an orderly and efficient manner through a unified driverless vehicle control system. order.

2.4.2 Research Status of Driverless Vehicle Technology

With the advancement of domestic urbanization, more and more large residential areas appear in suburban areas, and these large residential areas, as well as the interaction with public transportation outside the community, basically rely on slow transportation to complete. Therefore, improving the quality of slow transportation can greatly improve the quality of life of residents in large residential areas.

Table 2.1 Autonomous driving classification



Vehicle autonomy is classified according to the degree to which a human driver takes over the vehicle, as shown in Table 2.1. At present, there are two more authoritative classifications in the world. One is the five levels of L0-L4 proposed by the National Highway Transportation Safety Administration (NHTSA) in the United States. The other is six levels of L0-L5 proposed by the International Society of Automotive Engineers (SAE). The difference between NHTSA and SAE classification is the difference in the highest level. The L4 level of NHTSA includes the L4 and L5 levels of SAE. Both are highly automated driving stages, that is, the vehicle completes all driving operations, and human drivers do not need to maintain their attention. The autonomous driving at this stage is generally considered to be the driverless stage.

Autonomous driving technology began as early as the middle of the twentieth century. At that time, many technologically advanced countries were under national security considerations, and they began to explore this vehicle technology. American Barret Electronies company developed the world's first driverless vehicle in 1950, which can autonomously drive on preset experimental roads under preset conditions. In 1986, Vehiclenegie Mellon University began to study vehicle computer control systems, and launched semi-autonomous Navlab 1 and Navlab 2 in 1986 and 1990. In 1999, Vehiclenegie Mellon University developed driverless vehicles Navlab-V, completed a complete driverless experiment, conducted a cross-country drive in the east and west of the United States. At the 2017 CES (International Consumer Electronics Show), a series of traditional vehicle companies such as Audi, BMW, Mercedes-Benz, Toyota, Ford also brought their modified driverless models or concept models. In addition, Tesla, a pure electric vehicle brand, launched Autopilot 2.0 from the end of 2016 to the beginning of 2017, and the subsequent patches are gradually improving the functions and lifting the functions [19].

China began researching driverless technology in the 1980s. In 1992, the National University of Defense Technology developed China's first driverless vehicle, which was a zero breakthrough in China's driverless technology. In 2011, the Hongqi HQ3 driverless vehicle jointly developed by FAW and the National University of Defense Technology completed the first high-speed full-length driverless test from 286 kilometers from Changsha to Wuhan. In 2012, the Tucson off-road vehicle Junjiao Lion Ⅲ modified by the China Military Academy completed 114 kilometers of tests on the Beijing-Tianjin Expressway. On July 3, 2016, Baidu and Wuzhen Tourism held a strategic signing ceremony, announcing that the two parties will work together to achieve Level 4 driverless driving on scenic roads [20].

2.4.3 Research Status of Driverless Vehicle Related Services

Research on driverless vehicle related services is relatively in its infancy. In the past decade, driverless vehicle technology has gradually matured, driverless vehicle technology has begun to be gradually put into commercial and civilian use, and related functions and services have begun to rise.

Uber, the founder of ride-hailing, initially launched driverless vehicle passenger services in 2016 [20]. The service was first commissioned in Pittsburgh, the

United States. On the day of the trial operation, two engineers were still in the vehicle. One engineer was on the driver's seat as a safety officer. In most cases, the vehicle operated autonomously, and on more complex roads, there were The safety officer assists in driving. Another engineer is responsible for monitoring the development of the driverless vehicle. Uber accurately assesses road safety and driving conditions by equipping networked vehicles with equipment such as radars and laser detectors, as well as a large number of vehicle algorithms. The current state of driverless driving is still in its infancy, and personnel such as safety officers are still required to monitor driving conditions. In the future, Uber will gradually reduce the number of security personnel in the vehicle based on the maturity of driverless vehicle technology passenger service until it achieves a completely driverless driving. In 2018, an accident occurred in Uber's driverless vehicle, which hit a pedestrian in the automatic driving mode, and the pedestrian eventually died of ineffective treatment. This accident is also the world's first fatal accident caused by driverless vehicles. Although at the time, pedestrians suddenly walking out of the shadows and crossing the road were already dangerous transportation behaviors, and their faults were not entirely on driverless vehicles, they still needed to be considered and valued. Next, how can autonomous vehicles avoid such risks?

China's driverless vehicle services are also gradually emerging. In April 2018, Baidu announced that commercial-grade driverless buses based on the driverless driving system "Apollon" were officially tested for the public. The driverless bus has no steering wheel, no driving space, accelerator and brake pedal. It completely relies on Baidu's self-developed driverless system for operation. At present, the vehicle has been mass-produced offline, and it is expected to be put into use in slow transportation environments such as scenic spots, parks and airports in the future.

2.4.4 Advantages and feasibility of driverless vehicle service in slow transportation

Although the commercial and civilian use of driverless vehicle technology is still in its infancy, in the future development process, its advantages can serve the slow transportation environment of large residential areas and further solve the current development of large residential areas. The bottlenecks encountered by slow transportation and the pain points in the process.

The advantages of driverless vehicles for slow transportation are as follows:

(1) Driverless vehicles have better adaptability in the slow transportation of the main transportation. The transportation environment in a large residential area is a slow transportation environment, and the main behavior is short-distance transportation. The transportation environment in large residential areas is relatively narrow, and slower transportation needs more flexibility. In such an environment, driverless vehicles can take advantage of their own on-board control, can more sensitively identify road conditions, and more accurately complete driving on narrow and congested roads.

(2) Driverless vehicles have better control over repeated roads. The urgent needs of the slow-transportation environment in large residential areas include commuting, getting take-away courier services, etc., which are relatively repetitive routes, and the residents 'own living paths in the residential areas are almost fixed and repeated routes. Driverless vehicles have a more stable algorithm to execute highly repetitive paths, and will not cause hidden dangers in road travel caused by driving fatigue caused by human conditions.

(3) Driverless vehicles can complete better human-machine interaction. At present, the mode of transportation in the slow transportation environment is basically in the form of bicycles and mopeds. It is only a vehiclerier of slow transportation. There is no good interaction between the vehicle and the user. Slow transportation is a living environment that is closely related to the daily life of residents in large residential areas. Driverless vehicles can be used as a vehiclerier of information transmission to enhance the information interaction between users and the living environment. The driverless vehicle itself has a rich human-machine interaction foundation, which can provide a platform for personalized interaction.

(4) Driverless vehicles can provide better integration of slow transportation functions. The slow-transportation environment in large residential areas is the main space for residents' life. It not only bears the daily travel needs of residents, but also the place where other living activities of residents occur, such as delivery and delivery of take-away courier, daily leisure walking and so on. These travel scenarios will also require the use of vehicles for slow travel. Compared with the independent slow transportation vehicles that are often used now, driverless vehicles are controlled by a unified driving platform, which is easier to integrate multiple services and functions, and to provide personalized and customized service paths for residents with different needs.

(5) Driverless vehicles can provide a more comfortable environment for slow transportation. An important role played by slow transportation is to solve the "last mile" problem of residents' lives, which is a highly repetitive and urgently needed demand. Therefore, improving the comfort of this slow transportation process can greatly improve the user experience of residents traveling. Driverless vehicles have more precise driving technology, operate more smoothly, and use clean energy. The noise pollution is small, which can greatly improve the driving comfort.

The driverless vehicle's computer algorithm is controlled by the unified background control system. Compared with the current mode of artificial driving, the driverless vehicle has a better regulation mechanism to avoid a series of interference caused by human factors affecting the safety risks of normal operation of the transportation order. Therefore, compared to the current mode of transportation under slow transportation, driverless vehicles have better adaptability and feasibility, and serve various services such as travel under slow transportation.

At present, there are examples of driverless vehicle services under the relevant slow transportation in China. As a leading domestic intelligent driving company, UISEE Technology officially launched the operation of driverless vehicles in Raffles City, a large commercial district in Hangzhou, in 2017. It is the first cross-border cooperation project in China for driverless vehicle technology and commercial real estate. The project aims to provide driverless vehicles to provide customers with on-board vehicle search services under the slow transportation environment of underground parking lots. The specific service process is as follows: When the customer needs to drive the vehicle to leave the mall, use the smart terminal at the entrance of the underground parking lot, enter the license plate number, and then take the driverless shuttle to transport the customer to the designated vehicle to complete the service. At present, the operating environment of the driverless vehicle still requires a human driver to follow the vehicle, but the human driver also participates in the driving control of the vehicle only in an emergency. During normal operation, driverless vehicles are completely autonomously controlled by the system, including basic operations such as passing through narrow sections, turning at intersections, meeting with traveling vehicles, and avoiding pedestrians. At present, the maximum operating speed of the driverless vehicle in the parking lot is 8km / h, which belongs to the transportation environment of slow transportation. After the above operation tests, the operation of the driverless vehicle is also completely within the controllable and safe range, and the transfer is completed without error. The customer's stated goals [23]. Therefore, the application of driverless vehicle technology to the slow transportation environment is completely feasible.

CHAPTER 3 Design Principles of Service System Framework Based on Kano Model

3.1 Kano model overview

3.1.1 Kano model concept

The Kano model is a tool for classifying, optimizing, and sorting user needs, proposed by Tokyo University of Science Professor Noriaki Kano in the 1980s. This model introduces user satisfaction and dissatisfaction standards into the field of service quality assessment and management for the first time. By evaluating user satisfaction with service elements, it further analyzes the provided service quality and provides services for subsequent service design links. High-quality demand guidance.

The Kano model is now used in many design fields. Through its specific tools and methods, it guides the design at the level of requirements analysis, sorts and optimizes the combination of requirements, and summarizes the services provided in intuitive forms such as charts.

3.1.2 Kano model in two dimensions

The expression of the Kano model is mainly the different reaction relationship between the user's satisfaction with the product or service and the expected satisfaction degree in two-dimensional coordinates, which can be represented by Figure 3.1.

The graph shows that the abscissa represents the objective and actual quality of the product or service reflected in the user's desired level of satisfaction. The more to the right, the lower the actual quality of the product or service, the lower the user's satisfaction with their expectations, and vice versa The left is the higher the degree of satisfaction with the expected value. The ordinate represents the user's subjective satisfaction with the product or service. The higher the satisfaction with the product or service, the lower the satisfaction with the product or service.

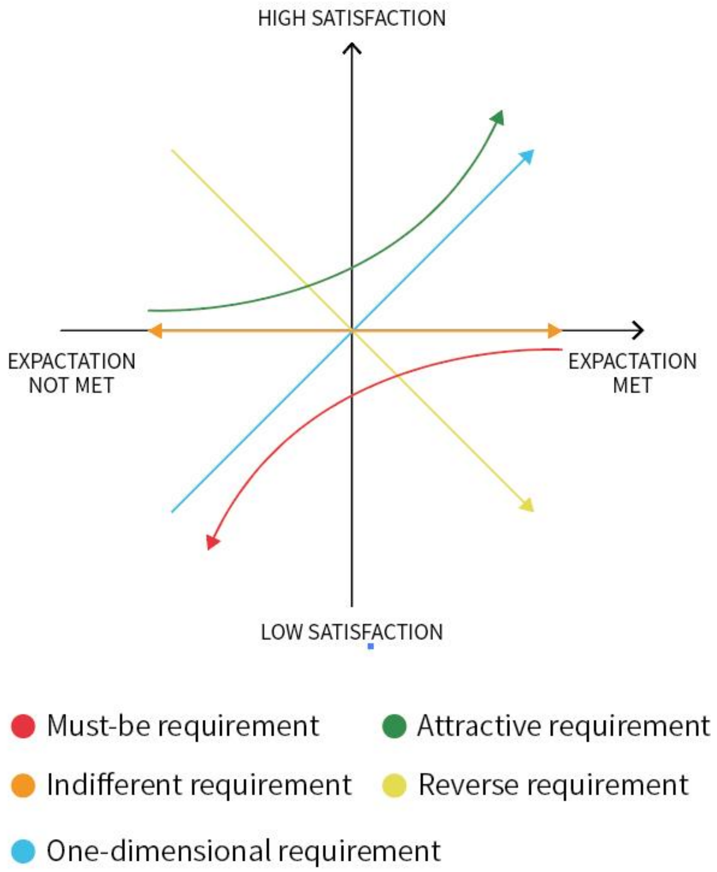


Figure 3.1 Kano two-dimensional property coordinate chart

The horizontal and vertical coordinates together constitute the two-dimensional form of the Kano model, and each product or service can be reflected in this two-dimensional model. According to the Kano model, a product or service can be divided into five different attribute categories based on the relationship between the degree of satisfaction of the expected value and the subjective satisfaction.

(1) Attractive requirement represents a type of demand that exceeds user expectations or surprises users. The display characteristics of this type of demand on the chart are that the more the abscissa

value goes to the right, the ordinate value will decrease and the decrease rate is smaller; otherwise the more the abscissa value is to the left, the larger the ordinate value and the larger the growth rate. The overall satisfaction level is above zero, that is, the presence or absence of this type of attribute requirements will not make users feel dissatisfied or disappointed.

Therefore, the attribute characteristic of this type of demand is that users will not feel dissatisfied even if this type of function or service is not provided or the demand is not met; once this type of functional service is provided, user satisfaction will be greatly To ascend. This type of demand is attractive to users. Therefore, for service designers, this type of product or service is an important part of improving user satisfaction, and users will feel joy for such products or services.

(2) Must-be Requirement represents the type of requirements that a product or service must have. The display characteristics of this type of demand on the chart are that the more the abscissa value goes to the right, the ordinate value will decrease and the reduction rate is larger; otherwise the more the abscissa value is to the left, the larger the ordinate value is and the smaller the growth rate is. The whole is below the zero value of satisfaction, that is, the presence or absence of this type of attribute demand will not make users feel extra satisfaction and surprise.

Therefore, the attribute characteristic of this type of demand is that even if more functions or services of this type are provided, user satisfaction will not increase significantly; once the provision of this type of functional services is reduced, user satisfaction will increase Slightly reduced. This type of demand can not bring surprises to users. Reducing this type of products or services will make users disappointed. Users think this type of products or services is necessary. For service designers, in the service design process, it is necessary to ensure that this type of requirements are met, otherwise the user's satisfaction and loyalty will be greatly reduced.

(3) One-dimensional Requirement is a requirement that has a proportional function relationship and represents the type of requirement that the user expects to achieve. This type of requirement is located between the charm attribute and the required attribute on the chart. The display characteristic is that the more the abscissa value is to the right, the smaller the ordinate value is; on the contrary, the more the abscissa value is to the left, the larger the ordinate value is. The user's sensitivity to this type of attribute demand is high, and the presence or absence of this demand will affect user satisfaction.

Therefore, the attribute characteristic of this type of demand is that the more functions or services of this type are provided, the user's satisfaction will be significantly increased; the reduction of the provision of this type of functional services will significantly reduce the user's satisfaction. This type of demand is what users expect, and users think that this type of product or service should be provided. For service designers, it is necessary to consider the satisfaction of this type of requirements, and any change in such requirements will affect user satisfaction.

(4) Reverse Requirement is a requirement that has an inverse proportional relationship and represents the type of requirement that the user does not expect to achieve. This type of demand is just the opposite of the expected attribute. The display characteristic on the chart is that the more the abscissa value is to the right, the larger the ordinate value is; on the contrary, the more the abscissa value is to the left, the smaller the ordinate value is. Users have a negative attitude towards this type of attribute demand.

Therefore, the attribute characteristic of this type of demand is that the more functions or services of this type are provided, the user's satisfaction will decrease; the reduction of the provision of this type of functional services will increase the user's satisfaction. This type of demand is not expected by the user, and the user thinks that this type of product or service does not need to be provided. For service designers, this type of products and services needs to be minimized. This type of products and services is disgusting to users and may even harm the interests of users.

(5) Indifferent Requirement represents a type of requirement that users do not vehiclee about. This type of demand is displayed on the chart as a straight line that coincides with the abscissa, and the satisfaction of the abscissa to the left or right is basically unchanged, and it will not affect the user's satisfaction. critical.

Therefore, the attribute characteristic of this type of demand is that whether this type of product is increased or decreased, or the provision of demand, user satisfaction will not change significantly. This type of demand is not of concern to users. Service doesn't matter. For service designers, because this type of demand cannot make users feel emotionally inclined, the emergence of this type of product or service can be considered in the early stages of design, but in the process of further optimization and adjustment, this type of product or demand should be avoided. Appear, reduce unnecessary waste of resources, and improve the efficiency of the overall product or service experience.

Through related two-dimensional mode implementation, different requirements can be classified into these five requirements attributes. In the further service design process, the requirements of different attributes will be optimized and adjusted according to their different service characteristics. The specific implementation of the two-dimensional mode is described below.

3.1.3 Kano model implementation in two dimensions

In the specific operation process of the Kano model, there are specific operation modes and tools to ensure the effective use of the model. Generally speaking, according to the use steps, there are three main tools of the Kano model: the Kano questionnaire, the Kano survey evaluation form, and the Kano survey result map.

The Kano questionnaire surveys the satisfaction of each feature. For each feature, two scenarios for satisfaction surveys are set up, one with and without the feature. In each situation, there will be five choices of answers with different degrees of satisfaction, from like to dislike, which are like, take for granted, indifferent, bearable and dislike. Gather user satisfaction intentions with and without functional features. As shown in Table 3.1.

Table 3.1 Kano questionnaire

		Like it	Expect it	Don't care	Live with	Dislike
Feature 1	feature present	1	2	3	4	5
	feature absent	1	2	3	4	5
Feature 2	feature present	1	2	3	4	5
	feature absent	1	2	3	4	5
...	...	...	...	...	...	...

Table 3.2 Kano survey evaluation form

User needs		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	Q	A	A	A	O
	Expect it	R	I	I	I	M
	Don't care	R	I	I	I	M
	live with	R	I	I	I	M
	dislike	R	R	R	R	Q

Attractive requirement （A） / One-dimensional requirement （O） / Must-be requirement （M）
Questionable requirement （Q） / Reverse requirement （R） / Indifferent requirement （I）

After collecting user satisfaction data, use the Kano survey evaluation form to count the number of users in each scenario with different functional characteristics for further statistical analysis. The Kano survey evaluation form is shown in Table 3.2

The Kano survey evaluation form is displayed as a two-dimensional form, which counts the number of users who choose different satisfaction combinations in the two scenarios, a total of 25 combinations. The 25 satisfaction combinations are classified into 6 demand characteristics according to their characteristics. It should be noted that the meaningless requirement attribute, that is, Questionable Requirement, is expressed in the case of users with and without the feature. Like or dislike. This situation is generally caused by a user's misfilling or misunderstanding, and the data is invalid.

After the attribute classification of the Kano survey evaluation form is completed, the survey results need to be further displayed. The commonly used statistical method is the Better-worse coefficient formula, which has the relationship of formula (3.1) and formula (3.2), and calculates the degree of satisfaction with and without providing the functional characteristics. The statistical formula is as follows:
Provide the satisfaction factor of the service function characteristics:

Better scores with feature present:

$$Better = (A + O)/(A + O + M + I) \qquad (3.1)$$

Worse scores with feature absent:

$$Worse = -(O + M)/(A + O + M + I) \qquad (3.2)$$

Better Scores represents the user's satisfaction coefficient in the context of providing this service feature. The closer the Better Scores to 1, the greater the impact of the presence or absence of this feature on the user's satisfaction level, and the higher the ranking of the service features, The more a service designer should provide this type of functionality. Worse scores represent the user's dissatisfaction coefficient in a situation where the service feature is not provided. The closer the Worse scores are to -1, the greater the impact of the presence or absence of the feature on the user's dissatisfaction. Up and down, so service designers should not give this type of features a priority.

After getting the Better and Worse scores of the service characteristics, we need to describe the data more intuitively and draw a map of the Kano survey results, as shown in Figure 3.2.

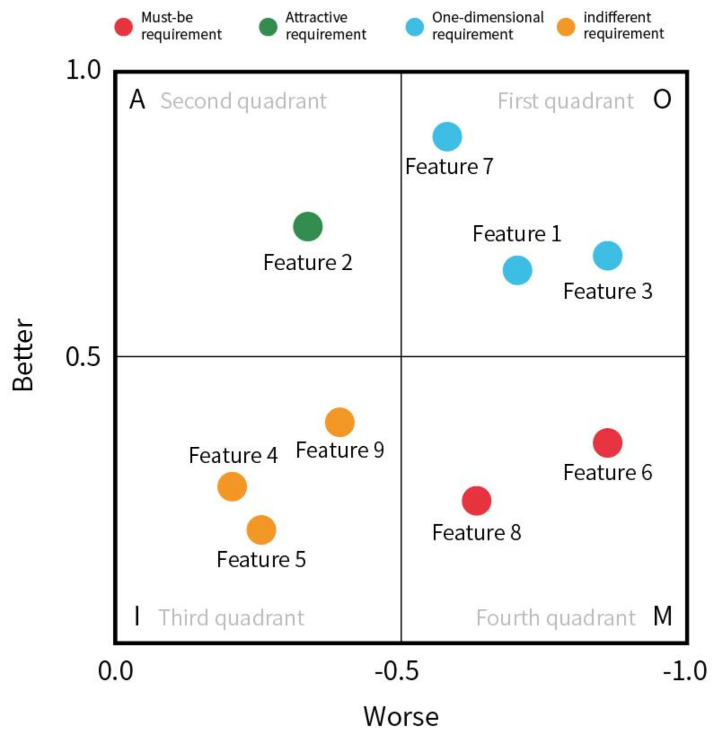


Figure 3.2 Kano model service function attribute classification diagram

The Kano survey results map consists of four quadrants, with the horizontal and vertical coordinates being Worse scores and Better scores, respectively. The four quadrants correspond to four functional attributes.

The first quadrant represents the functional characteristics of the One-dimensional Requirement. The quadrant has better Better scores and greater absolute values of Worse scores. The availability of this feature will affect the degree of satisfaction and dissatisfaction. dimensional Requirement scope.

The second quadrant represents the functional characteristics of the Attractive requirement. The quadrant has better Better scores and smaller absolute values of Worse scores. That is, providing this feature will quickly increase user satisfaction, and users who do not provide this feature will not be affected by it. Disappointment is within the scope of Attractive requirement.

The third quadrant represents the functional characteristics of Indifferent Requirement. The quadrant has better scores, and the absolute value of Worse scores is smaller. That is, whether the service features are provided will not affect the user 's satisfaction or dissatisfaction. Indifferent Requirement scope.

The fourth quadrant represents the functional characteristics of Must-be Requirement. The quadrant has better Better scores and a higher absolute value of Worse scores, which is contrary to the situation in the second quadrant. That is, providing this feature does not make users satisfied quickly. Not surprised by this, but not providing this feature will seriously affect user dissatisfaction, which belongs to the scope of Must-be Requirement.

According to the above analysis, after categorizing different functional attributes, it is possible to clearly obtain the degree of urgency of implementing different requirements, and to discuss the implementation order of the next service function.

The fourth quadrant is a feature of Must-be Requirement. It is the most basic user requirement. It will not give users a sense of surprise, but it will disappoint users if they are not provided. Therefore, for the implementers of the service function, the functional characteristics in the fourth quadrant should be provided first. The second is the One-dimensional Requirement in the first quadrant. Compared with the Attractive requirement in the second quadrant, the features that do not provide the One-dimensional Requirement will directly affect the user's dissatisfaction, and do not provide the features of the Attractive requirement, Users are not sensitive. Therefore, for service function implementers, after implementing the functional characteristics of Must-be Requirement, One-dimensional Requirement in the first quadrant that needs to be implemented, and with sufficient implementation conditions, then implement the Attractive in the second quadrant. requirement. The third quadrant belongs to Indifferent Requirement, which is at the end of the consideration in the satisfaction of user needs and the development of functional features.

3.2 Kano model application status

The Kano model has been developed for more than thirty years since it was proposed in the 1980s. Because it has a good guiding significance for the classification and optimization of product and service requirements, the Kano model is applied to all aspects of demand aggregation and optimization.

In terms of product design, WANG Shushan et al. (China, 2017) in the field of sports and health wearable smart product design, based on the study of user viscosity, establish their relevant models, and use the Kano model to analyze user needs in depth, and propose Design principles that help increase user stickiness. YU Zhiye et al. (China, 2017) also researched wearable smart products for the elderly based on the Kano model, conducted user needs through the Kano model, evaluated different categories and priorities of user needs, and provided necessary information for the final product design. Demand guidance. WANG Nan et al. (China, 2019) proposed a design idea for the elderly scooter design based on the Kano model. Through the implementation of the two-dimensional model of the Kano model, statistics and analysis are made on the mobility needs of the elderly, and the guiding principles for the design of the relevant scooters for the elderly are derived.

In the field of service design, the Kano model is also an important tool for measuring the quality of service functions. SUI Lihui et al. (China, 2014) introduced the Kano model as the main tool for the analysis of the service quality of chain coffee shops, and investigated the hygienic status, coffee taste, and user satisfaction of coffee shop service quality. Identify the main factors that influence the user's coffee shop experience. Wang Jingjun et al. (China, 2018) studied the influencing factors of user satisfaction of Internet medical services by introducing the Kano model as the basis of analysis, summarized and summarized the types of needs in Internet medical services, and proposed to improve the satisfaction of Internet medical users. Specific implementation measures. For user experience design, QI Xiaolei et al. (China,

2018) conducted research on supermarket shopping experience design by using Kano model and related tools. Summarize the general shopping process: generate shopping needs-before entering the supermarket-in the supermarket shopping-complete shopping, and in these four links, the "finding" action is the most frequent. Kano questionnaires and interviews were used to further verify the user needs of the above findings.

In summary, the Kano model has been used in many areas of design and has been recognized. Its efficient user requirements analysis function can accurately classify and sort user requirements, and is also a very important practical tool in the field of service design.

3.3 Advantages and feasibility of Kano model applied to the research of driverless vehicle service system

3.3.1 Advantages of Kano model applied to the research of driverless vehicle service system

The service design process generally includes finding pain points, defining requirements, designing solutions to requirements, and iterating on feedback. When the pain points are found and the corresponding user requirements are found, how to translate this demand into actual functions and services is a crucial step in the service design process. As an efficient model for analyzing demand, the Kano model can evaluate whether the functions and services meet the requirements that users want to achieve through user satisfaction.

Driverless vehicle technology has been gradually developed in the commercial and civilian fields in recent years, and research on driverless vehicle-related services started later. In the past one or two years, there have been substantial commercial operations for ordinary citizens. Driverless vehicle technologies in specific scenarios, such as research on driverless vehicle services in large residential areas, have not yet begun and are in the early stages of development. Therefore, the demand for driverless vehicles under slow transportation in large residential areas does not yet have a real user experience, and it is impossible to obtain relevant user needs through real case analysis. For the large-scale residential area driverless vehicle service at the concept stage, relevant models and tools and principles are needed to support its further development route. As an efficient demand analysis model, the Kano model has been verified in many design fields, and it can provide certain design guidance for large-scale residential area driverless vehicle services in the early research concept stage. In the design process of the driverless vehicle service in the slow-transportation environment of large residential areas, the introduction of this model can help to analyze the true value of the output service function and avoid the meaningless service content in the service design process.

3.3.2 Feasibility of applying Kano model to the research of driverless vehicle service system

It can be concluded from the above case analysis that the Kano model is not just a guiding principle, it has sufficient practical significance and is widely used in many product design and service design fields. Through the construction and analysis of the Kano model, design research can quickly obtain user needs and prioritize user needs, which is crucial for designers to plan and design further solutions. Since the research field of driverless vehicle services under slow transportation in large residential areas is relatively immature, it is very important to be able to mine real user needs through methods and tools in the service design process. The Kano model provides such a channel to help screen and optimize the demand for driverless services.

Secondly, the Kano model has highly implementable methods and tools, namely the Kano questionnaire, Kano survey evaluation form and Kano survey result map mentioned above. Through the perfect use process of the Kano model, at the level of user needs, it is possible to clearly output the effective demand for the driverless vehicle service of the slow transportation environment in large residential areas, and to obtain the related demand ranking.

3.4 Guide the 3D expansion of Kano models at the service level of driverless vehicles

The currently widely used Kano model can well sort out and optimize the demand for driverless vehicle services under slow transportation in large residential areas. Through user satisfaction surveys on service functions, it can be concluded that further adjustments and developments are needed. Functional characteristics, as well as the ordering of supply priorities that help designers to screen, summarize and summarize at the demand level.

Similarly, the Kano model, as a tool for demand analysis through user satisfaction, also has its limitations. The slow transportation service system based on driverless vehicles in a large residential area is a complex service network, which is composed of multiple sub-services with different functional characteristics. The role that the Kano model can provide is to obtain relevant user needs based on analysis, and help define the specific content of different sub-services, and to prioritize the supply of sub-services. The optimal combination of different sub-services cannot be further planned and adjusted by the Kano model.

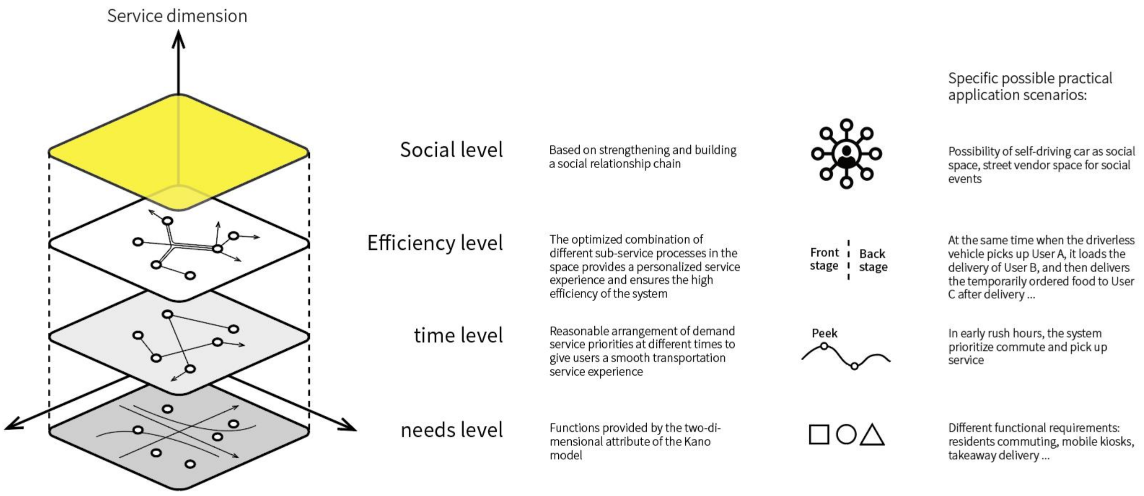


Figure 3.3 Three-dimensional expansion of the Kano model

Considering the limitations of the application of the Kano model, this paper proposes a further three-dimensional expansion model of the Kano model based on the Kano model and a study on the slow transportation service system based on driverless vehicles in large residential areas.
The three-dimensional expansion of the Kano model has four levels of guidance, as shown in Figure 3.3. The first level of guidance tool is the Kano basic model, which filters and sorts user needs in a two-dimensional mode. After the requirements of the first level are defined, the second and third levels are guidance for the time and efficiency levels, and integration and optimization are made through different dimensions of service functions. The last level is the group level, that is, in the context of slow transportation, in addition to the physical needs of residents, the relevant service functions are further designed for the spiritual needs of residents.

3.4.1 Requirements level: definition and selection of requirements

This level is the basic level requirements of users. The guiding principle is the Kano basic model. The specific guiding tools are the Kano questionnaire, Kano survey evaluation form, and Kano survey result map.

The definition of the requirements level is the most basic step in the service design process and it is crucial. In the process of designing driverless vehicle services for slow transportation in large residential areas, user needs are relatively blank compared to other more mature service design areas. There are not enough case supports in the market and exploration of helping user needs in this area. . Therefore, mining the demand level with the help of the Kano model is a very efficient step.

Based on the previous investigation and analysis, the pain points and demand points of slow transportation in large residential areas were discovered, and according to these investigation contents, the advantages of driverless vehicle transportation were used to design related service function characteristics. After making a list of features, use the Kano questionnaire to investigate their satisfaction one by one. Then perform statistical analysis of the data through the Kano survey evaluation form and Kano survey result map, and then present it through related visualization methods, get the prioritization of related functional characteristics, optimize the demand quality, and avoid meaningless service content at the demand level.

3.4.2 Time level: function priority optimization order

For slow transportation services in large residential areas, this article proposes to vehiclery out related transportation services based on the vehiclerier of driverless vehicles. As a transport vehiclerier, driverless vehicles can vehiclery a variety of sub-service functions. In the travel service, the travel time, travel time, and arrival time are important factors for positioning the travel service. Therefore, after deriving the content of the services that need to be provided, it is necessary to consider the arrangement of different time intervals of quantum services from the time level to ensure a good demand-supply relationship.

In the slow-transportation environment of large residential areas, residents' travel and other transportation needs are relatively regular and operate within a certain time path. For example, the time when commute demand is greatest is during morning work hours and afternoon work hours, and other times the demand for commute is relatively small. The highest demand for take-away delivery is at lunch, dinner and supper time. These are the peak times for take-away delivery. Therefore, in the case of limited driverless vehicle transportation resources, for the peak usage time of different sub-services, in the process of service design, it is necessary to make overall arrangements for the overall function and plan the service content to be provided at each time point. Ensure that the needs of residents can be met efficiently.

3.4.3 Level of efficiency: reorganization of services in space

After sorting and combining the slow transportation services in large residential areas at the time level, the priority relationship of different sub-services will inevitably appear at different points in time. As driverless vehicles are the main vehiclerier form in space, these services are not completely stripped of independence, they are not independent disjoint events. At the same time level of the space level, the driverless vehicle can optimize and reorganize the services, so that the sub-services in the space can be efficiently and orderly combined, and even generate further additional service value to improve the user experience.

For example, in a unified driverless vehicle space, manned services and vehiclego transportation services can be performed at the same time level, which can greatly improve the efficiency of driverless vehicle related services. Rather than allocating separate service functions to the driverless vehicle space, under the same destination path, integrating the functions in the same space collectively can make the driverless vehicle resources effectively used. For example, in the commute scenario, you can integrate the transportation of goods such as courier services, and vehiclery out courier delivery under a fixed path environment. Even when users commute home from work, they can pick up in the vehicle, which is more convenient to help users with multiple tasks at the same time, while improving service efficiency while avoiding waste of resources.

3.4.4 Social level: service enhances group value

The slow-transportation environment of a large residential area, as a daily living space for residents, not only vehicleries the transportation and daily needs of users, but also a social space for residents. The large residential area has a fairly large user group, with a scale of more than 30,000. The surrounding infrastructure construction makes it a residential area that can satisfy the daily life of residents. The social and social network between residents' neighborhoods is equivalent to the role of a lubricant, which can further optimize the construction of living systems in large residential areas. At present, although the number of large-scale residential areas in China is increasing, the material level has been greatly improved, but the social community structure of large-scale residential areas has not been improved by the social value of the group. The reason for this situation is that there is no physical physical contact between residents and no common travel path.

As a transportation vehiclerier, driverless vehicles have largely reorganized and optimized the travel paths and service paths of users, and also provided the possibility of new social platforms in residential areas to a certain extent. Therefore, in addition to providing transportation services in daily life, driverless space can also provide the possibility of higher-level social needs. For example, driverless vehicle space can provide space for the replacement of old objects, and can be used as a space for exchanges in buying and selling when building community markets. Driverless vehicles, as a link between social groups, can provide users with a better slow-transportation life experience to another extent.

CHAPTER 4 Design Practice

4.1 Investigation and Screening of Driverless Vehicle Service Contents Based on Kano Model

4.1.1 Determination of sub-service content

During the preliminary investigation in Chapter 2, the research was started from the slow transportation environment in a large residential area, and a detailed analysis was made on this particular slow transportation environment in a large residential area. Based on the analysis of the current status and problems of existing residential areas, the pain points of slow transportation services in large residential areas are summarized and summarized.

In Chapter 3, we study the realization of solving the pain points of slow transportation environment in large residential areas. Based on the analysis of the current state of driverless vehicle technology development and related explorations in the field of service design for driverless vehicle technology, the specific advantages of driverless vehicles to solve this pain point are proposed for the environment of large residential areas. User needs, and further research on the specific implementation of human-computer interaction in driverless vehicles.

After finding out the relevant problems and pain points, for the specific environment of the large residential area, determine the level of user needs such as commuting, vehiclego transportation, leisure and entertainment, and explore and sort out specific service content. Through the classification of different service entities, the driverless vehicle services are divided into three major categories: people, goods and pets. As shown in Figure 4.1.

The categories of people take into account the following categories of people: residents, visitors, security personnel, sanitation workers, and pedestrians. For residents, the following types of services are envisaged: commuting to and from work and transportation hubs; commuting and walking tools for the disabled in the community such as the elderly; emergency ambulances in the community; driverless vehicles as social vehicles for the party market; Temporary school bus services etc. Provide visitor guide service for visitors. Provide driverless patrol vehicle services for security personnel. Provide related vehicle instruction functions for pedestrians around, and some community affairs publicity.

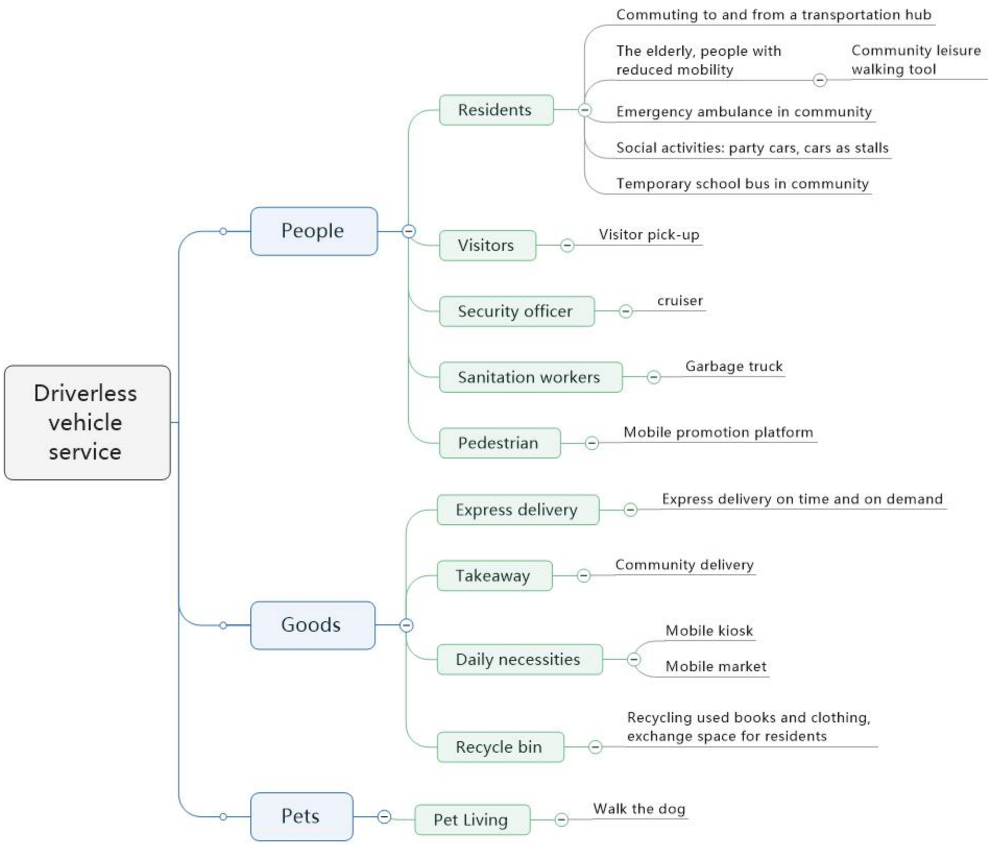


Figure 4.1 Classification of subservice content

The types of goods transported take into account the following categories: driverless vehicle delivery express; driverless vehicle delivery takeaway; driverless vehicle acting as a mobile convenience store role and a mobile vegetable market role; driverless vehicle acting as a residents' recycle bin, used books, old Exchange space for community residents of clothing.

For pets, when the owner does not have time to accompany the vehicle, can the driverless vehicle provide relevant vehicleing services?

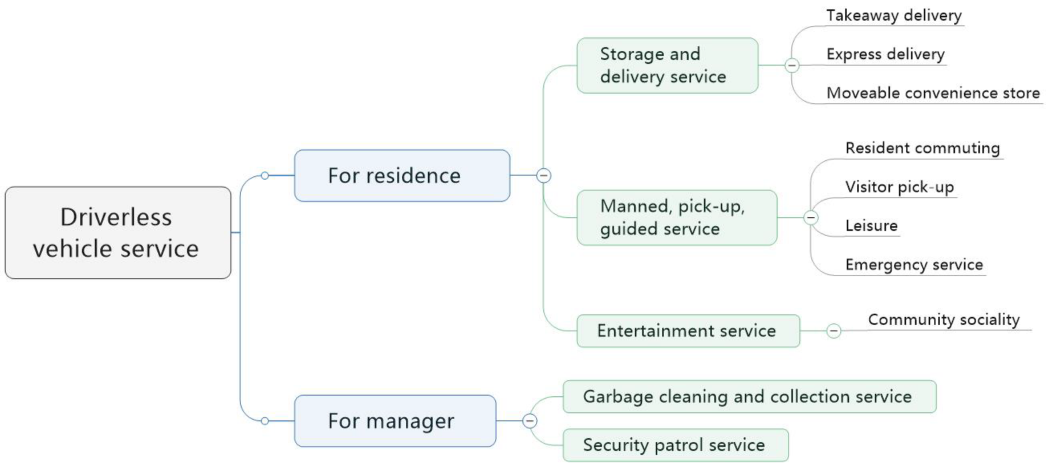


Figure 4.2 Service Function List

Regarding the driverless vehicle services under slow transportation in the large residential areas mentioned above, vehiclery out further reorganization and planning, eliminate unsuitable service categories, etc., and integrate some overly detailed service categories into reasonable service categories. For example, for the consideration of pet living services, under the current relevant policies and regulations, pets' activities in public spaces have strict regulations and require human accompaniment. Therefore, the pet bending service for driverless vehicles will not be considered for the time being, and the service will be eliminated. Relevant school bus services are merged with residents' commuting services, and comprehensive consideration is given to residents' out-of-office services during peak hours in the morning and evening to improve the efficiency of service integration and improve residents' travel quality. Further integrate the function of the recycle bin with the social needs of residents.

After further integration of the initial requirements, the following list of service functions is obtained, as shown in Figure 4.2. The related driverless vehicle services are divided into two categories, which are targeted at two major stakeholders, residents of large residential areas and managers of large residential areas.

For residents of large residential areas, including three major service categories, storage delivery services, crewing, transfer, guidance services, and entertainment services.

The storage delivery service includes three specific sub-services: takeaway delivery, express delivery, and mobile kiosks.

Takeaway delivery service: Takeaway personnel are unfamiliar with the community environment and use driverless vehicles instead of takeaway personnel to accurately deliver takeaways in the community, while also strengthening the management of outsiders.

Express delivery service: Users have time to pick up courier at home or other convenient time periods, and make reservations for driverless vehicles to deliver courier to reduce the waste of human resources.

Mobile convenience kiosks: In some emergency situations, driverless vehicles deliver some medical supplies, such as band-aids; delivery of daily necessities, such as suddenly finding that the seasoning is not enough during the cooking process, quickly making appointments for seasonings, etc., to provide users with sufficient life convenience.

Manned, transfer, and guided services include five specific sub-services: resident commuting, visitor pick-up, leisure crouching, emergency services, and interactive information display services.

Residents' commuting services: In the morning and evening rush hours, driverless vehicles serve as commuter vehicles, completing the user's transportation and passenger services between transportation hubs and user residences.

Visitor pick-up service: For visitors to the community, driverless vehicles provide pick-up and drop-off services to avoid unnecessary wayfinding; for visitors arriving by vehicle, driverless vehicles guide in front of the vehicle to help vehicles find parking spaces faster. Solve the problem that first-time visitors are unfamiliar with the new environment and avoid unnecessary trouble.

Leisure bend service: During off-peak hours, driverless vehicles serve as leisure mobility tools to help residents with reduced mobility, such as the elderly and people with disabilities, to slow down in the residential area to meet some of the spiritual needs of users.

First aid service: In the case of a fire or medical emergency in the community, driverless vehicles guide fire trucks or ambulances to find rescue points faster, and transfer patients when necessary. Solve the problem that the fire truck or ambulance is unfamiliar with the road conditions in the community, and the road is narrow or unobstructed.

Information interactive display service: There is a corresponding information display platform on the outside surface of the driverless vehicle, and information publicity and communication with pedestrians are used as an auxiliary platform for community information publicity.

The entertainment service refers to the sub-service of group socialization. The driverless vehicle is used as a social space to participate in social activities of the community, such as the exchange of old things, the form of party vehicles, and the booths in some community fairs. Trolley effect.

For the managers of large residential areas, there are two main services: garbage collection service and security patrol service.

Garbage cleaning and collection service: Driverless vehicles are used as a means of transportation for sanitation workers in the community. They are also equipped with a cleaning module and a garbage collection module, which can be cleaned autonomously on the road, and can collect fixed-point garbage independently at night.

Security patrol service: Security personnel's patrol route is generally relatively fixed. On this basis, driverless vehicles vehiclery security personnel or empty load, vehiclery related patrol monitoring equipment, access the security system of large residential areas, and conduct fixed-point patrols in the community an examination.

After sorting out and integrating, they are summarized into the above eleven sub-services. For these eleven sub-services, the Kano model is used to rank related satisfaction surveys.

4.1.2 Determination of sub-service supply priorities

Through the implementation of the two-dimensional model of the Kano model, that is, using the Kano questionnaire, the Kano survey evaluation form, and the Kano survey result map, etc., the eleven sub-service contents are further analyzed.

The author surveyed and counted 118 community residents through a questionnaire. In the first part of the questionnaire, the relevant basic questions are investigated. There were 60 men and 58 women in this survey. The age group is mainly distributed between the ages of 18 and 25, and the other age groups are also distributed, as shown in Figure 4.3.

The main occupations are students and office workers. The proportion of students accounts for 31.36%, and the proportion of corporate office workers and freelancers accounts for 27.97%, as shown in Figure 4.4. For these residents, there will be relatively strong commuting needs. Commuting services are the types of services that large residential areas need to provide.

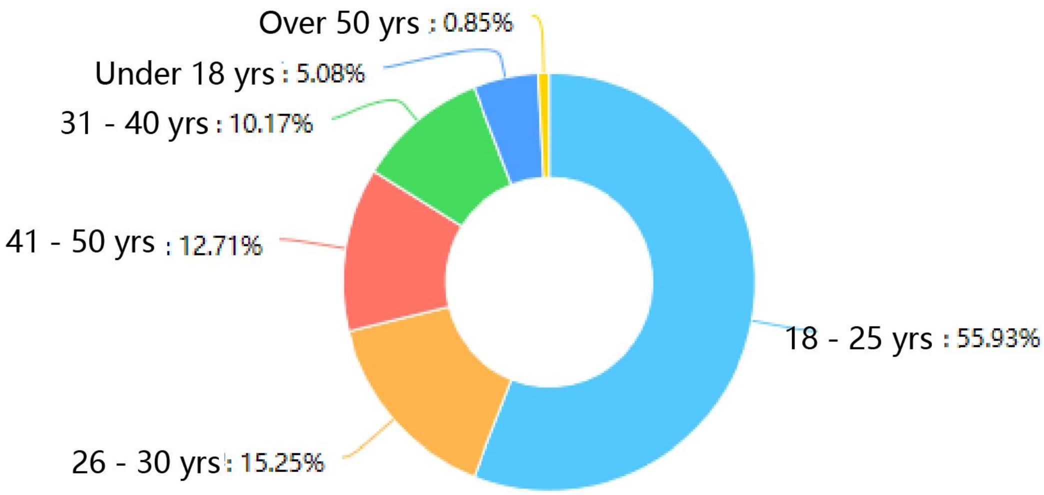


Figure 4.3　Statistics of the age distribution of the questionnaire

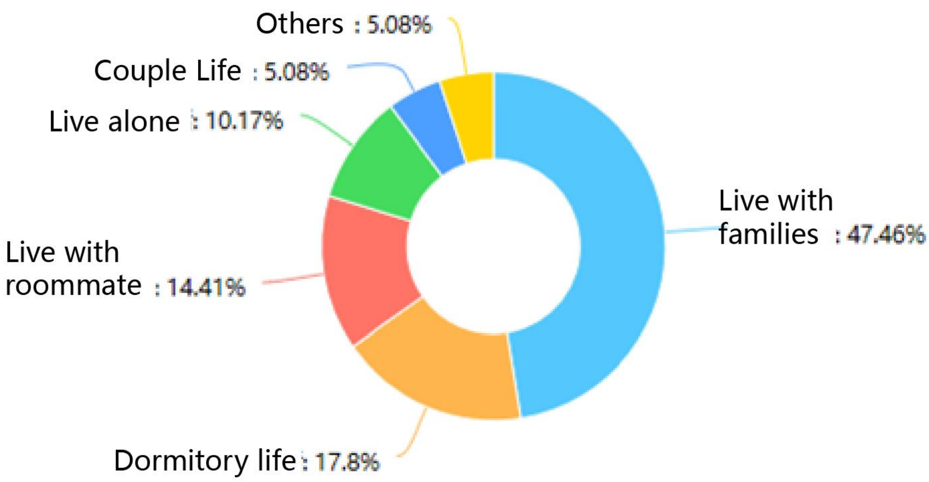


Figure 4.4　Survey of occupational categories in the questionnaire

The survey found that the living types of people living in residential areas are also relatively concentrated, mainly family life, accounting for 47.46%, and the rest are school dormitory living and shared living, each accounting for 17.8% and 14.41%, as shown in Figure 4.5. It can be seen that almost half of the residents in the residential area use family life as a unit, and the demand for family-related services accounts for the majority, such as the needs of elderly family members, the need for mobile convenience kiosks, and so on. The survey found that 69.64% of the residents live with their parents, 44.64% of

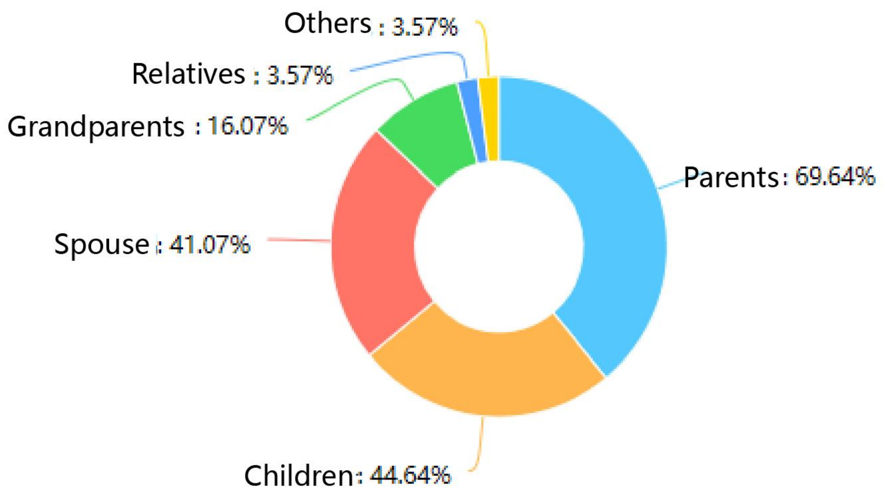


Figure 4.5 Statistics of residence types in the questionnaire

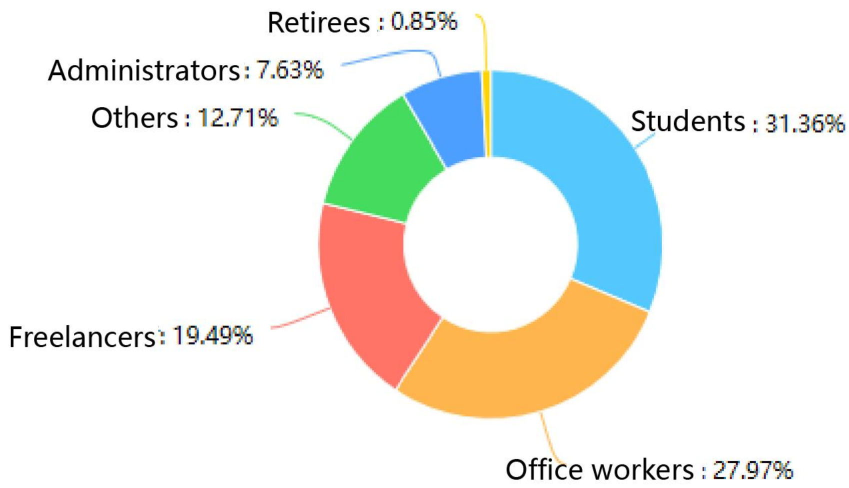


Figure 4.6 Survey of cohabitant types in the questionnaire

the residents have children, and 41.07% of the residents live with their spouses, as shown in Figure 4.6. Therefore, the proportion of middle-aged parents' demand for related services is also large.

On the question of the degree of understanding of the concepts related to driverless vehicles, the questionnaire set five levels of different levels of understanding, namely completely unknown, heard but not very clear, understanding the concept of driverless vehicles, and proactively understanding I have passed this concept and I am looking forward to it. I am very interested and understand it. I hope to experience it as soon as possible. Survey result

As shown in Figure 4.7, 43.22% of the respondents only heard about the concept of driverless vehicles, they were not very clear, and relatively few residents knew relatively little. Therefore, it can be predicted that during the demand investigation process of the Kano model, it can be said that almost no residents have experienced the driverless vehicle service, and relatively speaking, there may be less demand for being classified as a required attribute.

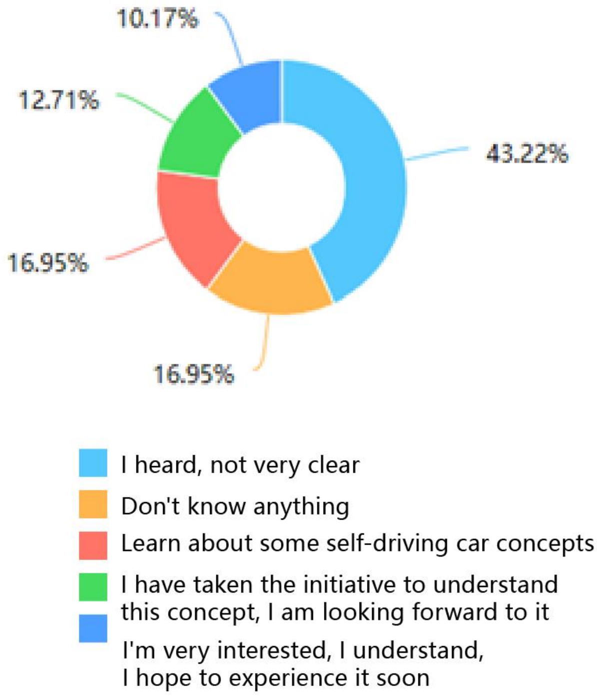


Figure 4.7 Statistics on the concept of driverless vehicles in the questionnaire

In the second part of the survey, a Kano demand model was introduced to allow the interviewees to evaluate the satisfaction of the selected eleven sub-service contents. The survey results are shown in Figures 4.8 - 4.10 below.

第二部分 Kano问卷

Second Part Kano questionnaire

Kano模型认为，产品功能的满足与用户满意不一定正相关，即产品提供某功能，用户不一定满意，不提供该功能，用户不一定不满意。针对大型居住区内可能的无人车服务的每一个功能，提出正向和反向两个问题，了解你对提供与不提供该功能的感受或态度。

The Kano model believes that the satisfaction of product functions is not necessarily positively related to user satisfaction, that is, the product provides a function, the user is not necessarily satisfied, and if the function is not provided, the user is not necessarily dissatisfied. For each function of the possible self-driving car service in a large residential area, ask two questions, forward and reverse, to understand your feelings or attitudes about providing or not providing the function.

本部分共提出11个可能的无人车服务，共有11道矩阵单选题。

This section proposes a total of 11 possible driverless services, with a total of 11 matrix multiple choice questions.

* **11. 外卖递送：外卖人员不熟悉小区环境，无人车代替外卖人员在小区内精准递送外卖，同时也强化了外来人员管理**

Food delivery: Takeaway personnel are unfamiliar with the community environment, and driverless vehicles instead of takeaway personnel accurately deliver takeaways in the community, while also strengthening the management of outsides.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

* **12. 快递递送：用户在家有空取快递的时间段，通过预约无人车上门递送快递快递递送：用户在家有空取快递的时间段，通过预约无人车上门递送快递**

Express delivery: When the user has time to pick up the courier at home, he can deliver the courier by booking driverless vehicle service.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

* **13. 移动便利亭：在一些紧急情况下，无人车递送一些医疗用品，如创可贴；生活用品，如做饭过程中突然发现调料不够，快速预约调料上门移动便利亭：在一些紧急情况下，无人车递送一些医疗用品，如创可贴；生活用品，如做饭过程中突然发现调料不够，快速预约调料上门**

Mobile convenience store: In some emergency situations, driverless vehicles deliver some medical supplies, such as band-aids; daily necessities, such as when you suddenly find that the seasoning is not enough during the cooking process, quickly make an appointment

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

Figure 4.8 Statistics of Kano questionnaire survey Figure 1

* 14. 居民通勤：无人车在早晚高峰时期，充当通勤车的作用，在交通枢纽和住处之间完成用户的运输服务居民通勤：无人车在早晚高峰时期，充当通勤车的作用，在交通枢纽和住处之间完成用户的运输服务
Residents commuting: During the morning and evening rush hours, the driverless vehicle acts as a commuter vehicle, completing the user's transportation service between the transportation hub and the residence.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

* 15. 接送访客：对到访小区的访客，无人车提供接送到家服务，避免访客不必要的寻路；对开车到达的访客，无人车在车前引导，帮助车辆更快寻找到停车位接送访客：对到访小区的访客，无人车提供接送到家服务，避免访客不必要的寻路；对开车到达的访客，无人车在车前引导，帮助车辆更快寻找到停车位
Pick-up and drop-off: For visitors to the community, self-driving cars provide pick-up and drop-off services to avoid unnecessary wayfinding; for visitors arriving by car, self-driving cars guide in front of the car to help vehicles find parking spaces faster

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

* 16. 急救服务：在小区内如发生火灾或医疗急救情况，无人车引导消防车或救护车更快寻找到救援点，以及接送病人等急救服务：在小区内如发生火灾或医疗急救情况，无人车引导消防车或救护车更快寻找到救援点，以及接送病人等
First aid service: If a fire or medical emergency occurs in the community, the driverless vehicle guides the fire truck or ambulance to find the rescue point faster, and transfers the patient, etc.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

* 17. 休闲遛弯：在非高峰用车时段，无人车充当休闲代步工具，帮助行动不便的居民，如老人、残障人士，在居住区内慢行休闲遛弯
Leisure walk: During off-peak hours, driverless vehicles serve as leisure mobility tools, helping residents with reduced mobility, such as the elderly and people with disabilities, to slowly walk around the area.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

Figure 4.9 Statistics of Kano questionnaire survey Figure 2

*18. 安保巡逻：在固定巡视路线的基础上，无人车运载安保人员或空载，在小区内安保巡逻：在固定巡视路线的基础上，无人车运载安保人员或空载，在小区内进行巡逻检查
Driverless vehicles carry security personnel or empty load, and conduct patrol inspections in the community.进行巡逻检查

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

*19. 垃圾清扫收集：无人车作为小区内环卫工人的运输工具，同时装备清扫模块，在路上可以自主清扫，在深夜可以自主收集定点垃圾
Trash cleaning and collection: driverless vehicles are used as a means of transportation for sanitation workers in the community. At the same time, they are equipped with a cleaning module, which can be cleaned on the road independently, and can collect fixed-point garbage at night.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

*20. 信息交互展示：无人车车体外表面有相应的信息展示平台，与行人进行信息宣传和交流等
Information interactive display: There is a corresponding information display platform on the outer surface of the driverless vehicle, and information publicity and communication with pedestrians, etc.

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

*21. 群体活动：无人车本身作为一个社交空间，参与到社区的社交活动中，比如作为旧物交换空间、派对小车的形式
Group activities: The driverless vehicle is used as a social space to participate in the social activities of the community, such as the space for old things exchange and the form of a party car

	不喜欢 Dislike	可以忍受 Live with	无所谓 Don't care	理所当然 Expect it	喜欢 Like it
提供该服务 Feature present	○	○	○	○	○
不提供该服务 Feature absent	○	○	○	○	○

Figure 4.10 Statistics of Kano questionnaire survey Figure 3

After passing the data collection of the Kano survey questionnaire, statistical analysis was performed on the data to obtain the corresponding Kano survey evaluation form for each sub-service. A total of 11 statistical forms corresponding to the service functions were generated. The specific form data is shown in the appendix, and some statistical forms are shown in the following table. 4.1-4.3.

Table 4.1 Kano survey and evaluation form for delivery service

Food Delivery		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	12	6	23	14	7
	Expect it	0	3	7	4	2
	Don't care	0	2	15	1	2
	live with	0	0	6	5	1
	dislike	1	1	0	0	4

Table 4.2 Kano survey and evaluation form for mobile kiosk service

moveable convenience store		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	2	27	19	13
	Expect it	2	4	6	2	1
	Don't care	1	1	12	2	0
	live with	0	0	2	6	0
	dislike	0	0	0	0	2

Table 4.3 Kano Survey Evaluation Form for Commuting Services

Commuting service		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	0	23	15	10
	Expect it	2	4	9	3	1
	Don't care	0	2	12	5	0
	live with	0	1	1	8	1
	dislike	0	2	1	0	2

After further integration of 11 statistical tables, a unified data statistical table is obtained, and the Better-worse coefficient of each sub-service is calculated according to the relevant calculation model in Chapter 4. The specific statistical data is shown in Figure 4.11 . M, O, A, I, R, and Q represent different functional requirements attributes, that is, required attributes, expected attributes, charm attributes, indifference attributes, reverse attributes, and problem attribute requirements. In the calculation process, neither the reverse attribute nor the problem attribute requirements are considered. Finally, the Better-worse coefficients of the sub-services are counted and displayed using the Kano survey results graph. The eleven services are classified according to different service attributes. The Kano survey results graph is shown in Table 4.4 and Figure 4.11.

Table 4.4 Kano survey results of driverless vehicle service

Service	M	O	A	I	R	Q	Worse	Better	Total
Food Delivery	5	12	46	35	4	16	−0.1735	0.5918	118
Express Delivery	1	13	41	44	4	15	−0.1414	0.5455	118
Movable Convenience Store	1	13	48	35	3	18	−0.1443	0.6289	118
Residents Comuniting	2	14	46	33	5	18	−0.1684	0.6316	118
Visitors Pick-up	3	11	41	40	4	19	−0.1474	0.5474	118
Emergency Service	3	24	34	33	3	21	−0.2872	0.6170	118
Leisure Walk	3	11	40	43	1	20	−0.1443	0.5258	118
Security Patrol	3	7	38	49	2	19	−0.1031	0.4639	118
Trash Cleaning & Collecting	3	12	48	30	3	22	−0.1613	0.6452	118
Info Display & Interaction	4	7	31	53	7	16	−0.1158	0.4000	118
Social Activity	2	8	35	49	7	17	−0.1064	0.4574	118

The relevant attribute classifications obtained in the Kano survey results graph are as follows:

(1) Must-be requirement. There is no demand for mandatory attributes. The predicted survey results are consistent with the actual survey status, that is, the driverless vehicle service is currently in its infancy, and there is no real user experience or optimization of driverless vehicle services. It is suggested that in the user's perception, no service content will be considered as a required attribute.

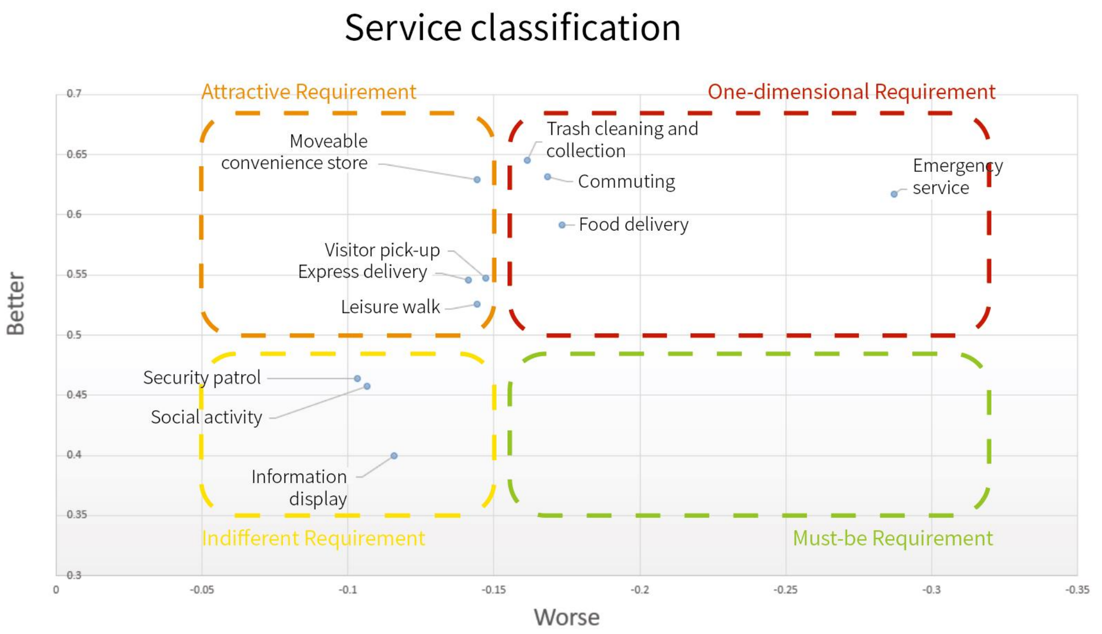


Figure 4.11 Classification of service attributes

(2) One-dimensional requirement. There are four service contents in the statistical results, which are emergency services, garbage collection services, commuting services, and takeaway delivery services. The absolute value of Worse for emergency services is larger than that of the other three sub-services. The absolute value of Worse for garbage cleaning and collection services, commuting services, and takeaway services is about 0.16, and the absolute value of Worse for emergency services is about 0.28, indicating that users believe that it is not For emergency services, users will be very disappointed, and the disappointment will be relatively greater.

(3) Attractive requirement, statistical results include mobile kiosk services, visitor pick-up and drop-off services, courier delivery services, and leisure bend services.

(4) Indifferent requirement, There are three sub-services in the statistical results, including security patrol, group activities, and interactive information display functions.

In summary, after screening the Kano model for eleven service functions, the above priorities are obtained, and then they are adjusted in an orderly manner based on the actual situation of the survey.

Prioritize the service functions in the desired attributes, including emergency services, garbage collection services, commute services, and takeaway delivery services. These services cover the service needs that users expect. During the previous survey and analysis, it was found that in large residential areas, commuting services are an obvious pain point for residents to go out. Due to the huge mass of the large residential area itself and the large number of residents' out-going needs, transportation needs such as commuting in the large residential area are urgently to be met. Secondly, because large-scale residential areas are currently stricter in the management of outsiders, the maturity of services such as takeaway delivery in the relevant communities is not very high. Delivery personnel are also likely to be unnecessary because they are not familiar with the terrain and road conditions in the community. Time is wasted, so takeaway delivery services can also be further enhanced by means of driverless transportation. The types of security services are relatively special. Although user needs cannot be distributed regularly, they should be proactively provided if necessary. Therefore, as a special service, residents have a strong expectation for such services, and safety as the most basic need of life must be met.

In the category of attractive requirement, it includes mobile kiosk services, visitor pick-up and drop-off services, express delivery services, and leisure bend services. These services can provide users with surprises and surprises, but not providing them will not disappoint users. Takeaway delivery service and express delivery service are the same delivery service but they have different attributes. The reasons are analyzed. First, compared to express delivery, takeaway is more time-efficient, hot food delivery time constraints are tighter, and the delivery time requirements are relatively high. Users generally expect their needs to be met in a short time. Secondly, in some communities, there have been independent self-contained containers in China, such as Hive Box, Jinlinbao and other brands. Although these pick-up points still require users to pick up goods at nearby pick-up points by themselves, home services cannot be achieved, but the current implementation has allowed users to complete more convenient pick-ups, while takeaway delivery still requires manual services, and the service is subject to The possibility of interference is greater. Therefore, improving the efficiency of takeaway delivery services can quickly increase user satisfaction, while reducing it will make users feel disappointed, which belongs to the category of desired attributes. Relatively speaking, the express delivery service is a bonus service. Based on the original self-delivery of express delivery, the efficiency and user experience of the express delivery service are further improved, and home delivery is made without occupying excessive human resources. Therefore, further improving the efficiency of express delivery services can surprise users, but it will not disappoint users. In the process of service adjustment, consider the integration of takeaway delivery and express delivery services, but in the priority of delivery services, takeaway delivery will be higher than express delivery.

Within the scope of indifferent requirement, including security patrols, group activities and pedestrian information interaction. Users believe that the availability of this type of service will not have a significant impact on user satisfaction. Analyzing the reasons, security patrol is a property service, and it is difficult for users to see the effect of the service from the outside. Therefore, users do not attach much importance to security patrol services. Group activities belong to higher-level community activities, and strengthen the community relations in large residential areas through the medium of driverless vehicles. As users of this type of services cannot obtain substantial material access, and residents are gradually diminishing their neighbourhood relations, residents do not have too many expectations for this type of social services. For information interaction services, it is a relatively fragmented combination of functions, that is, information interaction with pedestrians for different purposes, including safety notification of pedestrians around vehicles, and related information publicity in the community. Users do not have a very Intuitive recognition. After comprehensive consideration, the security patrol service is retained, and the possibility of the later development of the group activity function is reserved. The information interaction service is divided into different functions, and reorganized into different services to supplement and enhance the functions.

The adjusted service list is shown in Figure 4.12 below, which contains 9 sub-services.

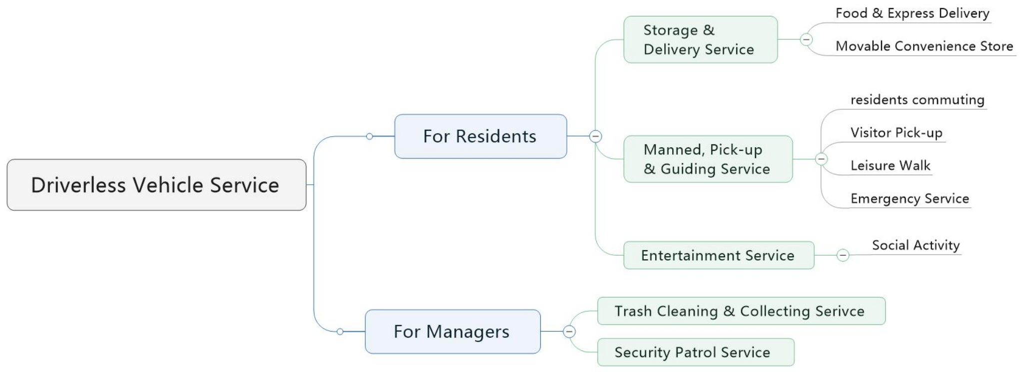


Figure 4.12 Service list

Resident-oriented sub-service types include storage delivery services, crewing, transfer, guidance services, and entertainment services. The sub-services of the storage delivery service are adjusted to takeaway express delivery service and mobile kiosk service. Sub-services for crewing, transfer, and guidance services include resident commuting, visitor pick-up, recreational crouching, and emergency services. Entertainment services include group social services reserved for later development.

Sub-services for managers include garbage collection services and security patrol services.

4.2 Construction of driverless vehicle service system for slow transportation environment in large residential areas

4.2.1 Framework of driverless vehicle service system

There are nine driverless vehicle-related sub-services in the slow-transportation environment driverless vehicle service system in large residential areas. The supply map of the service system is shown in Figure 4.13. The functional supply categories of the service system are mainly five: personnel transportation, vehiclego transportation, vehicle guidance, garbage collection and offline social networking. These five specific service functions cover the above nine driverless vehicle-related sub-services.

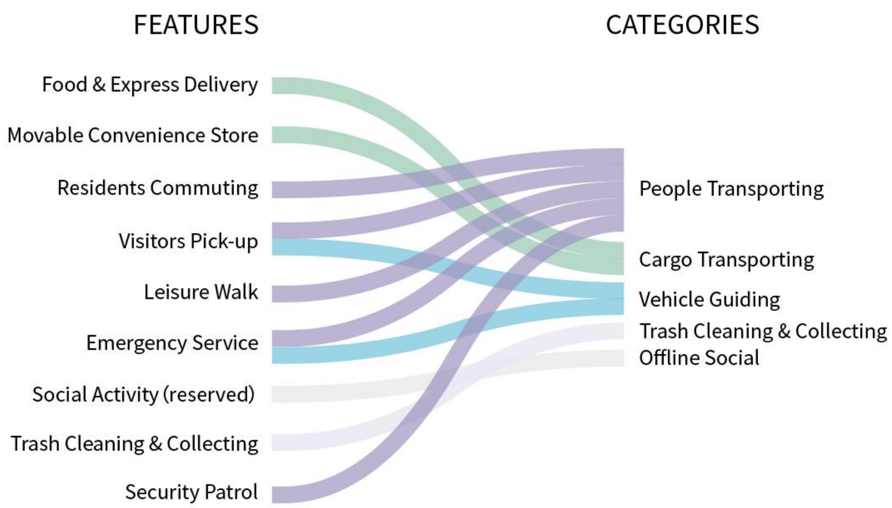


Figure 4.13 Service offering Map

People transporting function, there are five sub-services to provide this function, including resident commuting service, transportation of residents to commute and short-distance services to and from school; visitor pick-up service, pick-up and drop-off of visitors in the community; leisure crooking service, providing walking leisure for people with reduced mobility Travel assistance services; first aid services, transporting patients, family members and medical personnel in emergency situations; security patrol services, vehiclerying security personnel for related inspection activities.

Vehiclego transportating function, there are two sub-services to provide this function, including takeaway express delivery service and mobile convenience kiosk service. Takeaway express delivery services, takeaway and express delivery of goods according to user needs and habits, effective delivery;

mobile convenience kiosk service, serving as a temporary convenience store function in large residential areas, to provide users with necessary daily necessities in some emergency situations.

Vehicle guidance function, two sub-services provide this function, including visitor pick-up service and first aid service. Visitor pick-up service, orderly guide the visitor's vehicle, so that the visitor's vehicle can follow the vehicle in a slow transportation environment; emergency services, after the ambulance enters the community, efficiently guide it, and let the ambulance follow the vehicle Arrived smoothly to the rescue site.

The garbage cleaning and collection function is mainly provided by the garbage cleaning and collection service, that is, after the relevant cleaning and collection modules are installed in the driverless vehicle, autonomously complete the garbage cleaning and collection tasks in the community.

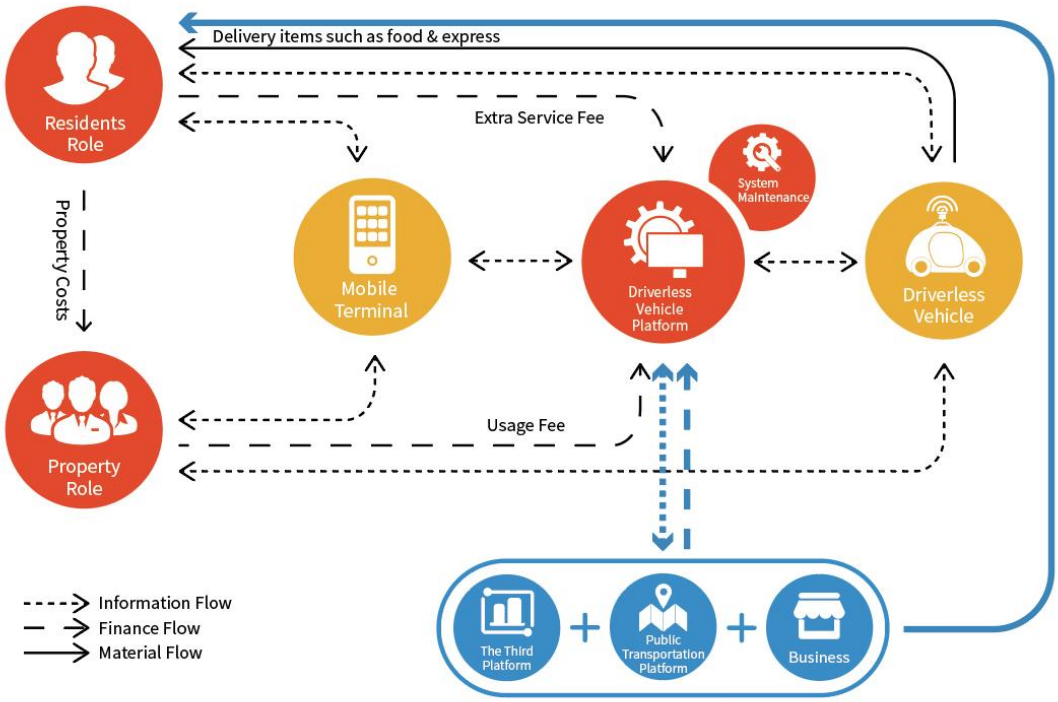


Figure 4.14 Service system map

Offline social functions, mainly provided by group social services, will use driverless vehicles as social media and social space. This service is a prereserved service and does not focus on development.

Figure 4.14 shows the framework of the driverless vehicle service system under slow transportation in a large residential area.

The system map mainly includes five stakeholders and related important platforms, which are resident role, property role, mobile terminal, driverless vehicle platform and driverless vehicle. There are three types of resource flow display in the system map, which are information flow, capital flow and material flow.

The distribution of information flow is the most frequent. Residents or property managers interact with mobile terminals to complete the input and output of information and match the corresponding service needs. The mobile terminal then interacts with the driverless vehicle platform for information, needs to further integrate and feedback, and finally reaches the driverless vehicle end to communicate instructions. During the interactive service process of related people and vehicles, such as security patrol services for property managers or commuter services for residents, driverless vehicles and property managers and residents will have corresponding information interaction processes to generate information. Flow of flow.

In this service system, the occurrence of material flow is rare, and it only occurs in some specific driverless vehicle service processes, such as delivery of goods such as take-out and express delivery. The ultimate purpose of users in such services is to obtain relevant goods. Therefore, the flow of resources that occurs is generally the material flow of driverless vehicles to related users.

There are a total of three capital flows, which are the residents 'capital flows to the property, that is, the relevant property fees paid by the residents to the property; the residents' capital flows to the mobile terminal, that is, some bonus services, users may need to provide additional costs; The flow of funds to the driverless vehicle platform, that is, the development costs paid by the property to the driverless vehicle platform.

4.2.2 Driverless vehicle service framework and content

This article describes the framework and content of the nine sub-services of the driverless vehicle service. For detailed blueprint description and user journey map description.

(1) Emergency services

That is, in large residential areas, when medical emergencies occur, related auxiliary first aid services are provided through driverless vehicles, including ambulance guidance services in large residential areas and services for transporting patients, family members and medical personnel under special circumstances. Considering the particularity and professionalism of emergency services, driverless vehicles are routinely used as functional transportation vehicles. In principle, they do not actively participate in or provide transportation services for patients, family members, and medical personnel. They only provide ambulance guidance in the community. service. Under special circumstances, such as poor emergency access, driverless vehicles temporarily provide related personnel transportation services.

The specific service process is shown in Figure 4.15 User Journey Map, which mainly displays user behaviors / requirements, touch points, and corresponding driverless vehicle behaviors through time flow lines.

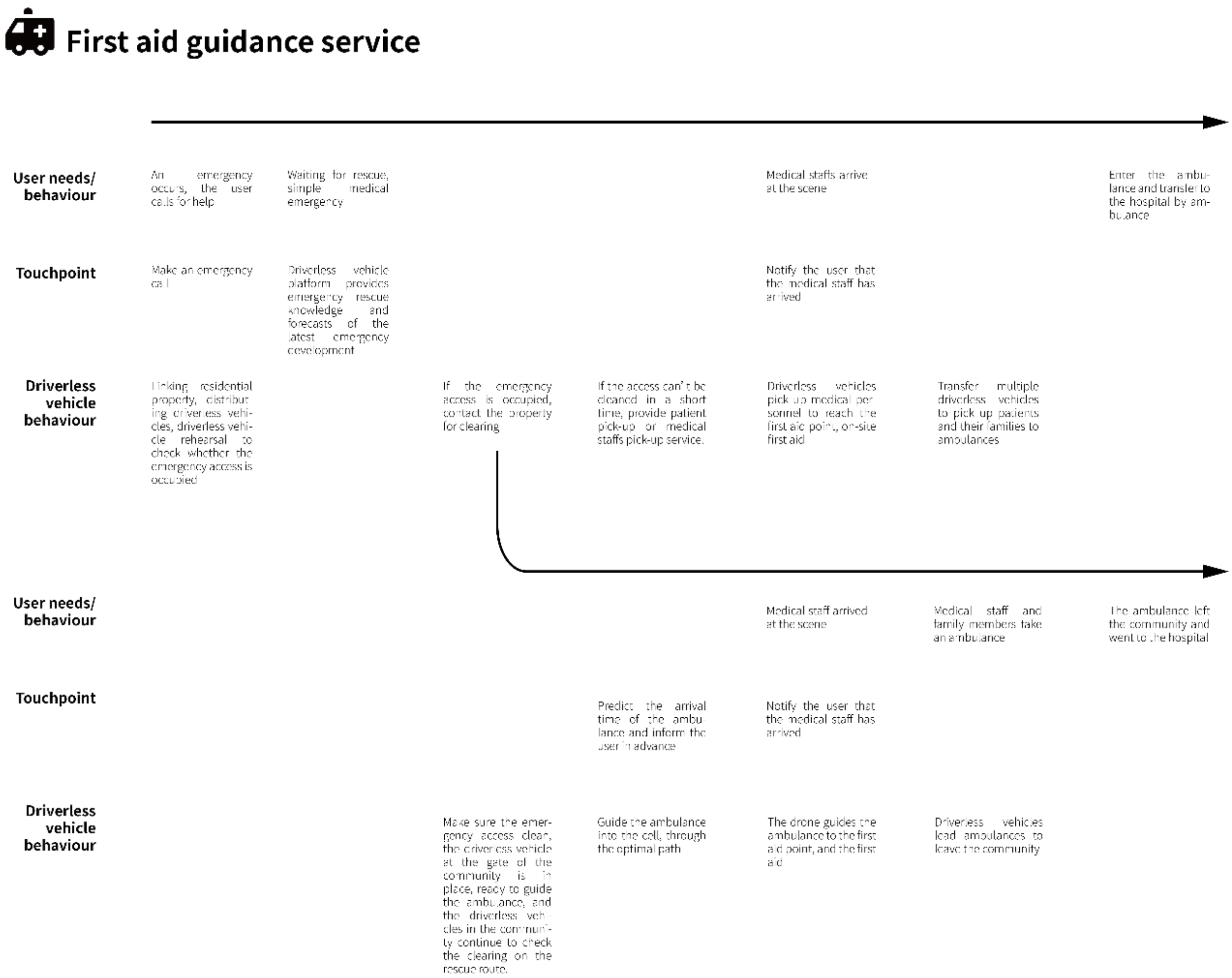


Figure 4.15　User journey map of emergency guidance service

Specific information is as follows:

When an emergency occurs, the user calls for help, dials an emergency number to contact the ambulance to come to the rescue. This information is also linked to the residential property, and the location information of the resident is instantly known to calculate the optimal ambulance pick-up channel. And assigned driverless vehicles, driverless vehicles began to vehiclery out rescue previews on this path, and check whether the emergency passage is smooth, and whether the ambulance can reach smoothly in the subsequent rescue process. Thereafter, the driverless vehicle platform uses user terminals, such as mobile phone platforms, to provide the most direct way to communicate information such as voice and pictures, provide users with emergency rescue common sense, and timely forecast the latest rescue developments.

During the investigation of the driverless vehicle, if it is found that the emergency rescue channel is occupied, such as temporary road parking, etc., contact the relevant personnel such as the property to clear the road. Whether the emergency passage can be ensured in a short period of time will determine whether the driverless vehicle chooses to only provide ambulance guidance services or provide personnel transportation services for related personnel.

1) If the emergency rescue passage is smooth or the passage can be cleared in a short period of time, the driverless vehicle only provides the guidance of the ambulance to play the role of assisting rescue, without additional use. The driverless vehicle platform further allocates relevant driverless vehicles to wait at the entrances and exits of the community, and is ready to respond to ambulances to perform guidance services, while the first-aid channels in the community still ensure that driverless vehicles are relevant to clear and clear roads to avoid new interference .

The driverless vehicle platform predicts the arrival time of the ambulance at the same time, and is ready to inform the user in advance. After the ambulance arrived in the community, it was guided by the driverless vehicle to reach the first aid point through the optimal path. The medical staff went out to the rescue and the user terminal notified the user that the medical staff had arrived and was ready. After the related rescue, the medical staff and related families took the ambulance with the patient, and also left the community under the safe and rapid guidance of the driverless vehicle. The driverless vehicle has thus completed the relevant first aid guidance service. The driverless vehicle platform continuously tracks the subsequent rescue information and provides possible follow-up assistance.

2) If the emergency rescue channel cannot restore the smooth flow of the ambulance in a short time, a smaller and more flexible driverless vehicle will provide relevant medical personnel, patients and family members with short-distance transportation services in the community. The driverless vehicle platform allocates relevant driverless vehicles to wait at driverless vehicles at the community entrance and exit, and is ready to accept ambulances to perform guidance services.

The driverless vehicle platform predicts the arrival time of the ambulance at the same time, and is ready to inform the user in advance. After the ambulance arrived in the community, it was guided by an driverless vehicle through the optimal path to the closest point where it can pass to the rescue point. At this time, driverless vehicles were used for the remaining distance of transportation, vehiclerying medical personnel and related medical emergency equipment to the rescue point. The medical staff went out to the rescue and the user terminal notified the user that the medical staff had arrived and was ready. In the implementation of related rescue processes, due to the small space of driverless vehicles, in addition to medical staff on the return journey, they also need to vehiclery patients and their families. The driverless vehicle platform will continue to allocate the remaining driverless vehicles and wait for docking. After the related rescue, the medical staff and related family members took multiple driverless vehicles with the patient to reach the previous ambulance parking point. The driverless vehicle and the ambulance vehicleried out the handover, and also left the community under the guidance of the driverless vehicle. The driverless vehicle has thus completed the relevant first aid guidance service. The driverless vehicle platform continuously tracks the subsequent rescue information and provides possible follow-up assistance.

The related service blueprint of emergency services is shown in Figure 4.16.

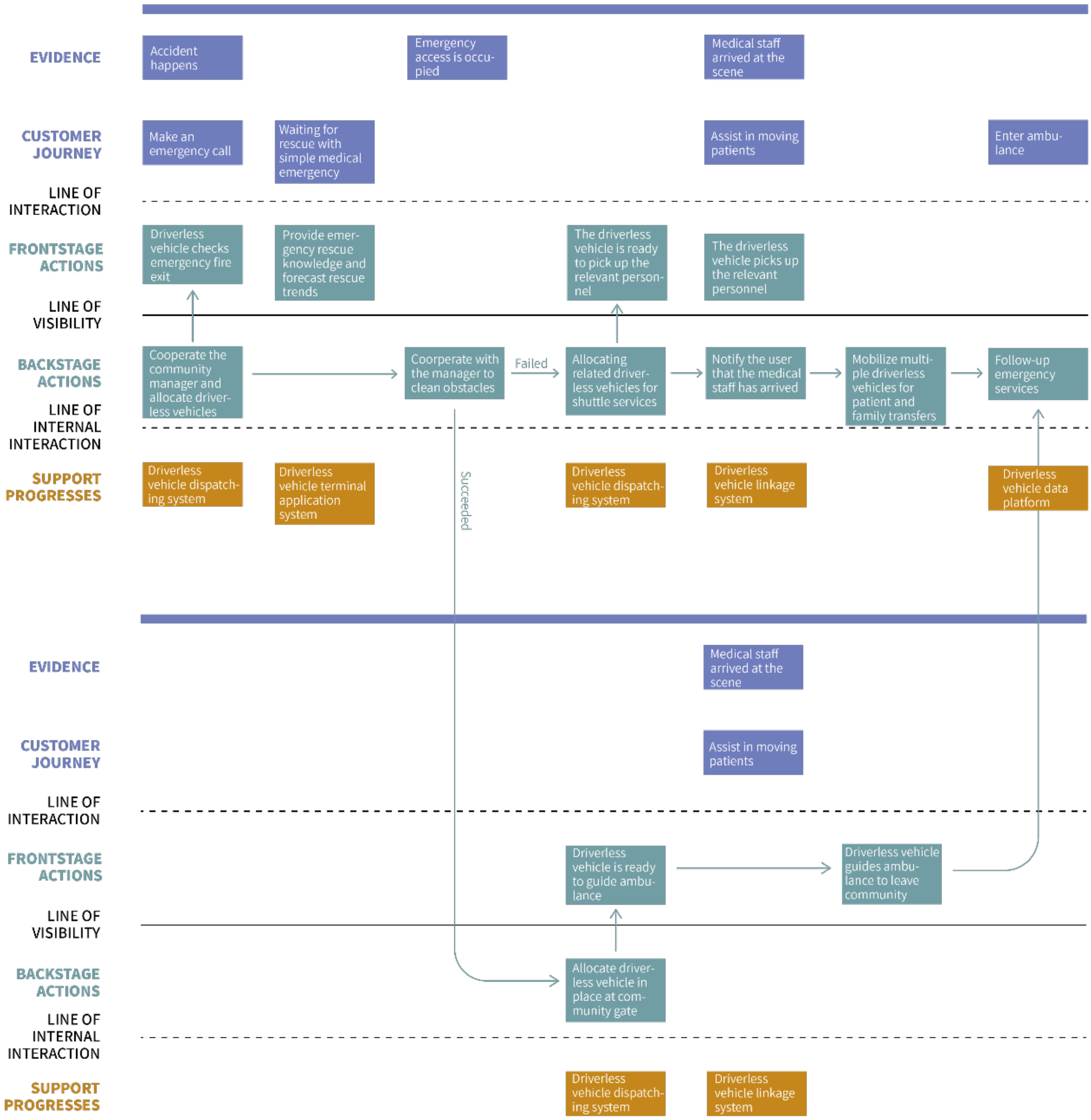


Figure 4.16 Blueprint for first aid guidance services

The service blueprint systematically combs the sub-service framework and content from the tangible display at the top level, to user behavior, driverless and front-end behavior, background behavior, to underlying technical support.

The tangible display, user behavior, and driverless and front-end behavior are similar to the content of the user journey map above. The logic that runs through the whole picture is mainly the background behavior, that is, the driverless vehicle platform links the residential property to conduct road investigation, assigns driverless vehicle for investigation task, and further informs the property to clear the road. If the clearance is successful, the relevant driverless vehicles will be allocated at the entrance of the community, waiting for the arrival of the ambulance, and guiding the ambulance to the rescue point. After the rescue is finished, the ambulance will be guided to leave the community. The driverless vehicle platform will further track and record the follow-up emergency services to improve the background data. If the weak road is unsuccessful, the relevant driverless vehicles will be allocated for the pick-up service. After the rescue, multiple driverless vehicles will be used to pick up the patients and their families, and transfer to the ambulance. Improve background data.

At the technical support level, it includes driverless vehicle dispatching systems, driverless vehicle terminal application systems, and driverless vehicles and multi-platform linkage systems, that is, driverless vehicles and property departments, as well as emergency response platforms, and large-scale autonomous vehicles Data platform to build a complete service database.

(2) Takeaway Express Delivery Service

That is to say, in large residential areas, through driverless vehicle delivery, we provide residents with takeaway and courier delivery services, replacing manual delivery and users' own pick-up at delivery points, reducing unnecessary waste of human resources. In the previous link analysis, in ordering the priority of delivery and express delivery, taking into account the different timeliness of different meals and express delivery, on the premise of ensuring efficiency, takeaway delivery priority is higher than express delivery. This article describes mainly takeaway delivery services.

The user journey diagram of takeaway delivery is shown in Figure 4.17. The specific process is as follows:

Figure 4.17 User journey of takeaway delivery

When the user generates a demand for takeaway, he starts using the takeaway platform for ordering. After the order is completed, the user makes a reservation for the food delivery service in the residential area, and imports the third-party takeaway order information into the driverless vehicle reservation platform with one click. The technical support for this process is that the third-party takeaway platform and the driverless vehicle platform have good data sharing cooperation, which can ensure that the driverless vehicle platform information interface can match the third-party resources. After importing the information, the driverless vehicle platform identifies the user's relevant information, address, and arrival time, etc., and assigns available driverless vehicles, the estimated delivery time provided by the third-party takeaway platform, and arranges the time to wait in advance.

After the courier arrives at the entrance of the community, he will transfer the food to a driverless vehicle, and the driver will identify the courier. As the delivery staff may deliver multiple takeaways at a time, different takeaways are stored in different storage rooms, and the driverless vehicle platform records the corresponding storage room information. When the driverless vehicle arrives at the user's residence, the driverless vehicle platform notifies the user to take meals. When the user goes downstairs to pick up the meal, the driverless vehicle will identify the user and automatically open the corresponding dining room. The user checks the meal and confirms the receipt, and the user completes the meal retrieval process.

The related service blueprint of takeaway delivery service is shown in Figure 4.18.

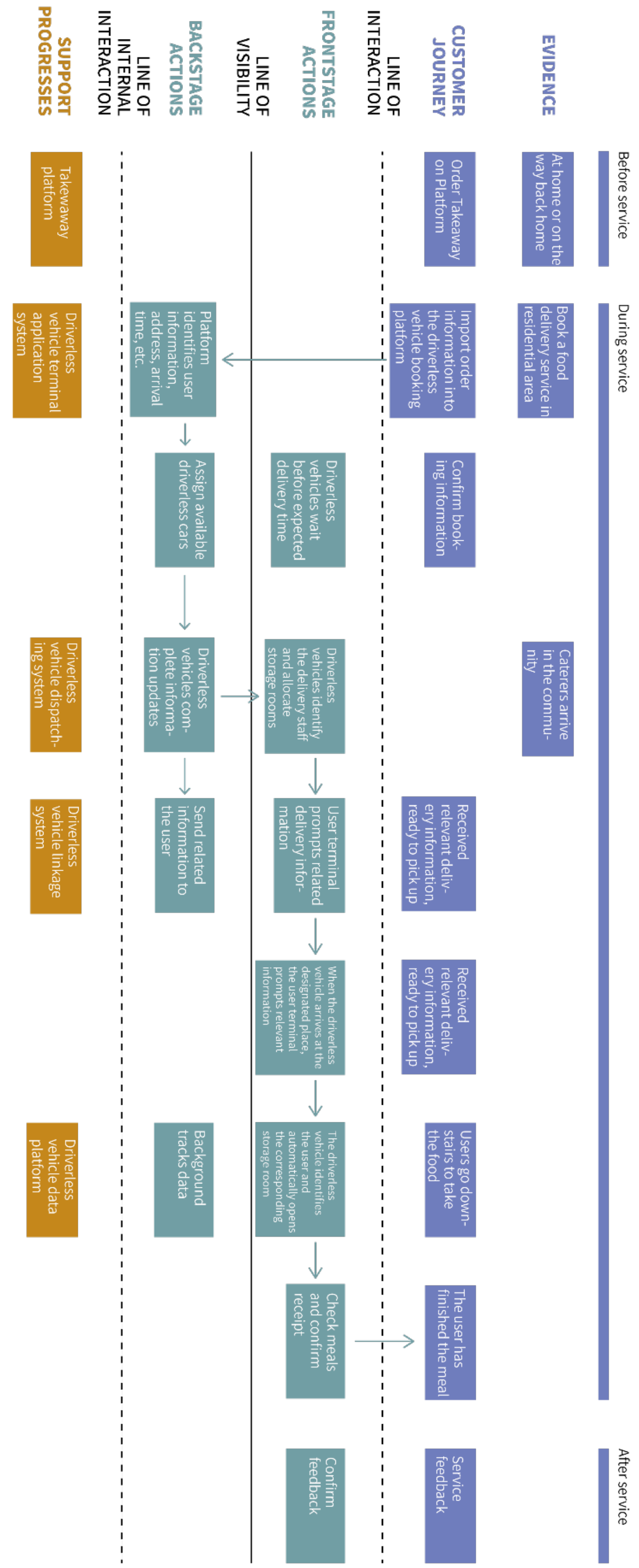


Figure 4.18 Blueprint of takeaway delivery service

The related service blueprint of the takeaway service is also described from the top-level tangible display part, to user behavior, driverless vehicle and front-end behavior, background behavior, and final technical support. The general service process is similar to the user journey diagram, which mainly shows the background operation Complete logic flow.

User behavior is used as a starting point, and the orders booked on the third-party platform are imported into the driverless vehicle reservation platform, and the background reaction is started. Relevant driverless vehicle platforms identify user-related information, and assign driverless vehicles to be responsible for delivery, and monitor the delivery progress of third-party takeaway platforms. After the delivery person arrives, the driverless vehicle completes the information update in the background, including identifying the delivery person's identity, meal information, and assigning a storage room to store meals. The user terminal also receives the delivery information of the driverless vehicle platform at the same time, and performs real-time forecasting for the user. After the driverless vehicle arrives at the designated delivery place, the relevant pickup information is sent to the user through the driverless vehicle platform, and the user performs identity identification, picks up the goods, and completes the logical process of the entire service.

The overall service process of the courier service is similar. The biggest difference is that after the courier arrives, users can schedule different pickup times according to their own time. The driverless vehicle platform learns through long-term user habits. When there is a need for express delivery, it will also actively recommend users to get used to the express time period. For users, express delivery does not need to be obtained in a timely manner, and related express delivery services will be adjusted efficiently based on this feature.

(3) Commuting service

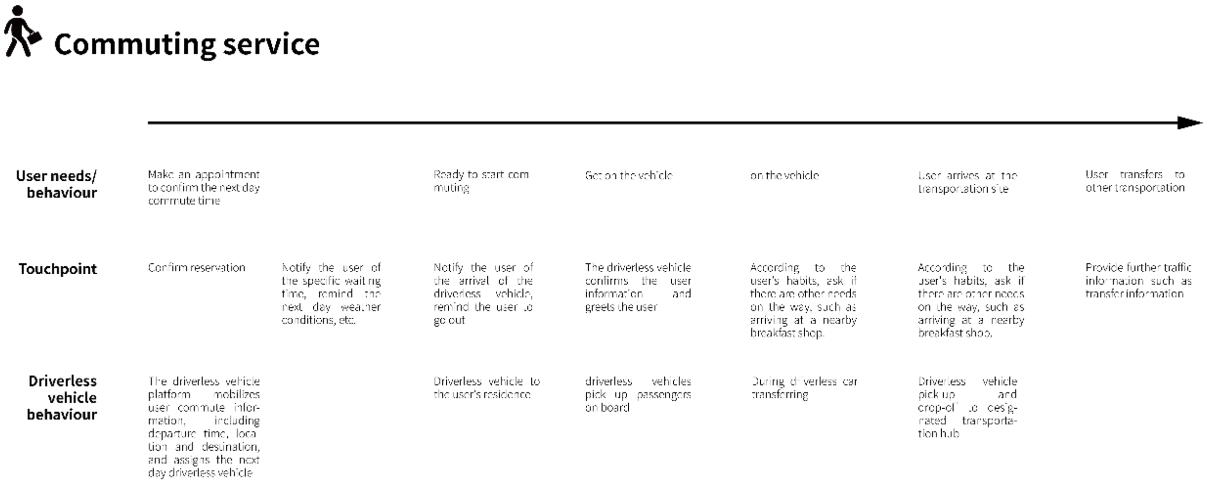


Figure 4.19 Commuter Service User Journey

Commuting service, that is, to provide residents with driverless vehicles during their daily commute and school hours. The commuting section is a transportation hub between the residential areas in the large community and the outside community, which plays a connecting role, connecting the residential areas in the slow transportation environment with the nearby transportation hub, and solving the "last mile" problem.

The commuting service user journey diagram is shown in Figure 4.19. The specific process is as follows:

The user makes an online reservation before commuting service is needed to confirm the commute time required. After confirming the appointment, the driverless vehicle platform mobilizes the user's commute information, including departure time, place, and destination, etc., and assigns driverless vehicles for the reserved time period.

The driverless vehicle platform through the analysis of big data, including the user's daily commuting habits and commuting needs, will also actively recommend the user's corresponding commuting arrangements, and actively provide users with other relevant travel information, including travel weather conditions, etc.

When the scheduled commute period is about to be reached, the user terminal notifies the user of the arrival of the driverless vehicle and reminds the user to go out. After the driverless vehicle arrives at the designated pick-up point, the driverless vehicle confirms the user information and greets the user. During the ride, driverless vehicles are used to analyze the travel habits of users, such as asking if there are other needs on the way, such as buying breakfast at a nearby breakfast shop. After the driverless vehicle arrives at the designated transportation station, the user gets off the vehicle and transfers to another mode of transportation to continue commuting. The driverless vehicle bids farewell to the user. After the service is over, the user's front end will further confirm to the user whether he needs to take off work and other services. By learning the user's habits, he will actively plan the trip for the user.

The service blueprint for the commute service is shown in Figure 4.20.

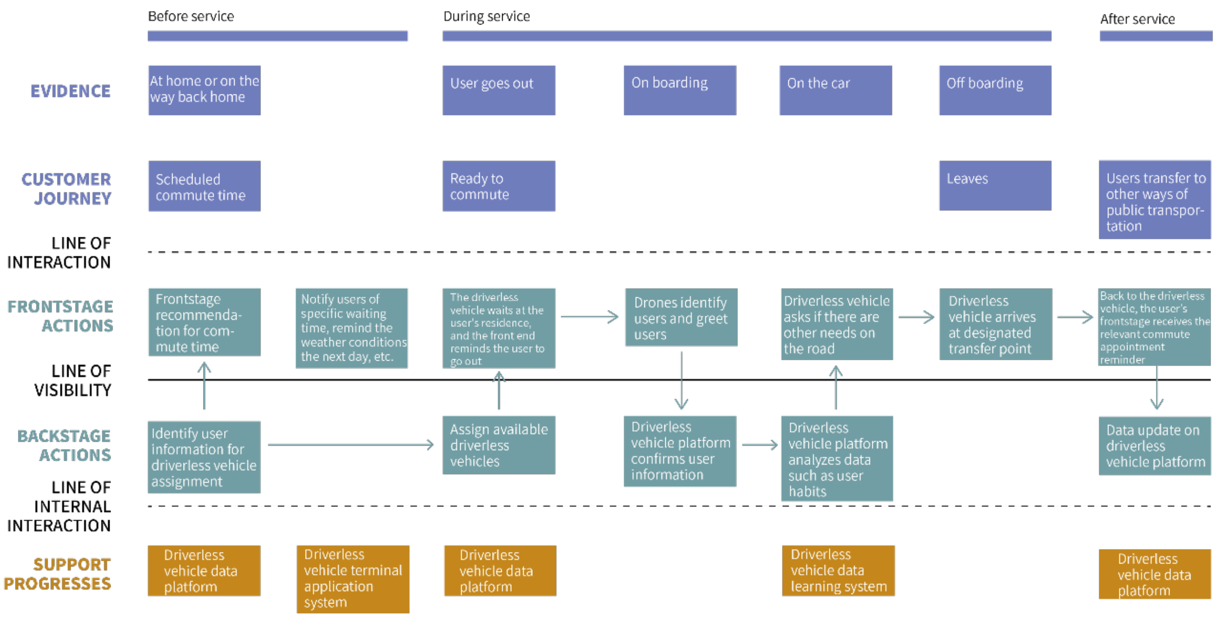


Figure 4.20 Blueprint of Commuting Services

The service blueprint also covers the user experience process of the user journey map, which mainly shows the background logic behind the user service. The background logic is as follows: After the user reserves the commute travel service, the driverless vehicle platform recognizes the user's identity information and proactively recommends the appropriate travel time according to the recorded user habits. Before traveling, the driverless vehicle platform will remind users to go out. During the ride, the driverless vehicle first identifies the user's identity, confirms it in the background, and greets the user actively, analyzes the user's daily travel habits and other needs on the road, and recommends it to the user. After arriving at the designated transportation interchange point, the user gets off the bus, the driverless vehicle bids farewell to him, and recommends the user's return time from work or class, asks whether the shuttle service is still needed, etc., and plans a comprehensive daily travel schedule for the user.

(4) Garbage cleaning and collection service

This service is a property service and replaces the community operations of some sanitation personnel by means of driverless vehicles. Due to the large area of large residential areas, the use of driverless vehicles can largely replace higher cost human resources. The garbage cleaning and collection service mainly includes two operations, garbage cleaning and garbage collection, which requires driverless vehicles to perform additional cleaning and a combination of collection modules. The next section of this article will specifically introduce the design of relevant vehicle body modules.

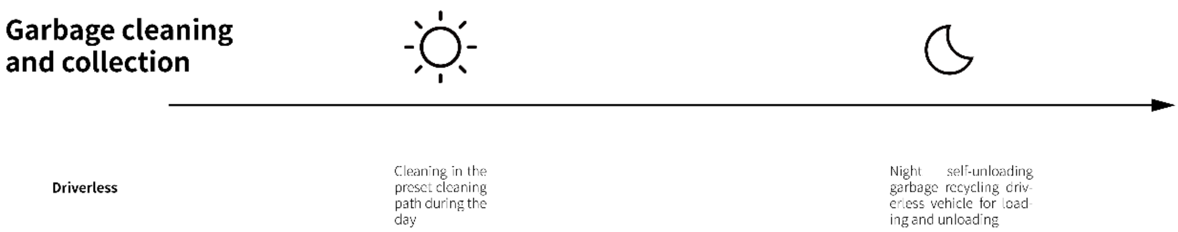


Figure 4.21 Flow chart of garbage collection service

As a property service, this service has a high degree of autonomy, without the participation of relevant users, and only shows simple time function blocks.

During the daytime period, the cleaning drone performs autonomous cleaning on a preset path by installing a related cleaning module. At night time, there is less demand for driverless vehicle services for residents, and driverless vehicles undertake more property services. At night, self-dumping garbage-collecting driverless vehicles are used to load and unload garbage at designated garbage collection points below the residents.

Make full use of driverless vehicle resources to replace human resources. Driverless vehicles are different from humans and do not require rest time. Therefore, in daily situations, driverless vehicles serve the needs of related residents and other users for more time periods. When there is less relevant demand at night, idle driverless vehicles can be mobilized to perform property services such as garbage collection.

The above four services that belong to the attractive requirement need to be developed and provided first. Under the one dimensional requirement, three sub-service contents that belong to the attractive requirement need to be considered, namely mobile convenience kiosk, visitor pick-up service and leisure bending service. This article will briefly explain the three sub-service contents.

(1) Mobile convenience kiosk

Mobile kiosk services, that is, mobile convenience stores in large residential areas, are vehicleried in the form of driverless vehicles. Mobile convenience kiosks provide residents with all kinds of emergency convenience products, including medical emergency supplies such as band-aid bandages, kitchen condiments, etc. Kiosks will provide services in the community, so once users have such needs, mobile kiosks can provide relevant help to users in a timely manner.
This service is similar to a takeaway express delivery service, which is a freight service, but except for the replenishment process of the mobile convenience kiosk itself, the service does not have a functional process for handing over to

the community. Its main service content occurs between the mobile convenience kiosk and the user.

The specific process is as follows: when the user generates a demand for related emergency supplies, the user terminal is used to order the items. After the order is completed, the driverless vehicle platform receives the relevant requirements and informs the mobile kiosks serving in the community to go to the designated user location to provide the item. After arriving, the user is notified to go downstairs to pick up the goods. The driverless vehicle also uses the method of user information identification to open the corresponding storage room for the user and the user completes the pickup. After the driverless vehicle confirms the successful pickup, the data is fed back to the driverless vehicle platform for statistical analysis, which further improves the product list of emergency goods that users most often purchase, and improves service information.

(2) Visitor pick-up service

That is, using a driverless vehicle to pick up or drop off visitors, or guide the parking of visitors 'vehicles, instead of the current need for the host to pick up passengers, or visitors to find their own way in the community based on the address, to avoid some unfamiliar road conditions. Unnecessary trouble.

Visitor pick-up and drop-off service mainly includes two possible pick-up and drop-off forms, which are divided into passenger-vehiclerying and pick-up service from driverless vehicle to visitor and guided service from driverless vehicle to guest vehicle. The specific service process is as follows:

Driverless passenger transfer service to visitors: When a visitor visits the residents of the residential area by walking, the visited residents can make passenger reservations in the driverless vehicle terminal in advance, enter user information, and visit time periods. Information, the driverless vehicle platform will make the relevant allocation of driverless vehicles according to this demand. When the visitor arrives at the community entrance, the driverless vehicle will identify it. After the respondent confirms the visitor's identity, the driverless vehicle will vehiclery the visitor to the designated visiting place. Respondents responded to the visitor, and the driverless shuttle service was completed. The driverless vehicle platform will further provide a return service for recommending visitors. Users can also make a return appointment before the visitor leaves by themselves, and the driverless vehicle will pick up and return the visitor.

Guidance service of driverless vehicle to visitor vehicle: When a visitor comes by driverless, the visited residents can make a passenger reservation in the driverless vehicle terminal in advance, enter the visitor information such as the user's vehicle information and the visiting time period. , The driverless vehicle platform will make the relevant allocation of driverless vehicles according to this demand. When the visiting vehicle arrives at the entrance of the community, the driverless vehicle platform confirms the identity of the vehicle. After the confirmation, the driverless vehicle guides it to the nearest parking space at the visitor point, records the parking space information for it, and sends it to the visitor and the interviewee. The terminal facilitates its location, and then reminds the respondent to reserve a return trip service in advance. When visitors leave, they also leave the community smoothly with the guidance of a driverless vehicle.

(3) Leisure walk service

This service is a long-term passenger service, that is, a driverless vehicle is used as a means of travel to help some people with reduced mobility to leisurely bend in the community. It is a recreational service.

There are well-equipped landscape leisure areas in large residential areas, so the service presets multiple leisure paths for residents to choose from. Residents can also personalize their definitions according to their hobbies and needs.

The specific service process is as follows: The user uses the terminal device to make an online reservation for the leisure bending service. The online can choose the path planned by the system, or make a personalized road plan to complete the relevant appointment. After arriving at the appointment time, the driverless person will take a slow tour in the slow transportation environment, and at the same time, possible human-computer interaction with the user, including greeting the user, asking the user for their needs, mobilizing the user's previous tour records through big data, and learning The user is accustomed to recommend a nearby drop-off leisure spot for the user. Users can also interact with driverless vehicles according to their own needs and choose the location where they want to get off the bus and relax. During this process, the user maintains good communication and interaction with the driverless vehicle. After the tour, transfer the user back.

Finally, there are two service activities that need to be considered, including security patrol services and group social services reserved for later periods.

(1) Security patrol service

That is to say, to vehiclery out security patrols in large residential areas in the form of driverless vehicles vehiclerying people or air vehicles instead of existing security patrol vehicles. Compared with the existing security patrol vehicles, driverless vehicles have better unified controllability, can better patrol on the system's preset path, and can achieve uninterrupted and efficient operations 24 hours a day, avoiding manual operations. The resulting instability in patrol efficiency.

The property system and the driverless vehicle platform work together to formulate appropriate regular inspection routes, and arrange security personnel to vehiclery on-board or no-load operations according to the actual situation. The driverless vehicles used for security patrol services will be equipped with security patrol modules, including surveillance cameras, patrol lights, etc., according to the actual situation.

The specific service process of the security patrol service is as follows: during the preset patrol time, the driverless vehicle performs patrol services, the driverless vehicle platform and the security system are linked, and in an emergency, the security platform is urgently contacted to take action and pass the driverless vehicle On-site shouting and so on. During the patrol of the vehiclerying situation, after the driverless vehicle identified the security personnel, it vehicleried the security personnel for the patrol. The drone and the security personnel conduct human-computer interaction to confirm the information. When there is an unexpected situation, control the driverless vehicle by using commands such as voice to take action on the spot.

(2) Group social services

This service is a group social service, that is, a driverless vehicle is used as a mobile social space in a large residential area, and participates in different forms of social activities, including possible forms such as old things exchange space, booths in community fairs, and so on. In the driverless vehicle service system constructed in this article, this service is only used as a reserved service in the early stage of development, and it will be developed at a higher level when the later stage of the driverless vehicle service development technology is more mature.

4.2.3 Driverless vehicle concept design

Aiming at the service framework of the service system of slow transportation driverless vehicles in large residential areas, this paper proposes a suitable conceptual design of driverless vehicle bodies to meet the corresponding service needs.

In the process of designing the body of the driverless vehicle, the author considered the following main design principles:

(1) The size of the driverless vehicle is shown in Figures 4.22 and 4.23. Large residential areas, as densely populated residential areas, have narrower transportation roads than urban roads, and are narrow roads with slow

transportation. Therefore, in the design and consideration process of the vehicle body, the smaller form of vehicle is adopted as much as possible. The dimensions are shown in Figure 666. The maximum body length is controlled within 2500mm, the vehicle height is about 1600mm, and the vehicle width is 1600mm Within, keep the space scale of small delivery vehicles.

(2) The appearance of driverless vehicles. As a brand-new service content, driverless vehicle service has a low acceptance of citizens at the beginning of implementation, and there must be a certain degree of fear and anxiety. During the questionnaire survey in this article, it was also found that most residents are still unaware of driverless vehicle technology. Especially for this type of travel issues that involve safety, residents are still skeptical of their safety.

Appearance and styling is an important factor to alleviate the tension of users.

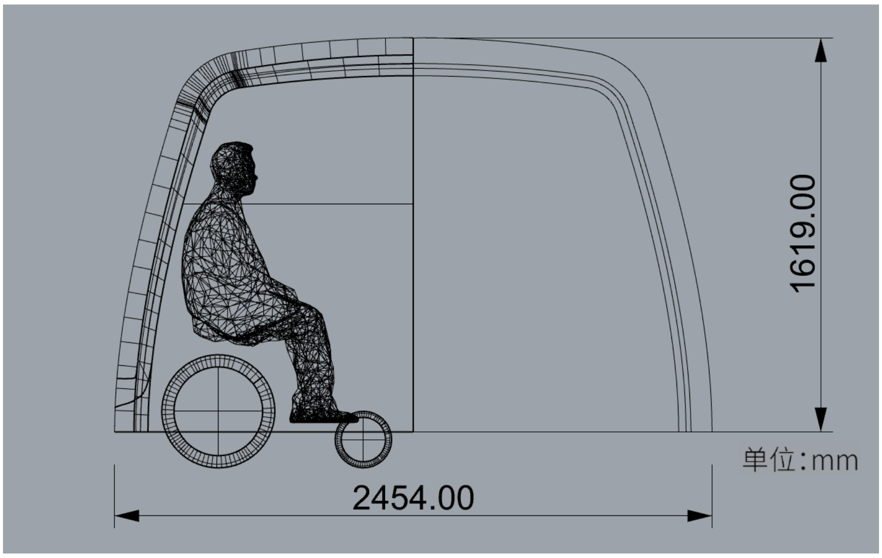


Figure 4.22　Driverless vehicle size chart 1

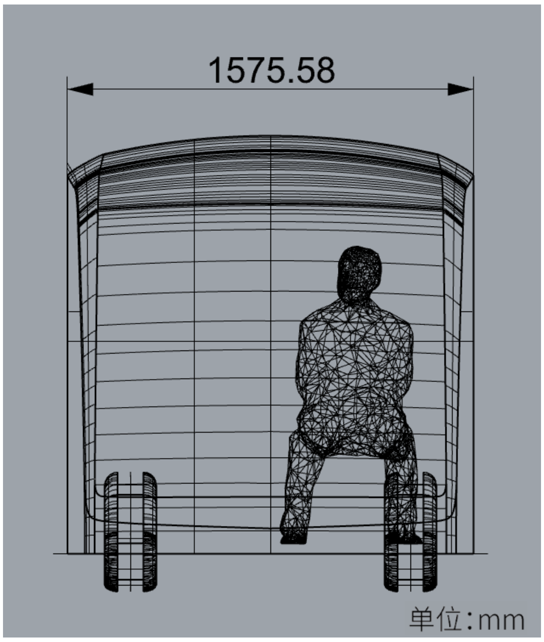


Figure 4.23　Driverless vehicle size chart 2

Therefore, when considering the relevant styling language of driverless vehicles, a more friendly and friendly design language is adopted [18]. The design concept is shown in Figure 4.24. It adopts a large rounded chamfer design to reduce the occurrence of sharp chamfers such as right angles. The integrated design is used to weaken its functional attributes as a vehicle. The driver's door is on both sides, and people get on and off from the side. The whole body uses black and silver as the overall color of the driverless vehicle,

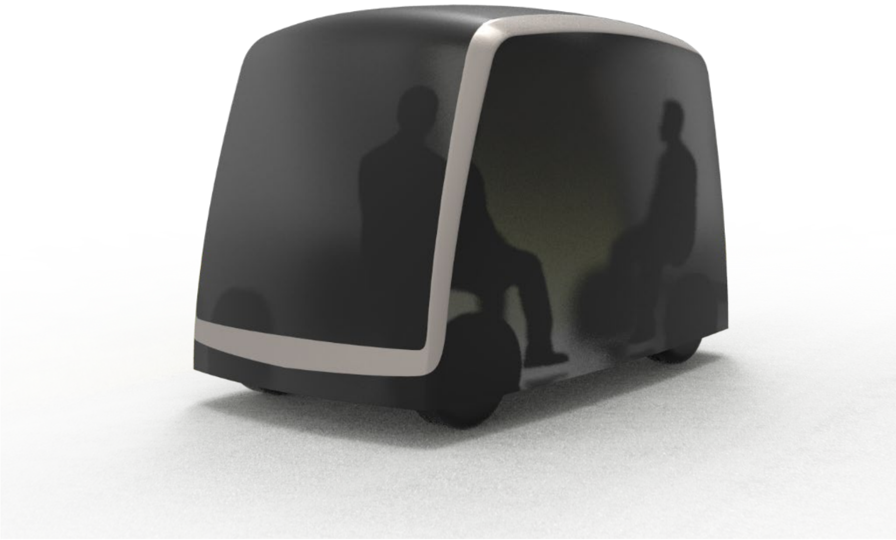


Figure 4.24 Effect map of driverless vehicle

highlighting its attributes of technological sense, and enhancing users' trust in it. As a service-type manned robot, driverless vehicle is no longer a simple means of transportation. Its design language should be closer to life, closer to the psychological range acceptable to users, and reduce the user's distrust of new technologies.

(3) More flexible bodywork design. Considering the complex road and demand attributes in large residential areas, the design practice in this article adopts the modular design of driverless vehicles. That is, the operation of the driverless vehicle adopts the basic unit form. The smallest unit is a two-person form. The two basic units can be spliced into a four-person unit, as shown in Figure 4.25.

The smallest unit is mainly a travel space for 1 or 2 people, providing better privacy. The smallest unit is also the most basic unit of different functional modules. That is, the driverless vehicle modules that provide different service functions have different modeling attributes. This article shows four main driverless vehicle modules, including the first aid module, the commute module, the cleaning module, and the express delivery module, as shown in

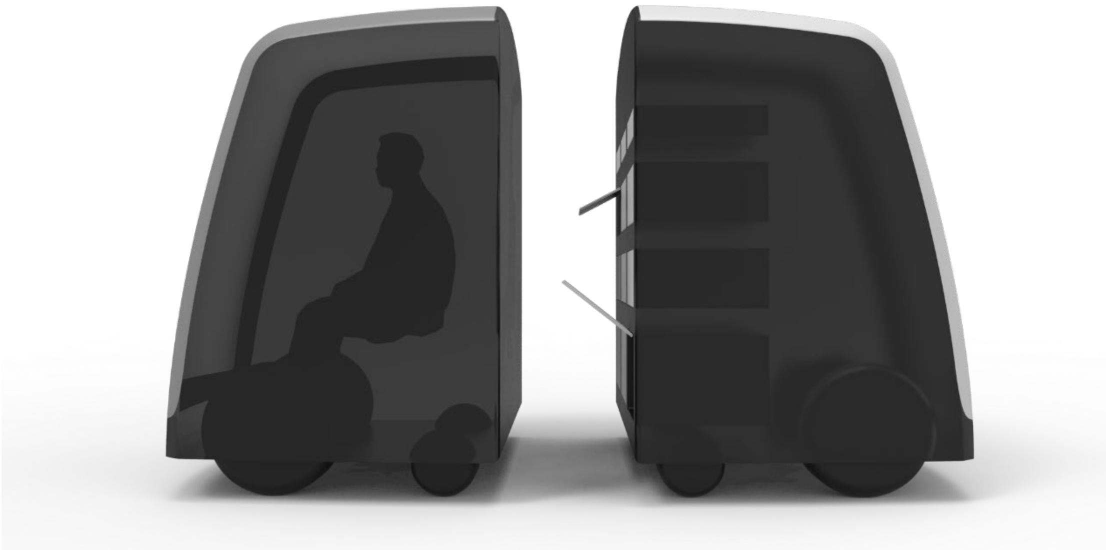


Figure 4.25　Assembling of driverless vehicle module

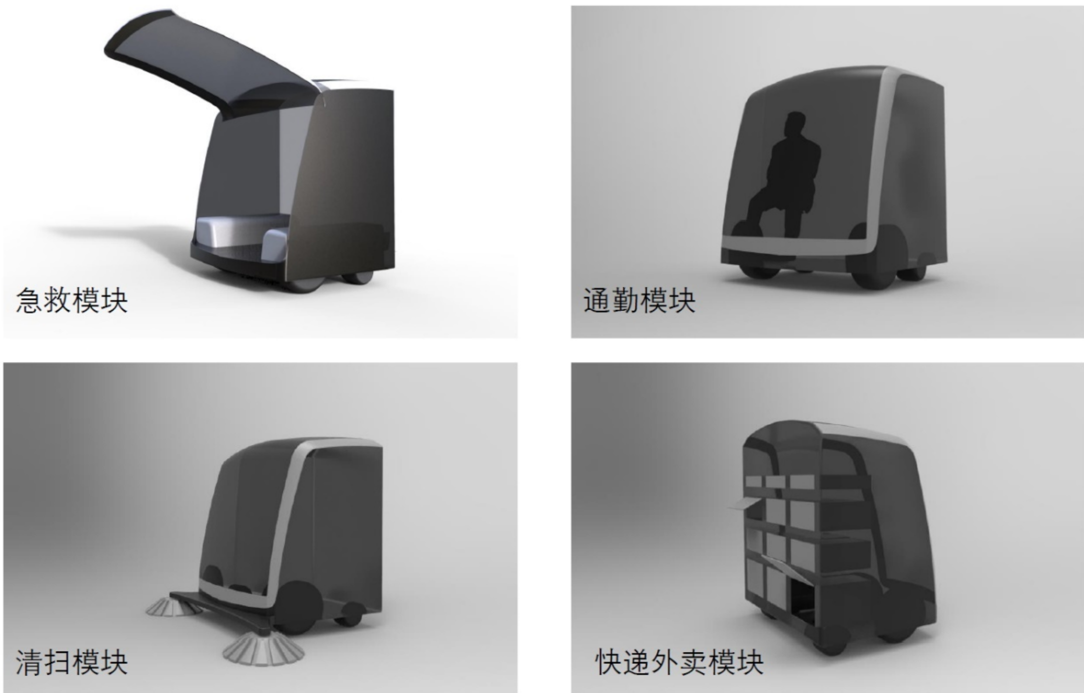


Figure 4.26　Different function modules of driverless vehicle

Figure 4.26. The basic prototypes of different modules are the same. The main difference is that different modules will have corresponding morphological changes for different service needs, but the splicing method of these modules is conceivable, that is, different modules can be spliced in pairs according to needs.

First-aid module: The door of the first-aid module is opened at the rear, and there is more space for entering and exiting. It is convenient to vehiclery medical equipment, medical staff, patients and family members in the necessary situations during the first-aid process, and the seats are on both sides of the train. Under normal circumstances, two first-aid modules need to be spliced to become a larger-capacity first-aid driverless vehicle.

Commuting module: The most basic commuting module. The basic commuting module can accommodate 1-2 people. The combined module can accommodate up to 4 people. Use scenarios such as traveling together of users in the same family or the same residential building. Whether to perform splicing is determined according to the actual situation and user needs.

Cleaning module: The main feature of the cleaning module is to configure corresponding cleaning components, including two automatic roller brushes at the front. Similarly, the cleaning module can be operated independently or combined, and configured according to actual needs.
Express delivery module: The vertical plane of the module is used for storage and retrieval of the express delivery. The module has storage spaces of different sizes and specifications, suitable for different sizes of goods.

Different modules can run independently or can be combined according to needs. Reasonable splicing combination can make the service combination more diversified and improve service efficiency. Modules can also be converted into different module forms according to the specific demand. Therefore, in the form of a modular driverless vehicle, the user's needs can be better adjusted and matched organically to achieve more accurate customized services.

4.2.4 Multi-terminal human-machine interface design for driverless vehicles

The interface interaction part of the driverless vehicle service in the slow-transportation environment of large residential areas mainly includes two parts, the user terminal interface design, that is, the mobile phone or tablet application, and the interface interaction in the driverless vehicle, that is, the display screen on the inner wall of the vehicle. This article will select several important key services for the description and display of the human-machine interface.

(1) User terminal interface design

The interface design of the user terminal is mainly designed for the application of the user's mobile phone. Users can manage and reserve driverless vehicle related services through smart terminals such as mobile phones, and conveniently use various types of driverless vehicle services in the community.

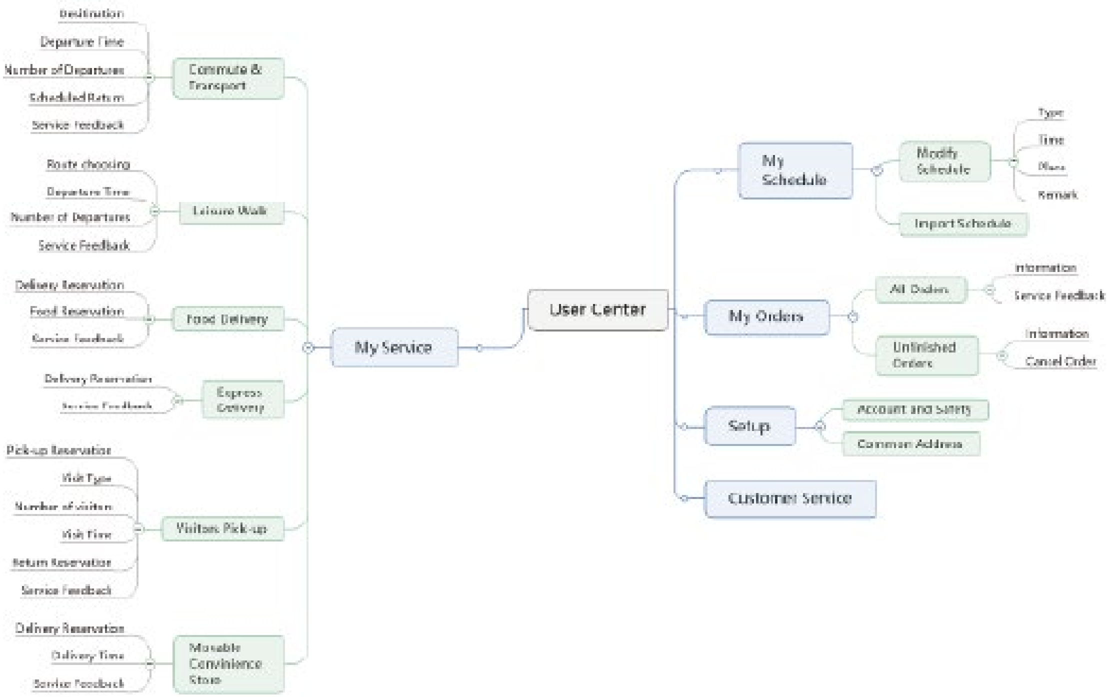


Figure 4.27 User terminal application information architecture

The information architecture of the user terminal application is shown in Figure 4.27. The main functional modules are "My Services", "My Schedule", "My Orders" and related settings and customer service.

On the first registration page, the system collects user information through the terminal, as shown in the flowchart in Figure 4.28. After login and registration, the user selects an identity and selects the role of owner or manager. There are different types of services available for different user roles. This article takes the role of the owner as an example. After entering, you can choose the service category you want, modify, delete, etc.

"My schedule" module, users can add, delete or modify the day schedule by

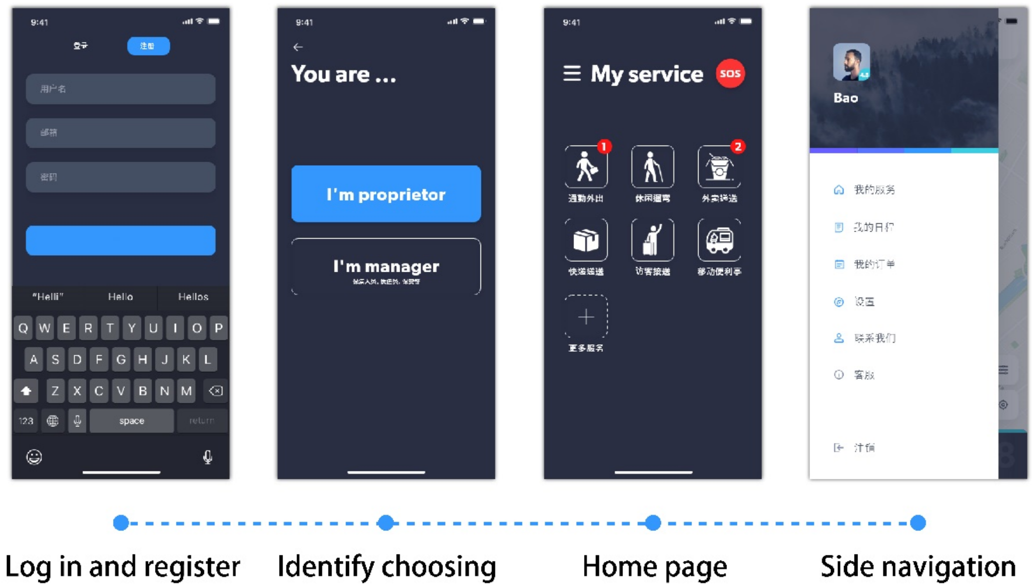


Figure 4.28 Key page of the registration process

themselves, or import the schedule into the driverless vehicle service system by importing the calendar. The driverless vehicle platform will analyze whether matching needs to arrange driverless vehicles for service according to the corresponding service content, and actively plan related driverless vehicle experiences for users.

The interface interaction part of the driverless vehicle service in the slow-transportation environment of large residential areas mainly includes two parts, the user terminal interface design, that is, the mobile phone or tablet application, and the interface interaction in the driverless vehicle, that is, the display screen on the inner wall of the vehicle. This article will select several important key services for the description and display of the human-machine interface.

(1) User terminal interface design

The interface design of the user terminal is mainly designed for the application of the user's mobile phone. Users can perform driverless vehicle related operations through smart terminals such as mobile phones.

On the first registration page, the system collects user information through the terminal, as shown in the flowchart in Figure 4.28. After login and registration, the user selects an identity and selects the role of owner or manager. There are different types of services available for different user roles. This article takes the role of the owner as an example. After entering, you can choose the service category you want, modify, delete, etc.

"My schedule" module, users can add, delete or modify the day schedule by themselves, or import the schedule into the driverless vehicle service system by importing the calendar. The driverless vehicle platform will analyze whether matching needs to arrange driverless vehicles for service according to the corresponding service content, and actively plan related driverless vehicle experiences for users.

The "My Services" module mainly has the following specific functional modules: commuting out, leisure cornering, takeaway delivery, express delivery, visitor pick-up, and mobile convenience kiosks. The emergency service is a special service, located in a conspicuous place in the upper right corner, which cannot be modified. It guarantees that users can find the service entrance as quickly as possible in the event of any emergency.

The manned service takes the commute travel service as an example. The key high-fidelity page flow is shown in Figure 4.29.

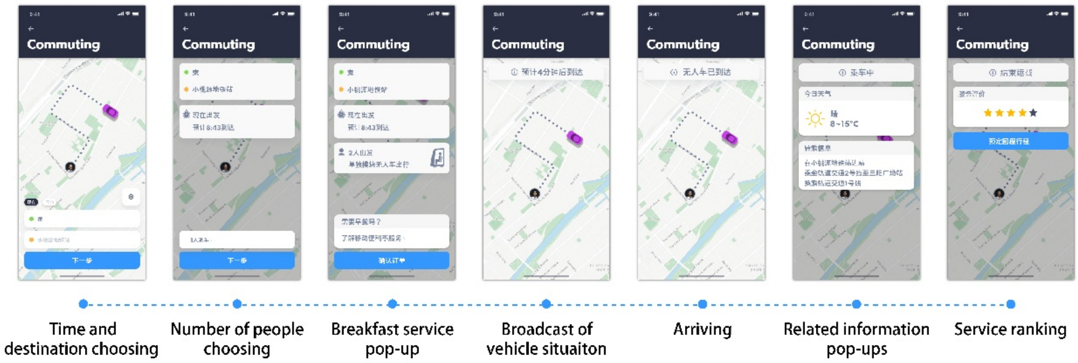


Figure 4.29 Key page of commute service

After the user clicks to select the commute service page, the user enters the time and destination of the commute. The dialog box also presets the commute location of the user according to the travel habits of the user, which facilitates the user to perform operations faster. After completing the relevant entries, the number of travellers is then selected. The driverless vehicle platform will allocate corresponding driverless vehicle modules for a period of time. The driverless vehicle platform will also push breakfast services to users at the same time, that is, combining the corresponding mobile convenience kiosk module based on the original commuting module to provide users with more commuting convenience. While the user terminal is waiting for the driverless vehicle, the user terminal will continue to follow up the arrival of the driverless vehicle. During the ride, the user terminal will broadcast the relevant practical travel information, such as weather and transfer information, for the user. After the service is completed, the user is asked for a service evaluation, and the user is pushed to reserve the return trip service and so on.

The takeaway delivery service for freight services is taken as an example. The key high-fidelity page flow is shown in Figure 4.30. The premise of the service

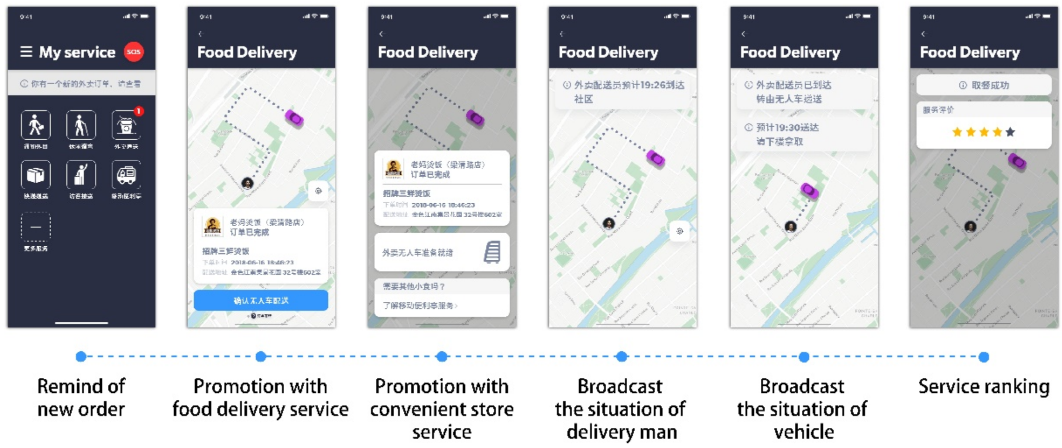


Figure 4.30 Key page of takeaway delivery service

is that the user authorizes the driverless vehicle platform to read the user's relevant takeaway order information to ensure the smoothness of the driverless delivery service.

The specific use process is as follows: After the user successfully orders on the third-party takeaway platform, the driverless vehicle platform recognizes the corresponding order information of the user, displays the corresponding information in the "My Services" module of the user terminal, and asks the user if they need to use People and vehicles deliver courier services, or users can pick them up by themselves. After the user selects the driverless vehicle delivery service, the driverless vehicle platform simultaneously pushes the mobile convenience kiosk service to the user and asks if the user needs other snacks, that is, the delivery process uses a combination of a takeaway delivery module and a mobile kiosk to provide services. The platform assigns corresponding driverless vehicles to it for standby for distribution. In the process of delivery by a delivery person and transshipment delivery by an driverless vehicle, the user terminal always pushes the latest delivery progress of the meal for the user. After the user completes the meal, the service ends and the user is asked for service evaluation.

(2) Display interface design of driverless vehicle

Since the driving of the driverless vehicle is controlled by the system, no manual control is required, and many safety guarantees of the driverless vehicle based on human driving safety considerations can be omitted. Therefore, for driverless vehicles, the front and rear windshields no longer need to maintain an unobstructed state due to consideration of driving safety. The front and rear windshields can be completely used as a vehiclerier for user information, and the driverless vehicle is even more inconsistent.

Aiming at this cabin characteristic of the driverless vehicle, when considering the position of the information display in the driverless vehicle, according to the user's different situational needs, provide two front and rear symmetrical information display modes. The camera in the vehicle monitors the user's orientation, and adjusts the information display position according to the user's seat orientation at any time, as shown in Figure 4.31.

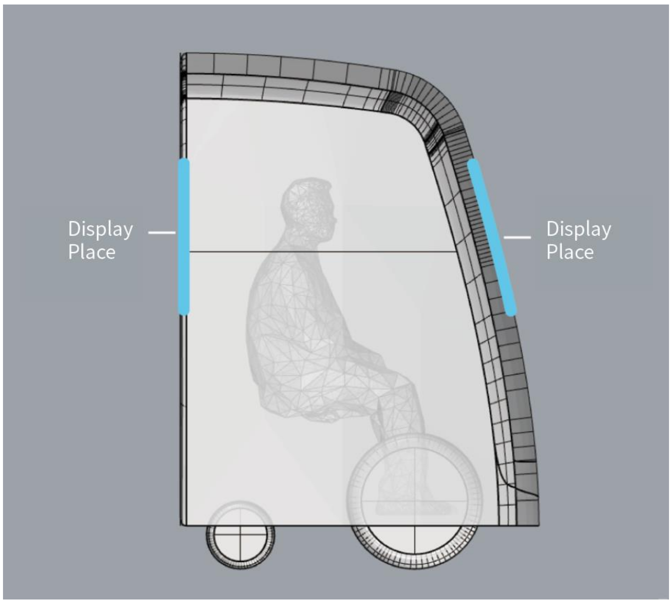


Figure 4.31 Schematic diagram of information display position in the vehicle

The specific information display content is shown in Figure 4.32. In the slow transportation environment, the use of driverless vehicles is mainly based on

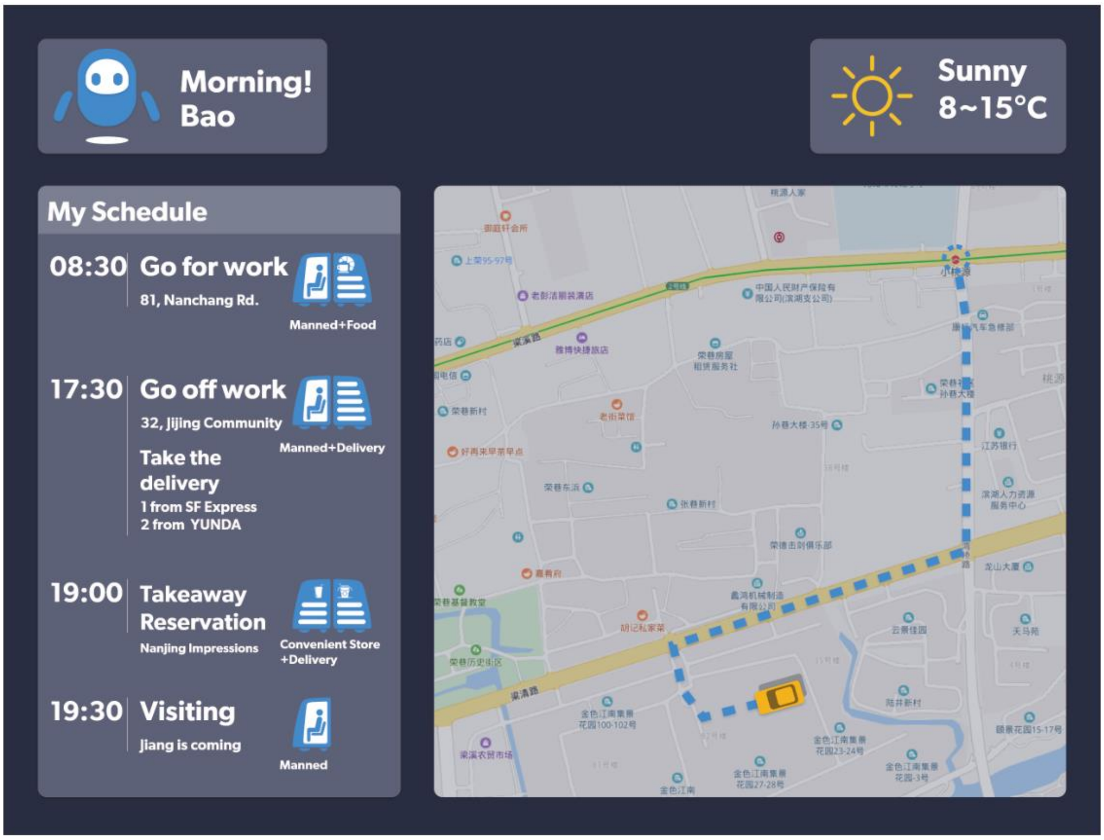


Figure 4.32 Information displayed in the vehicle

short-distance services. Therefore, the display of information is as simple and practical as possible. It is mainly used to display user information, weather and other practical trip information, user schedule display, and user travel Real-time display of location information, etc.

The user schedule page mainly displays the user's daily schedule. Related items that need to use the driverless vehicle service will be displayed in the form of the driverless vehicle module combination icon, which prompts the user about the driverless vehicle related service methods.

The main interaction forms between users and driverless vehicles are gesture operations and voice operations. During the user's boarding process, the driver's voice system actively interacts with the user, prompting the user to interact with the driver by voice. The camera in the vehicle will also monitor the user's expression at the same time, and provide more humanized services according to the current situation. The camera also plays a role of monitoring user gestures, etc., in the process of some specific interface operations.

4.3 Optimized combination of different levels of driverless vehicle service under 3D Kano model

The related levels of the 3D Kano model are described in the related introduction of the 3D Kano model in Chapter 3, including the demand level, the time level, the efficiency level, and the group level. Section 4.1 of this chapter has described the design practices of applying the Kano base model at the requirements level. The design practice of the driverless vehicle service system in this article will also be reflected in the design of time level, efficiency level and group level.

(1) Time level:

After the relevant subservice framework and content are determined, the functional priorities of the subservices are optimized and adjusted through the time-level combing. The related sub-service functions are analyzed in time series, as indicated in Figure 4.33. The blue bar indicates the high-frequency usage period of the sub-service content corresponding to the ordinate, and the light blue shade represents the priority service provided under the abscissa period. Through this chart, more suitable service content within each time period is arranged.

For example, emergency services may occur at any time and should be a priority service at any time. This is a special security guarantee. Commuting services generally occur during morning and evening rush hours, and these services are prioritized. The take-away service usually occurs at noon, evening, and supper. During these periods, taking into account the timeliness of take-out, it will also give priority to services as far as possible. In contrast, express delivery services will not take priority over takeaway delivery services.

During some nighttime hours, the demand for related services for residents will be relatively small. During this time period, property services such as garbage cleaning and collection services and security patrol services will be given priority. The possible idle time of driverless vehicles will be fully utilized to maximize the Utilization of human and vehicle related resources.

This chart is not a static timetable. During the operation of the service system, the chart will be continuously updated according to the continuous statistics of service needs, and the sub-service priorities in the table will be further optimized and adjusted, and continuous dynamic updates will be completed at the time level. Priority charts are always used efficiently.

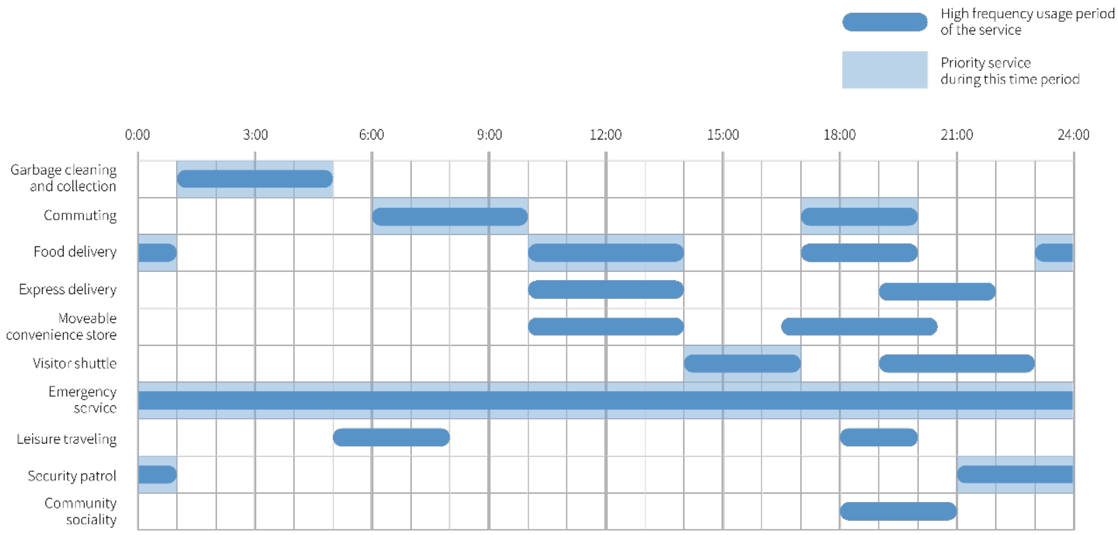


Figure 4.33 Prioritization of time-level services

(2) Efficiency level:

Under the overall arrangement of the time level, at each time point, there may be more than one sub-service being provided at the same time, and these sub-services can be better run through effective combinations to achieve the intersection of services and maximize the use of resources.

In the use of some services, the efficiency of the overall service system can be better improved through different service combinations. This article shows four possible service combinations, as shown in Figure 4.34.

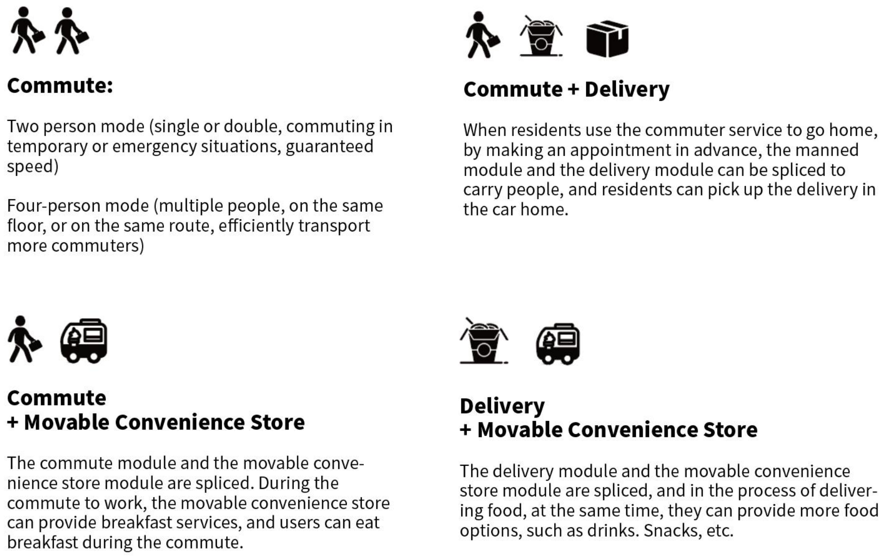


Figure 4.34 Consideration of Efficiency Tier Service Portfolio

Residents 'commuting: Residents' commuting services can be divided into private mode and multi-person mode according to the needs. In the private mode, that is, a passenger unit is used to vehiclery people. It is suitable for temporary or emergency commuting. wait. Multi-person mode, that is, two transport units are spliced to form a more efficient multi-person transport, which is suitable for users on the same floor or on the same route, and more efficiently shuttles more commuters.

The combination of commuting services and delivery services: that is, in the process of residents using the commuting services to return home, by making an appointment in advance, the crew module and courier delivery module can be spliced to vehiclery people in a combined form. Users can get takeaway or courier in the vehicle to improve service efficiency.

The combination of commuting services and mobile kiosk services: the relevant modules of these two services are combined and vehicleried in a combined form. For example, during work or school, the mobile kiosk can provide breakfast services to users who work or go to school, and users can purchase edible breakfast during the commute process.

The combination of takeaway delivery service and mobile kiosk service: the related modules of these two services are combined to provide users with more snack options, such as drinks and snacks, in the process of delivering takeaway, and increase the user's Dining options.

The combination of these services is also reflected in the combination and matching of vehicle body modules. In the related design of the vehicle body module, the possibility of combination between different modules is also considered, and the two vehicle body planes of a single body are used for stitching and combination, as shown in Figures 4.35 and 4.36. Figure 4.35 shows the combination of a cleaning module and a manned module to meet the operation needs of cleaning and sanitation workers. Figure 4.36 is a combination of a manned module and a courier module, which meets the needs of taking delivery of goods such as courier during work or after school.

(3) Social level

The social level is a service guide on the spiritual level of the community, and is an important step to further improve the user experience of driverless related services. In the pre-development process of driverless vehicle services, considering the related requirements of necessary attributes and charm

Figure 4.35 Combination of driverless vehicle cleaning module and manned module

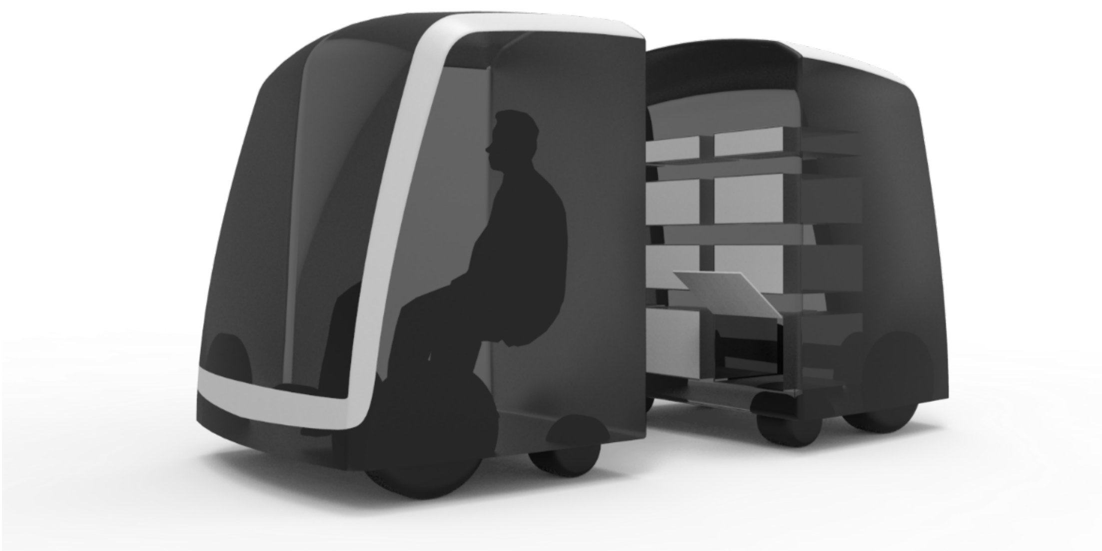


Figure 4.36 Combination of Manned Module and Express Module

attributes are first met, the group social services that belong to the indifferent requirement are temporarily used as the early-stage outlook services. This level of service design guidance does not involve too much participation in the design of the slow-transportation driverless vehicle service system in this article. It serves only as a guide for the future development. The possible forms include:

Residents 'old things exchange space: Driverless vehicles are used for storage functions, and serve as the exchange space for old things such as old clothes and books in the community. Through the old things exchange service, the community's sustainability is improved, and the residents' social is connected through the old things exchange space. demand.

Community bazaar party vehicle: As a single unit of operation, the driverless vehicle acts as a stall in the bazaar party, which has better flexibility and mobility. Through the use of driverless vehicles as a bazaar social space, offline communication is used to enhance communication and connection between users.

CHAPTER 5 Summary

5.1 Conclusion

This article analyzes and summarizes the current situation of slow transportation environment in large residential areas, summarizes the pain points of the slow transportation environment of residents in this environment, and then proposes to solve the problem of optimizing the slow transportation through the use of driverless vehicles. The advantages and feasibility of driverless vehicles for slow transportation. After determining to solve related problems through driverless vehicle technology, this paper proposes to build a slow transportation service system based on driverless vehicles in a large residential area, build a relevant design framework from the perspective of service design, and effectively improve the efficiency and use of driverless vehicles User experience for driverless vehicles.

According to the relevant process of service design, starting from the mining of user needs, this paper introduces a Kano model that analyzes the priority of user needs to help users in the large residential area slow transportation environment to further summarize and summarize, according to different demand attributes Reasonable order. This article further analyzes the service characteristics of driverless vehicles used in slow-transportation environments, and proposes more design levels based on the original demand level: including functional priority optimization ordering at the time level, and in-space services at the efficiency level. Reorganization and promotion of service group value at the group level. Through the expansion of the original basic Kano model, the two-dimensional attributes of the model are further expanded to a higher-level three-dimensional level, and a targeted design framework guidance is provided for slow-transportation driverless vehicle services in large residential areas.
Based on the application of the three-dimensional Kano model, this article gives the corresponding design practice for the driverless vehicle service

system of the slow transportation environment in large residential areas. The Kano basic model is used to investigate the user needs of the residents in the real residential area, and the corresponding driverless vehicle service list and priority order are given. The driverless vehicle service framework is further optimized and adjusted through multiple levels of design levels. In terms of design details, the concept design of the driverless vehicle body suitable for the application of slow-transportation environment in large residential areas is discussed. The form, color, and module combination are discussed. At the same time, the human-computer interaction interface design of the relevant terminal is given. Give the corresponding design examples.

5.2 Further research directions

5.2.1 Construction of Design Code for Large-scale Residential Areas

This article mainly discusses the establishment of a large residential area driverless vehicle service system under the Kano model, and gives specific service system design practices. On the basis of this, the next step to the landing stage is to design the corresponding large-scale residential area driverless vehicles.

The design code is mainly composed of two parts, one is the environment-related code, and the other is the driverless vehicle-related code. In terms of environment, we mainly consider designing corresponding driverless vehicle road specifications and possible road hardware facilities for supporting driverless vehicles. In terms of driverless vehicle specifications, including the development of relevant specifications for body size and equipment, as well as road behavior guidelines for driverless vehicles.

5.2.2 Extension and linkage of autonomous vehicle services under the concept of smart communities

With the development of modern science and technology, the concept of smart community has gradually received widespread attention as an important community management model. Smart community refers to the provision of a safer, more convenient and comfortable community life for residents through the current generation of technology such as the Internet, big data and artificial intelligence. From the past artificial management to the current Internet management, the management efficiency of the community can be greatly improved, and the user's living experience can also be maximized. The intelligence of the community is the development trend of the future community. Network-based and artificial intelligence management methods can largely avoid the lack of human management. Big data analysis can provide more personalized services for residents' lives.

The service system in the smart community mainly includes three service environments, which are transportation environment, property environment and home environment. Within the service scope of large residential areas, the services targeted by driverless vehicle services are mainly related to the types of services under slow transportation. In the construction of slow transportation driverless vehicle services in large residential areas in this article, not only travel-related transportation services, but also some property services, such as garbage collection and cleaning services and security patrol services.

In the current state of development of smart communities, small service robots such as property robots and home robots have appeared. In 2017, the domestic Frevi Intelligent Robotics (Shanghai) Co., Ltd. released the third-generation home service robot, the third generation of Vera, which can already implement a very intelligent home control and management system. Through the big data technology behind it and related artificial intelligence technology, the third generation of Vera has its own environmental cognition, human body dynamic recognition, etc., and can actively integrate into the user's life and realize intelligent living. For driverless vehicles, due to its own conditions, it is less feasible to directly participate in home life, but for the entire smart community ecosystem, the transportation services provided by driverless vehicles and related peripherals Services can be well linked with home services to improve a complete smart community ecosystem from all aspects.

For the further research and development of driverless vehicle services, it must be based on the smart community and the ultimate goal of improving the lives of residents. As an important part of the smart community service system, driverless vehicle service has its irreplaceable transportation attribute functions, but at the same time, driverless vehicle service has gradually expanded to other specific service systems in other smart communities, such as property services and home services. Driverless vehicle service is not an isolated service area. It needs to be more closely linked with real estate and home services, ranging from home life to commuting services inside and outside the community, covering users' food, clothing, and transportation, forming an intertwined, information exchange. Service context to jointly promote the development of smart communities.

Acknowledgement

The three-year graduate study career was fleeting and filled with emotion.

First of all, I would like to sincerely thank my supervisor, Prof. Davide Fassi for my careful guidance on my study and research at Tongji University and Polytechnic University of Milan in the past three years, as well as my strong support and guidance for the research work of this article in the last year. Prof. Davide Fassi's rigorous and striving attitude in the field of professional research deeply influenced me and gave me great help.

I would also like to thank my co-supervisor Prof. Sun Xiaohua, who gave me great support and help during the paper writing stage, for providing me with professional academic guidance.

Thanks to my classmates and friends who helped me. It is your strong support for me, so that I have the conviction and perseverance to move forward bravely above academics.

Whether it is a difficult process, or a moment of joy, all the experiences are precious, and I am forging ahead.

April, 2020

Reference

[1] 云美萍, 杨晓光, 李盛. A Brief Review of Planning for Ped and Bike System 慢行交通系统规划简述[J]. 城市交通, 007(2):57-59.

[2] 张辉. 回归以人为本——多系统协同的慢行交通规划[A]. 中国城市规划学会、沈阳市人民政府.规划 60 年:成就与挑战——2016 中国城市规划年会论文集(05 城市交通规划)[C].中国城市规划学会、沈阳市人民政府:中国城市规划学会,2016:13.

[3] 申婵, 刘明林. 国内外慢行交通系统综述及其应用[J]. 中国市政工程, 2015 (4): 12-15.

[4] 张东明,李友文.国内城市慢行交通系统现状分析及优化建议[J].价值工程,2016,35(23):43-46.

[5] 熊文,陈小鸿, 胡显标. 城市慢行交通规划刍议[J]. 城市交通, 2010 (1): 44-52.

[6] 成都市规划两网多线慢行交通体系 拟将形成. (2017, August 26). Retrieved from http://www.sohu.com/a/167392340_124757

[7] 熊文. 城市慢行交通规划：基于人的空间研究[D]. 同济大学交通运输工程学院, 2008.

[8] 杜力.完善城市慢行交通系统的几点思考[J].交通运输部管理干部学院学报,2011,21(01):34-37.

[9] 赵晓楠.城市住区慢行系统构建研究[D].深圳:哈尔滨工业大学深圳研究生院, 2010.

[10] 袁华东.谈车辆行驶速度规定[J].辽宁警专学报,2012,14(04):83-85.

[11] 张阳. 经济转型期大型居住区的特征、问题及建设对策研究[D].天津大学,2006.

[12] 吴杨. 社区公交疏通公共交通"微循环"[N]. 乌鲁木齐晚报(汉),2014-03-27(A02).

[13] 吴晓林,侯雨佳,唐进君.城市超大社区的交通效应研究:结构影响与治理策略[J].湘潭大学学报(哲学社会科学版), 2018, v.42； No.207(04):21-26+33.

[14] 李本科.试论居住区的后续规划[J].城市规划汇刊,1998(06):35-39+65.

[15] 强威. 社区公共交通工具设计[D]. 2017.

[16] 陈诚.无人驾驶汽车市场应用研究[J].现代制造技术与装备,2016(01):167-168.

[17] 王森.基于用户心理搭建无人驾驶信任度的研究[J].信息与电脑(理论版),2018(16):89-90.

[18] 张明,江磊.面向"无人驾驶技术"的车辆设计趋势研究[J].汽车实用技术,2018(15):30-32.

[19] 陈亚伟,程前,邵毅明,胡广雪.自动驾驶汽车的发展综述[J].汽车工业研究,2018(04):57-59.

[20] 穆康乐.无人驾驶汽车发展现状及未来展望[J].电子技术与软件工程,2017(21):112-114.

[21] 谭浩,赵丹华,赵江洪.面向复杂交互情境的汽车人机界面设计研究[J].包装工程, 2012, 33(18): 26-30.

[22] 董长青,丁田妹,黄晓延, 等.无人驾驶的人机交互方式研究综述[J]. 时代汽车, 2017 (7): 11-12.

[23] Team, U. U. (n.d.). " 用无人驾驶解决十亿级别人群的交通和物流问题 ". Retrieved from https://www.uisee.com/#case

[24] 纪振宇.Uber 无人车迈出重要一步:正式向公众开放服务[J].信息与电脑(理论版),2016(18):10-11.

[25] 高颖, 许晓峰. 服务设计：当代设计的新理念[J]. 文艺研究, 2014(6).

[26] 徐皓, 樊治平, 刘洋. 服务设计中确定服务要素组合方案的方法[J]. 管理科学, 2011,

24(1):56-62.
[27] 莫同，徐晓飞，王忠杰．面向服务系统设计的服务需求模型[J]．计算机集成制造系统，2009, 15(4):661-669.
[28] 陈俊虎，梁翠翠，吴进军，et al．基于 Kano 模型的服务需求研究进展[J]．中国卫生事业管理, 2010, 27(3).
[29] 王明仪．基于服务设计的公共交通研究策略探[J]．中国高新区, 2017(16):14.
[30] 丁鼎．基于 kano 模型的顺风车服务设计研究[D].
[31] 李欣，于渤．服务质量评价特征及服务补救策略[J]．管理科学, 2004(3):72-75.
[32] 甘为．基于社会化媒体的共生交互及汽车社交设计[D]. 2015.
[33] Tiwari G, Jain D, Rao K R. Impact of public transport and non-motorized transport infrastructure on travel mode shares, energy, emissions and safety: Case of Indian cities[J]. Transportation research part D: transport and environment, 2016, 44: 277-291.
[34] Deng S, Ye X. A Model to Research Off-street Parking Across the Travel Time Based on the Impact of Non-motorized Traffic and Other Factors[J]. Procedia engineering, 2016, 137: 299-308.
[35] Campbell M, Egerstedt M, How J P, et al. Autonomous driving in urban environments: approaches, lessons and challenges[J]. Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences, 2010, 368(1928): 4649-4672.
[36] Yalcin O, Topcu N, Arar O F, et al. Akay02 driverless vehicle architecture for campus environment[C]//Signal Processing and Communications Applications Conference (SIU), 2014 22nd. IEEE, 2014: 2257-2260.
[37] Berger C, Rumpe B. Autonomous driving-5 years after the urban challenge: The anticipatory vehicle as a cyber-physical system[J]. arXiv preprint arXiv:1409.0413, 2014.
[38] Urmson C, Anhalt J, Bagnell D, et al. Autonomous driving in urban environments: Boss and the urban challenge[J]. Journal of Field Robotics, 2008, 25(8): 425-466.
[39] Montemerlo M, Becker J, Bhat S, et al. Junior: The stanford entry in the urban challenge[J]. Journal of field Robotics, 2008, 25(9): 569-597.
[40] Waldherr S, Romero R, Thrun S. A gesture based interface for human-robot interaction[J]. Autonomous Robots, 2000, 9(2): 151-173.
[41] Sidobre D, Broquere X, Mainprice J, et al. Human–robot interaction[M]//Advanced bimanual manipulation. Springer, Berlin, Heidelberg, 2012: 123-172.
[42] Stiefelhagen R, Fugen C, Gieselmann R, et al. Natural human-robot interaction using speech, head pose and gestures[C]//Intelligent Robots and Systems, 2004.(IROS 2004). Proceedings. 2004 IEEE/RSJ International Conference on. IEEE, 2004, 3: 2422-2427.
[43] Thrun S, Montemerlo M, Dahlkamp H, et al. Stanley: The robot that won the DARPA Grand Challenge[J]. Journal of field Robotics, 2006, 23(9): 661-692.
[44] Liu C, Tomizuka M. Safe exploration: Addressing various uncertainty levels in human robot interactions[C]//2015 American Control Conference (ACC). IEEE, 2015: 465-470.
[45] Liu C, Zhang W, Tomizuka M. Who to blame? Learning and control strategies with

information asymmetry[C]//2016 American Control Conference (ACC). IEEE, 2016: 4859-4864.

[46] Brady M K , Knight G A , Cronin J J , et al. Removing the contextual lens: A multinational, multi-setting comparison of service evaluation models[J]. Journal of Retailing, 2005, 81(3):215-230.

[47] Stelzer A, Englert F, Hörold S, et al. Improving service quality in public transportation systems using automated customer feedback[J]. Transportation Research Part E: Logistics and Transportation Review, 2016, 89: 259-271.

[48] Friman M, Gärling T, Ettema D. Improvement of public transport services for non-cycling travelers[J]. Travel Behaviour and Society, 2018.

[49] Kurniawan J H, Ong C, Cheah L. Examining values and influences affecting public expectations of future urban mobility: A Singapore case study[J]. Transport Policy, 2018, 66: 66-75.

[50] Mulley C, Nelson J D, Wright S. Community transport meets mobility as a service: On the road to a new a flexible future[J]. Research in Transportation Economics, 2018, 69: 583-591.

[51] Liu T, Ceder A A. Analysis of a new public-transport-service concept: Customized bus in China[J]. Transport Policy, 2015, 39: 63-76.

[52] 共享单车：城市治理新变革. (2018, February 08). Retrieved from https://www.sohu.com/a/221689140_365037

Kano evaluation form of driverless vehicle service for slow transportation in large residential community

Leisure Walk		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	2	25	12	11
	Expect it	0	6	9	4	2
	Don't care	0	0	13	4	1
	live with	0	1	1	5	0
	dislike	1	0	0	0	4

Security Patrol		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	2	22	14	7
	Expect it	0	5	8	5	2
	Don't care	1	2	18	3	0
	live with	0	0	1	7	1
	dislike	0	1	0	0	3

Garbage Cleaning & Collecting		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	20	2	29	17	12
	Expect it	1	2	4	5	1
	Don't care	0	2	10	1	0
	live with	0	2	0	4	2
	dislike	0	1	0	1	2

Information Interaction		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	14	2	19	10	7
	Expect it	3	4	7	1	4
	Don't care	0	2	26	2	0
	live with	0	1	1	9	0
	dislike	0	3	0	1	2

Social Activity		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	14	4	18	13	8
	Expect it	0	4	4	2	1
	Don't care	0	2	22	5	0
	live with	0	0	2	8	1
	dislike	1	3	2	1	3

Moveable Covenience Store		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	2	27	19	13
	Expect it	2	4	6	2	1
	Don't care	1	1	12	2	0
	live with	0	0	2	6	0
	dislike	0	0	0	0	2

Express Delivery		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	13	3	20	18	13
	Expect it	2	4	4	6	1
	Don't care	0	4	13	2	0
	live with	0	1	1	9	0
	dislike	1	0	0	1	2

Food Delivery		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	12	6	23	14	7
	Expect it	0	3	7	4	2
	Don't care	0	2	15	1	2
	live with	0	0	6	5	1
	dislike	1	1	0	2	4

Cmmute Service		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	16	0	23	15	10
	Expect it	2	4	9	3	1
	Don't care	0	2	12	5	0
	live with	0	1	1	8	1
	dislike	0	2	1	0	2

Emergency Service		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	19	2	13	19	24
	Expect it	2	5	5	1	2
	Don't care	1	3	10	3	1
	live with	0	0	0	6	0
	dislike	0	0	0	0	2

Pick-up Service		feature absent				
		Like it	Expect it	Don't care	Live with	Dislike
feature present	Like it	17	2	19	20	11
	Expect it	2	3	6	4	3
	Don't care	1	4	13	3	0
	live with	0	1	0	6	0
	dislike	0	0	0	0	2