

Development Strategy of Shared Mobility for Smart Cities in the Future

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Abstract: This paper first analyzes the development environment, trends, and opportunities for shared mobility and the symbiotic relationship between shared mobility and smart cities. The typical development mode and practical experiences of shared mobility in China are summarized and analyzed. Then, new concepts for shared mobility development are expounded from three dimensions: new technologies, new demand, and new modes. Given this, five typical paths for an innovative development of shared mobility in China are summarized and proposed. Finally, an ecology of shared mobility is conceived for the future of smart cities in China.

Keywords: smart city; shared mobility; development mode; path analysis; ecology conception

Shared mobility is based on the Internet, big data, artificial intelligence, and other advanced technologies aimed at matching the supply of and demand for travel resources. It is multi-dimensional sharing—of time, space, and the right to use of automobiles. Furthermore, shared mobility effectively integrates passengers' travel, vehicle use, and smooth traffic demands, and it is being gradually incorporated into the new concepts of traffic management and the construction of smart cities. As an essential part of intelligent transportation and key travel mode of smart cities, shared mobility plays an indispensable role in improving travel efficiency, distributing social resources, and promoting the construction of smart cities. Meanwhile, shared-mobility service platforms reshape the ecology of the mobility industry, thus leading to profound reforms in urban transportation systems [1–3].

1 Development trends and the unprecedented opportunity offered by shared mobility

As Chinese residents' living standards increase, problems arise due to the huge consumption of automobiles and the demand for mobility. Urban traffic suffers from problems such as environmental deterioration, frequent accidents, and road network congestions. By the end of 2018, China had 369 million drivers and 240 million automobiles on its roads. On the one hand, the gap between the increasing number of drivers and the total number of automobiles perpetuates the desire and demand for automobile consumption. On the other hand, in China, there are only 172 automobiles per 1000 people—a large gap when compared with developed countries. However, the continuous increase in the number of drivers and automobiles intensify urban traffic load; the carrying capacity of urban traffic is approaching upper limits in some cities. A city-traffic analysis report conducted by the Gaode Map [4] shows that, during peak commuting hours, 10%–15% among the 361 monitored cities are threatened by congestion and that 55%–60% are in suspended states. Resources for passenger space are wasted, and city environments suffer from pollution.

Smart cities must address urban demands and come up with innovative and wise solutions to urban development issues. As a solution, shared mobility can alleviate urban traffic problems and help sustainable urban development. It can be elaborated in the following three aspects.

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(1) Shared mobility proceeds from the multi-dimensional mobility demands of passengers, including the number of passengers, cost, time, and service experience, to improve the efficiency of passenger mobility. Roland Berger's report [5] shows that the average number of passengers in a given automobile in China is less than 1.5 during transit, and the average idle time accounts for about 95% of a given day. Shared mobility can utilize this idle capacity and relieve the load of urban transport. Deloitte estimates that shared mobility can reduce the average cost per passenger and per mile to 30 cents from the current 1 USD; meanwhile, Didi Chuxing Technology Co.'s DiDi Express, DiDi Premier, and DiDi Luxe services can satisfy the differentiated demand of customers for budget, superior, and chauffeur-driven services, respectively.

(2) Shared mobility involves comprehensive resource configuration requirements, such as customization, scattered vehicles, and big data, to appropriately allocate idle social resources. According to the report on city traffic operation, presented by the DiDi Chuxing Technology Co. [6], the number of their daily mobility scale reaches 30 million; route planning requests exceed 40 billion; and daily data processing exceeds 4800 TB. Shared mobility dynamically allocates scattered vehicles, meets passengers' custom mobility demands, and improves vehicle utilization.

(3) Shared mobility proceeds from the demand for city construction, such as City Brain by the Alibaba Group, vehicle infrastructure integration, and dynamic management, thus to promote the construction of a smart city. The management of vehicle operation data, traffic-dynamics data, and infrastructure data is coordinated by the City Brain, which matches city resources with dynamic management of the city traffic and can have an unprecedented comprehensive effect on city management. The development and evolution of smart cities and shared mobility rely on each other, as shown in Fig. 1.

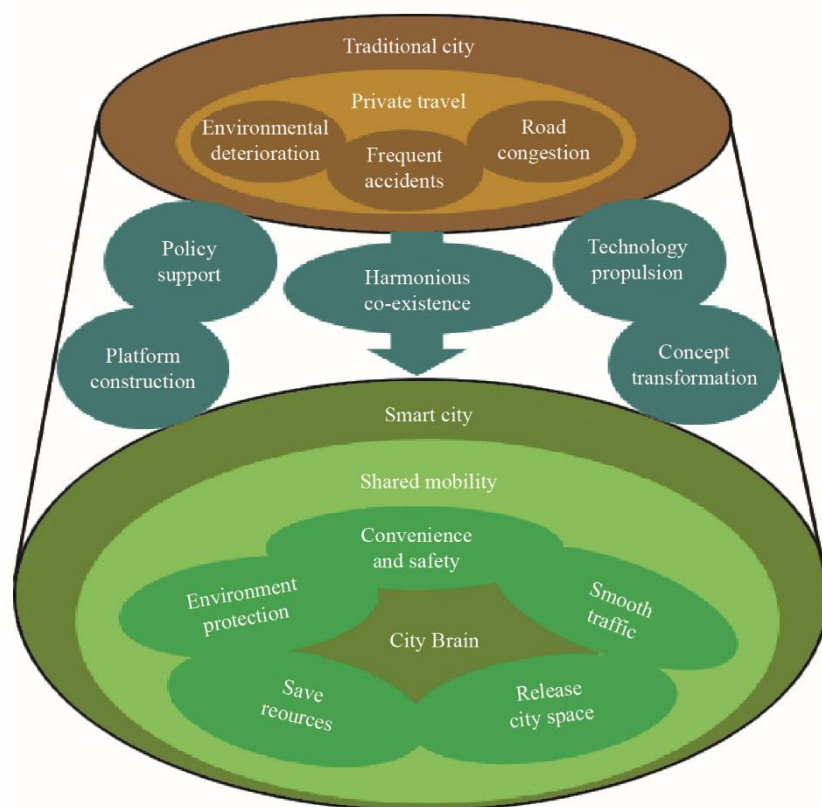


Fig. 1. The symbiotic relationship of the smart city and shared mobility.

2 Typical development model and practical experience of shared mobility in China

Shared mobility is an important solution for sustainable development of smart-city transportation. Its core implication is maximizing the use value of a given vehicle. At present, the typical development model in China mainly includes instant rentals, online car-hailing, time-sharing rentals, person-to-person (P2P), and customized buses. The city transportation system is diverse, and a new mobility ecosystem is promoted by the multi-dimensional shared-mobility services.

2.1 Instant rentals

Taxis provide instant, flexible, and convenient mobility services. The property and management rights of cruise taxis are generally owned by taxi companies. Due to the reasonable arrangement of drivers' working hours, cruise taxis perform all-weather mobility, which is one of the most extensive forms of shared mobility. By the end of 2017, China had 1.39 million cruise taxis, with an operating passenger flow of 36.54 billion person-times [7], which plays an important role in maintaining the vitality of the city. Instant cruise taxis are the best practitioners of new energy automobiles. While traveling, customers can experience and understand the advantages of the new energy vehicles, which eliminates their worry and anxiety about the technology. They can also promote the use of new energy vehicles (electric taxis) that reduce environmental pollution. Taiyuan is the first city in China to achieve complete electrification of taxis. This not only promotes green development within the city but also maximizes the effect of urban-space utilization through appropriate allocation of changing infrastructures.

2.2 Online car-hailing

For online car-hailing, passengers send requests to a mobility platform through smart-phone applications. The platform then provides passengers with the best route and non-cruise taxi services by matching supply and demand. They include the options of hiring an Express, Premier, or Hitch car. China's first online car-hailing service platform Yidao Yongche was established in 2010, and the service was officially introduced to urban residents. In July 2016, the *Guidance on Deepening Reform to Promote Healthy Development of the Taxi Industry* and the *Interim Measures on the Operation and Management of Online Taxi Booking* were issued. The measures established the legal status of online car-hailing practices and encouraged the extension of shared mobility through sharing part of the cost or giving each other free rides. Online car-hailing breaks the traditional way of reducing the number of automobiles on the roadways by organically integrating the demand of passengers and drivers through an Internet platform. On the one hand, it optimizes the passenger travel experience and alleviates the difficulty of taking a taxi for daily commuting. On the other hand, it reduces the vacant driving rate of vehicles and maximizes automobile resource-sharing. However, the public safety problems caused by online booking are significant, as the safety of passengers cannot be guaranteed, and the safety management of operating vehicles is deficient. Therefore, the key aspects in the development of online car booking are to improve emergency response capacity and to ensure travel safety.

2.3 Time-sharing rentals

Time-sharing is an hourly rental service that allows customers to rent a car at any given time and to use the vehicle for the duration of the lease. Time-sharing rentals realize all-weather sharing of the right to use the vehicle and can greatly improve vehicle utilization rates. Time-sharing rentals originated with Zipcar, an online automobile sharing platform. Using a membership system, Zipcar can unlock and lock its cars, as well as upload real-time dynamic information about the cars to ensure operational safety. In 2017, China issued guidelines to promote healthy development of small and micro bus leasing to encourage responsible advancement of time-sharing rentals. EVCARD, GoFun, and other time-sharing rental platforms actively explored the market. Meanwhile, as business scenarios for customized electric vehicles for time-sharing rentals keep emerging, the shared-mobility platform of BAIC BJEV provides an option to travel in a shared electric vehicle in Hainan. Time-sharing rentals are regarded as the best landing scenario for self-driving cars developed to carry out new functions such as automatic pick-up, return of rented vehicles, and automatic charging, which are conducive to time-sharing rental scenarios.

2.4 P2P

In the P2P shared-mobility model, both providers and potential renters provide car supply and demand information on a platform. The rental process is independently traded by providers and renters. P2P provides private car owners with a new way to earn income and maximize the use value of idle resources. Private car-sharing platforms such as Turo and Wheelz have matured in other countries, which obtain personal and vehicle property insurance for their drivers during the rental period. Therefore, this private shared-mobility model is very popular in foreign countries. However, P2P is still in the initial exploration stage in China. Although private car owners can maximize the use value of their idle resource by renting it out, such consumption pattern requires a mature business system and a complete personal credit system. Other potential problems during the rental process might include incomplete rental procedures, unreliable people, falsified identities, and unclear usage problems. Furthermore, there are regulatory risks in private shared mobility, including the failure of timely record management of vehicles, illegal

use of vehicles, and identification of accident liability. Therefore, for its healthy development, P2P needs promotion by government policies, guarantee of a social credit system, and strict certification of enterprise platforms.

2.5 Customized buses

Customized buses set personalized routes by collecting passenger mobility demand in many ways including full-cycle reservation, less-than-a-full-cycle reservation, or remaining-seat reservation for the next day. Customized buses provide passengers with the best commuter services: assigned seats, a special line to board, and direct arrival to one’s destination. Customized buses include commuter, community, hub, and business buses, among other custom forms. They depend on customer demand; the best travel time and route is designed for each passenger—customized routes are created by booking in advance. In addition, new bus routes can be designed based on data from city traffic operations, and the data can be combined with a questionnaire survey to investigate demand. Customized buses have many features including accurate positioning, lower cost, and flexible routes. Although they have a broad market space for development, there is a lack of clear management regulations and policy guarantees. Customized buses integrate the traditional concept of bus services and the new concept of shared mobility, dealing with many problems of traditional buses such as not being able to reach a destination, long waits between transfers, and operating under capacity during off-peak seasons. It is an innovation to the traditional bus operation model.

The five typical development models for shared mobility cited above form a three-dimensional, complementary pattern of shared mobility in a city. Different mobility modes have varying characteristics, as shown in Fig. 2. The travel scenarios of instant rentals and online car-hailing are relatively similar, and most are per-share and satisfy immediate needs. In online car reservations, the cost of shared mobility is lower than that of instant rental. While the cost of Express cars is not different from instant taxis, that of Premier and Luxe cars are higher. The different services offered by online car booking meet the custom demands of passengers. Most travel scenarios of time-sharing and P2P rentals involve on-time and meeting planning demands such as business trips and outdoor traveling. The utilization rate of these two renting methods is three to five times higher than private cars. Time-sharing and P2P rentals are still in market exploration phases because a commercial system suitable for China has not been formed. Providing a relatively low-cost way of shared mobility, customized buses are mostly in periodic, permanent demand for work commutes, transfer connections, and so on. Accordingly, cities should formulate relevant policies to encourage the extension of customized buses.

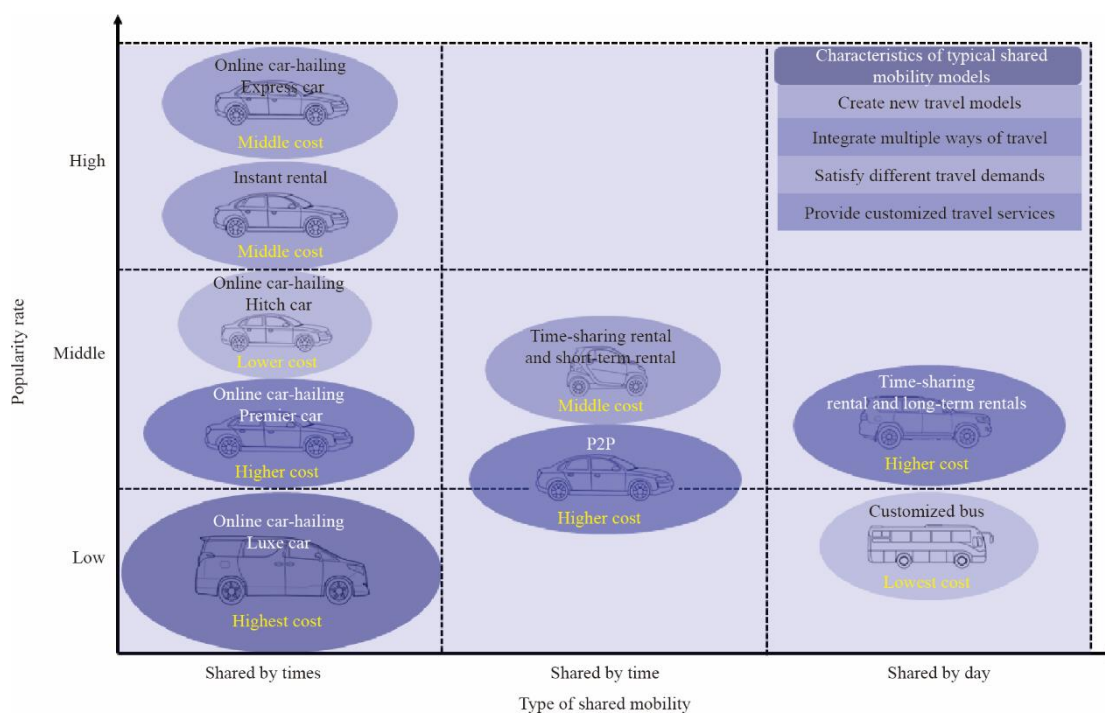


Fig. 2. The typical development modes of shared mobility.

3 New technologies, new demand, and new modes of shared mobility

Shared mobility is related to numerous innovative technologies, integrates different industry ecologies, and builds sustainable development modes of city traffic. Emerging technologies support the new demand for shared mobility. A new business mode of shared mobility is built based on application scenarios inspired by new demand and puts forward new requirements for innovative technology. New vitality, energy, and charm are constantly injected into shared mobility ecosystems, leading to its improvement and to building a new auto society where vehicles are utilized according to demand, and resources are shared and saved (Fig. 3).

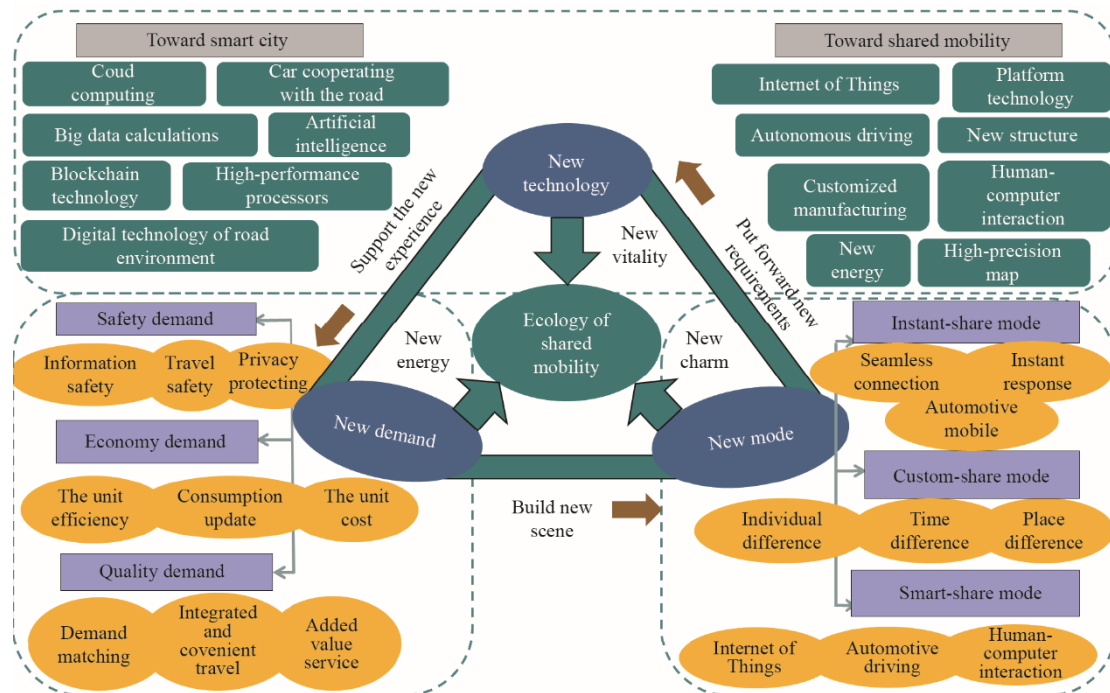


Fig. 3. The relationship analysis of new technologies, new demand, and new modes.

3.1 New technologies

With new technology reforms, the interlacing of innovative technologies motivates the rapid development of shared mobility. Shared mobility is the best carrier of pioneering technology at present and will continue to push technology to advance in the future. Data on demand and supply, travel trajectories, traffic dynamics, vehicle positions, and user behavior generated by shared mobility can only be harvested by a cloud computing server with ultra-high real-time performance, stability, and computing power. Through an artificial intelligence algorithm, the core computing processor can accurately match dynamic supply and demand, optimize dynamic route planning, and intelligently adjust the price to provide passengers with the best services. City traffic can be accurately managed in real time by the “brain” of a smart city by capitalizing on the efficient use of resources. To provide reliable and safe services, blockchain technology has been integrated, which ensures that both providers and suppliers have a reliable digital identity and reputation quality. Shared mobility will be the optimal application scenario once the technology of autonomous driving matures. Many enterprises have promoted the development of autonomous driving. For example, the Baidu Apollo program for autonomous driving and shared mobility commenced its trial operations in Chongqing’s autonomous-driving demonstration park in May 2018, and Google’s Waymo launched the world’s first commercial autonomous taxi service in December 2018. These examples demonstrate how autonomous driving technology is motivating shared mobility toward an ideal state.

3.2 New demand

For a solid foundation of its healthy commercialization, shared mobility can satisfy passengers’ precise consumption demands and provide ideal application scenarios. The primary demand of passengers is safety. Customers in this new era have new definitions for safety, involving their own private data, the reliability of drivers’ skills, and legitimacy of rental processes. Additionally, they are concerned about the stability of vehicle performance,

the maturity level of intelligent driving systems, the existence of rapid response emergency plans, and availability of insurance services for different scenarios. With ensured safety, consumers pay more attention to the cost performance. To obtain sustainable profits, enterprises should improve research and development of key technologies to deal with the main cost factors. Meanwhile, with the continuous improvement of the quality of shared mobility services, consumers will pay more attention to user experience and enjoy integrated and convenient mobility services; immediate response services; and the derived added value services such as automobile social networking, singing, and cinema.

3.3 New mode

Flexible and individual intelligence as a new mode of shared mobility enables sustainable development of city transportation. Through instant sharing, shared-mobility platforms can rapidly and adaptively complete automobile and rent scheduling upon customer request. Customers can enjoy intelligent services including autonomous driving, keyless start–stop, and automatic parking. They can also travel via seamless connections, which reduces waiting time and improves traveling efficiency. Customized sharing can provide customers with the most suitable models for different travel scenarios including accessibility for persons with disability, experience of automobiles for tourism, entertainment automobiles with leisure snacks, and commercial automobiles for help with personal office work. While customized sharing enables customers to enjoy the travel process and improves their experience, intelligent sharing can realize autonomous driving so that customers can more accurately and safely experience shared mobility. Meanwhile, city pollution and traffic congestion can be alleviated by these green, intelligent automobiles. The mobility efficiency of passengers and transportation management is improved by the Internet of Things. As such, passengers can fully enjoy the best experience possible, enabled by intelligent sharing.

4 Innovative development paths for shared mobility

Cross-border integration, product updates, industry reshaping, market restructuring, and concept transformation constitute the innovative development connotation of shared mobility practices. Shared mobility is rapidly becoming more safe, green, intelligent, economical, convenient, and flexible. The concrete path for realizing shared mobility mainly involves cross-border integrated development by mobile travel platforms, new players for producing automobiles, traditional automobile companies, and integrated service platforms that take advantage of government resources. The path to forming a new ecology of shared mobility to realize sustainable development of city traffic and construction of smart cities is shown in Fig. 4.

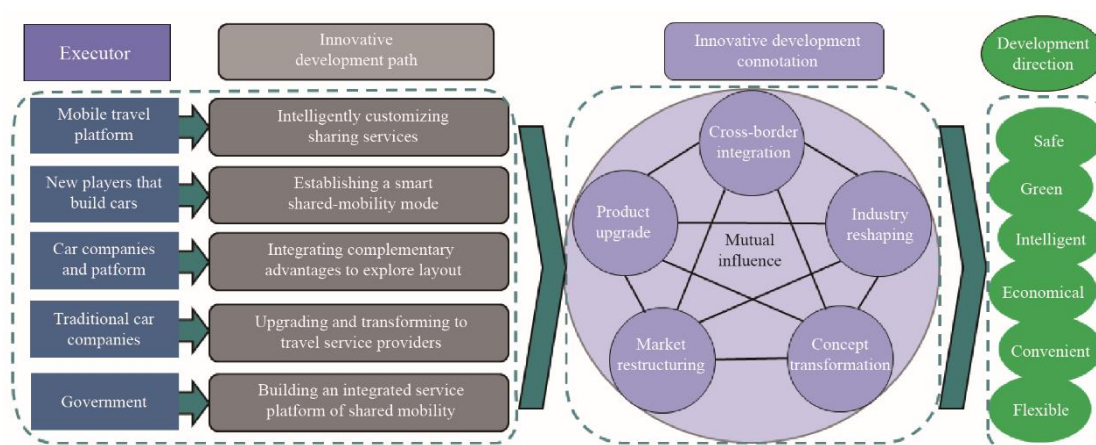


Fig. 4. The innovative development path for shared mobility.

4.1 Customized sharing services with intelligent mobile travel platforms

Mobile travel platforms have immediate impact on the sustainable development of shared mobility services. The basic development path is to build a one-stop integrated mobile travel platform; improve the operations, maintenance, and management abilities of shared vehicles; and provide intelligent, customized shared mobility services. As the largest mobile travel platform in China, Didi Chuxing Technology Co., has formed an ecological chain of travel services after eight years of layout and construction. Next, it will focus on new modes of transportation for the

sustainable development of shared mobility services. To that end, it has explored customized, shared travel services. In February 2018, Didi Chuxing Technology Co., announced strategic cooperation with 12 automobile manufacturers, including BAIC BJEV, to build a sharing service system of new energy automobiles to satisfy passenger demands for time-sharing rentals. On April 24, 2018, the company launched “torrent alliance” with 31 automobile industry chain enterprises to define and design the next-generation shared and intelligent vehicles. On January 28, 2019, Beijing Xiaoju Technology Co., Ltd., owned by Didi Chuxing Technology Co., established Jingju New Energy Automobile Technology Co., Ltd., together with BAIC BJEV, which mainly aims to design customized online-hailing automobiles to establish smart modes of shared mobility and promote competitiveness.

4.2 Positioning of smart and shared mobility by new players in automobile production

Clear positioning has a major impact on improving the core competitiveness of enterprises. The new players in automobile production position themselves as providers of smart, shared mobility services. Meanwhile, they have numerous advantages in terms of reviewing the demand and improving the experience of passengers. Since its establishment, WM Motor has been eager to improve the smart-mobility industry’s ecosystem; its tourism platform for shared automobiles, GETnGO, currently provides customers with daily car rental services in the Hainan Province. It also plans to open services up in popular tourist cities. This is the best way for new players to enter the field of shared mobility and accurately target their customers. LEAPMOTOR and Yidao Motor jointly built a new model of “car manufacturing + shared mobility” and a platform for urban shared mobility, targeting young urban groups and providing them with shared transportation services so that they “have an automobile to drive anytime and anywhere.” Beijing Car and Home Information Technology Co., Ltd., and Didi will establish a co-partnership company, and their strategic positioning integrates automobile production with shared mobility.

4.3 Integration of complementary advantages of car companies and travel platforms

Car companies have the core advantages in vehicle design and manufacturing, while mobile travel platforms have the advantage of access to information resources. Car companies use the big data of the platforms, while platforms build green, intelligent, customized vehicles relying on car companies. The two parties can integrate their advantages to then launch more valuable shared mobility services to gain mutual benefits in the field of transportation. For example, Toyota is actively cooperating with enterprises from the field of mobile travel services to seize the best opportunities in shared mobility. In 2016, Toyota cooperated with Getaround, an American P2P car-sharing service, to attract more vehicles that can provide sharing services based on the travel service platform developed by Toyota. This partnership was forged to provide shared mobility services for more passengers. In 2018, Toyota invested 1 billion USD into Grab—the largest shared mobility platform in Southeast Asia. In December of the same year, Toyota offered a customized mobile travel program named Total-care Service, which could potentially improve the management efficiency and passenger experience of Grab for its fleet and gradually expand the number of online car bookings. In August 2018, Toyota announced a 500 million USD investment in Uber, a partnership focused on shared mobility, providing Uber drivers with a new car rental service. Trends of shared mobility are good opportunities for Toyota and Uber to achieve mutual benefits.

4.4 Traditional automobile manufacturers upgraded as travel service providers

Traditional automobile manufacturers should focus on not only producing safe and reliable products but also upgrade to be green and intelligent transportation service providers. The Daimler Group launched their car2go shared-mobility program, which adopts a free-flowing, real-time sharing system for Mercedes-Benz’s Smart model to provide more convenient rental services. Meanwhile, BMW has launched a shared-mobility program named BMW DriveNow. To obtain a large market share and global influence, Daimler and BMW announced the integration of car2go and DriveNow to build one of the largest mobile travel service providers in the world. Traditional domestic automobile manufacturers also seized transformation development opportunities. For example, FAW Group Corporation, Dongfeng Motor Corporation, and Chang’an Motor Group Co., Ltd., integrated their advantages and collaborated with Internet companies such as Tencent and Alibaba Group. Together, they established the T3 Travel Service Company to forge a smart travel ecosystem on March 22, 2019, in Nanjing. Furthermore, Geely Auto Group Co., Ltd., launched a new energy vehicle travel service under the brand name Caocao Premier. The Great Wall Motors Co., Ltd., launched an automobile sharing service brand named OLA Sharing. Another example is SAIC Motor Co., Ltd., that launched the new mobile travel brand Xiangdao Chuxing. The switch from traditional automobile manufacturing to providing mobile services has become an important path for innovation in the shared

mobility space. The value of travel services provided by vehicles has attracted more attention in recent years, and a new shared-mobility industry ecosystem has emerged.

4.5 Government efforts to build an integrated service platform for shared mobility

Governments have a profound influence on promoting cross-boundary industrial integrations, encouraging residents to utilize shared mobility services, and ensuring their safety. It boosts the development of shared mobility, and it is the best constructor of large integrated service platforms for shared mobility. Shared mobility is currently in the market exploration and development stages. There are many problems that need to be solved with the help of the government. On the one hand, the policy regarding shared mobility practices and the consumer credit system must be improved. In addition, the cost of shared mobility is high; the business mode of sustainable development is unclear; and profits cannot be generated in the short term. First, governments should encourage market development for shared mobility with early-release strategy planning and a specific roadmap. Furthermore, they should push for more exploration and establishment of an integrated service platform and for the strengthening and support of the development of city infrastructure, such as collaboration on roads, automobiles, and intelligent logistics. The government could release restrictions on policies about the style of vehicles, license plates, and parking. Second, the government should establish and perfect the consumer credit system and enforce strict punishment on human-caused damage, malicious theft, and other criminal behaviors. Meanwhile, it should create a green and intelligent social atmosphere and gradually improve the new automobile culture of shared mobility. Finally, the government should focus on strengthening safety regulations regarding shared mobility to ensure not only consumer safety but also the property security of shared automobiles. It should achieve sustainable, healthy ecosystem development of the shared-mobility industry by establishing a service platform for shared mobility that integrates intelligent management, smart analysis, real-time monitoring, behavior regulation, and early-warning disposal.

5 Ecological concepts for shared mobility for the smart cities of the future

With the gradual reform of transportation systems to a low-carbon, intelligent, networked, and shared mode, city development changes are rapidly upgrading for ecological sustainability, dynamic management, and intelligent services. As an important part of the city transportation system, shared mobility can provide support for promoting green travel by developing sustainable transportation and helping to build a smart city. The ecological characteristics for shared mobility for the smart cities of the future may be demonstrated in the following three aspects (Fig. 5):

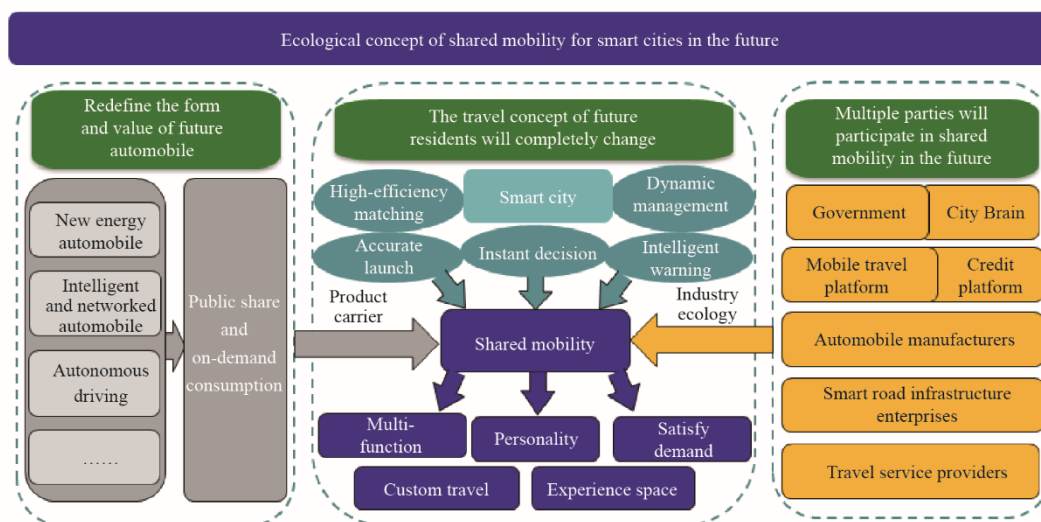


Fig. 5. Ecological concepts for shared mobility for the smart cities of the future.

(1) The form and value of future automobile products will be redefined.

The traditional, manned automobiles will be replaced by autonomous vehicles that will become a daily goods. The form of automobiles will be completely changed by new materials, structures, and functions to enable a more comfortable and convenient ride for citizens. The automobile will be a node connected to others on the Internet.

(2) Multiple parties will participate in shared mobility in the future.

Shared mobility requires not only the participation of the government, mobile platforms, automobile manufacturers, and other major players in its construction but also the integration of smart shared-mobility systems. This can be achieved through integrating credit system platforms, big data management of cities, and decision-making platforms, along with travel service providers, smart road infrastructure enterprises, and other relevant parties.

(3) The concept of travel will be completely altered in the future.

Automobiles will be transformed into multi-functional mobile spaces that provide personalized services. The demand for simple, short-term travel and excellent routes will be integrated with customized travel services, creating a compelling experience. The traditional concept of private ownership and idle resources will evolve into a new social culture of public sharing and on-demand access. City construction will be decentralized by the improved efficiency of shared mobility, and residents will enjoy more free city-experience spaces.

References

- [1] Zhong Z H, Qiao Y J, Wang J Q, et al. Summary of strategy research on automobile power in new era (I) [J]. Strategic Study of CAE, 2018, 20(1): 1–10. Chinese.
- [2] Zhao F Q, Liu Z W, Hao H, et al. Characteristics, trends and opportunities in changing automotive industry[J]. Journal of Automotive Safety and Energy, 2018, 9(3): 233–249. Chinese.
- [3] Qiao Y J, Ji X H. Developing car sharing to promote an automobile power strategy [J]. Strategic Study of CAE, 2018, 20(1): 120–126. Chinese.
- [4] Gaode Map. 2018 Q3 traffic analysis report of major cities in China [R]. Beijing: Gaode Map, 2018. Chinese.
- [5] RolandBerger. Analysis and forecast report of shared mobility market in China in 2018 [R]. Shanghai: RolandBerger, 2017. Chinese.
- [6] DiDi Smart Transportation Division. City traffic operation report by Didi Chuxing[R]. Beijing: Beijing Xiaoju Technology Co., Ltd., 2018. Chinese.
- [7] Department of Comprehensive Planning, Ministry of Transport of the PRC. Statistical bulletin of the development of the transportation industry in 2017 [R]. Beijing: Department of Comprehensive Planning, Ministry of Transport of the PRC, 2018. Chinese.