

# Baidu Turnip Fast Running Self-driving Car Industry Development Status and the Discussion of Existing Problems

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**Abstract.** Self-driving cars have become an important trend in global development, and their promotion in China has unique advantages and challenges. Taking Baidu as an example, this paper summarizes Baidu's R&D process and testing status in the field of autonomous driving in China, reviews the policies and regulations put forward by the Chinese government in recent years to support autonomous driving technology, analyzes the opportunities and obstacles encountered in the development of the Chinese market, and proposes that autonomous driving technology can not only optimize the management of urban traffic and improve the energy efficiency of transportation but also bring about the environmental benefits with positive impacts. This will also promote the rapid development of the entire intelligent transportation industry and greatly improve user satisfaction. The results of this study will provide profound strategic insights for companies in the field of automated driving, which will be an important reference for the future development of the intelligent transportation industry.

**Keywords:** Autonomous driving; Intelligent transportation; Baidu Apollo Go; Business model innovation; Technological innovation.

## 1. Introduction

With the rapid development of autonomous driving technology, the world's major technology companies have invested in this field in order to occupy an important position in the future of intelligent transportation. China, the world's largest automotive market, has driven the rapid commercialization of autonomous driving technology through policy support and technological innovation. Baidu launched the Apollo Program in 2013, relying on its accumulation of artificial intelligence and cloud computing, and gradually established a leading position in the field of autonomous driving. Its self-developed "Turnip Express" project has been commercialized in many cities, marking a major breakthrough in China's intelligent transportation [1].

According to recent studies, the deployment of automated online car services like Apollo Go has led to a paradigm shift in urban transportation patterns [2,3]. These services offer alternatives to traditional cabs and ride-hailing companies and are designed to provide cheaper, more reliable and cost-effective transportation options. The Turnip Express is expected to revolutionize the future of transportation systems by improving traffic safety [2], smoothing traffic flow [3], and improving transportation energy efficiency [4,5].

The main objective of this paper is to analyze Baidu's innovative breakthroughs in L4 autonomous driving technology and to evaluate its market expansion strategy and environmental benefits marketing, which not only provides valuable experiences and references for other autonomous driving companies but also provides strategic support for government and industry decision-makers.

## 2. Enterprise Development

Apollo Go is Baidu's pioneering project in the field of autonomous driving, reflecting Baidu's technological accumulation and innovation in the field of intelligent transportation. Baidu first launched the Apollo Program in 2013, an initiative to develop the world's leading open autonomous driving platform. With the gradual maturation of technology, Baidu launched the Apollo open platform in 2017, opening up its autonomous driving technology to developers and partners around

the world [1]. Since 2022, Turnip Express has opened commercial operation services in 11 cities, including Beijing, Chongqing, Wuhan, and Shenzhen, with Wuhan having the most available areas, and 1,000 vehicles will be operating in Wuhan by the end of the year. Fully unmanned self-driving travel services in five cities: Beijing, Wuhan, Chongqing, Shenzhen, and Shanghai, and testing in cities such as San Francisco and Los Angeles, California. At present, Turnip Express has put in a total of about 1,000 cars and plans to break even in Wuhan by the end of 2024 and enter the profit-making period in 2025. 20,000 additional vehicles (mostly Gen 5 vehicles) to be launched in 2027, with a layout reaching 70 cities. This scale of operation plan shows Baidu's deep insight into the commercialization path of autonomous driving. With further layout, Radish Express is expected to form a greater influence in the domestic and international markets.

In terms of competitors, Radish Express faces strong competition from major domestic and international technology companies, such as Pony.ai, Dripping Mobility, WeRide, and AutoX, as well as internationally renowned companies such as Tesla and Waymo. Unlike other companies that rely solely on cameras and AI algorithms for fully autonomous driving, Baidu improves safety through higher-precision maps and rich algorithmic optimization, which gives it a considerable competitive advantage by enabling it to perform even better in complex local road environments.

Turnip Express' customer base includes urban mobility users, government and public service organizations, and intelligent transportation infrastructure partner companies. First, young office workers and high-end businesspeople in first-tier and new first-tier cities, part of the user group has a high degree of acceptance of intelligent travel, especially the pursuit of technology and convenience. Studies have shown that high-income tech-savvy men who live in urban areas and experience more traffic accidents are more interested in these new technologies and are willing to pay more for them [6].

The core value of Turnip Express is reflected in many aspects such as efficient travel, a green environment, safety and cost reduction. First of all, through the L4 level of self-driving service, Radish Express is able to optimize urban traffic flow, reduce congestion and provide users with a convenient travel experience. Second, driverless vehicles are mostly electric, which is more environmentally friendly than traditional fuel vehicles, helping to improve urban air quality and reduce carbon emissions. Thirdly, Turnip Express is more responsive under complex road conditions, which can effectively reduce human driving errors and improve overall road safety. Finally, by reducing labor costs, Baidu can offer users more competitive travel prices, which further enhances its market competitiveness.

### **3. Competitiveness and Differentiation Strategies**

The competitiveness of Radish Express is mainly reflected in its technology leadership, government cooperation resources, and open platform strategy.

#### **3.1. Technology Leadership and Independent R&D Capability**

Baidu's ACE Intelligent Transportation Engine covers the three major areas of automated driving, vehicle-road collaboration, and mobility, and consists of a digital base, intelligent engines, scenario applications, and a "vehicle-road cloud map" product matrix. The interconnection and fusion of data between the intelligent transportation system and different subjects, such as public transportation and high speed, has substantially improved the prediction accuracy and iteration speed. According to the operation data, the cumulative accident rate of Radish Express is far lower than the industry average, reaching less than 0.02 accidents reported per million kilometers, thanks to the continuous optimization of the algorithms of the Apollo platform and the assistance of high-precision maps. Compared with competitors, such as Google's Waymo and GM's Cruise, Turnip Express has a clear advantage in terms of local Chinese technology accumulation and scenario adaptability.

### 3.2. Government Cooperation and Policy Guidance Strategies

Parent company Baidu has received substantial policy support and road test permits through years of cooperation with local governments and city traffic management authorities. For example, in Beijing, Chongqing, Wuhan, and other cities to obtain the commercialization of the pilot qualification, so that the radish quickly runs its policy to promote a clear advantage. This model of deep cooperation with the government can help it land quickly. Apollo has a market share of more than 34% in the domestic autonomous driving market, leading the industry, in Figure 1.

Market Share of Autonomous Driving Development Platforms in China, 2022

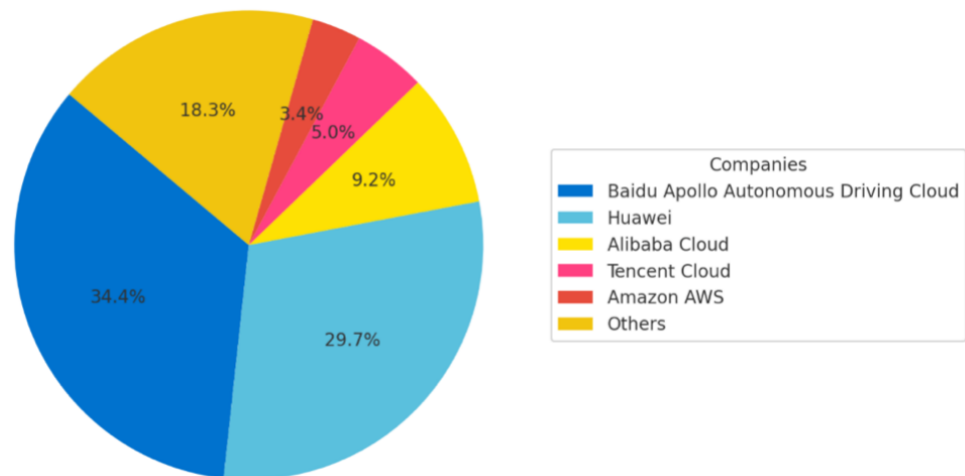


Fig. 1 Market share of autonomous driving development platforms in China.

### 3.3. Open Platform Strategy

Attracted more than 100 partners, including world-renowned automakers and technology companies NVIDIA and Intel. This strategy accelerates the pace of technological innovation and diffusion by integrating the power of external technological resources and partners, thereby creating a significant differentiation from closed-development competitors.

In addition, Turnip Express has further enhanced its competitiveness by making lean improvements in several details. In order to open up the market quickly, Radish Express mainly provides competitive low-price service. For example, the starting price for its operation in Wuhan is only RMB 4, which is much lower than traditional cabs. This low-price strategy not only quickly attracted a large number of users, but also effectively lowered the threshold of users.

Meanwhile, Turnip Express is not just limited to the urban core, it also tries to deploy in complex suburbs, parks, and urban fringes to provide diversified mobility services. In terms of commercialization layout, it not only focuses on B2C travel services but also explores multi-scenario applications such as logistics and enterprise services, forming a differentiated and diversified business model.

## 4. Product and Business Model Innovation

### 4.1. Product Innovation

The deep collaboration architecture between cloud and vehicle is one of the unique innovation points of Radish Express. While other drone companies are exploring synergies between the two, Turnip Express has a higher level of integration in this area and a wider range of application scenarios. Baidu's cloud-based system can process more than 100,000 frames of image data per second and is able to complete optimization calculations for path planning in less than 10 milliseconds, feeding the optimal decision-making solution back to the vehicle.

market, and based on data from its parent company Baidu, it has made multi-faceted scenario-based innovations for China's unique road environment and user needs. For example, the complexity of China's road environment, such as changing traffic regulations and dense concentrations of electric vehicles and pedestrians, requires driverless systems to be extremely flexible and resilient, which Radish Express does. According to the test data conducted by Baidu in Guangzhou, the average number of emergency takeovers of the Apollo system in complex traffic environments is less than 0.02 times/thousand kilometers.

Turnip Express' deep fusion of AI technology and driverless innovation has enabled it to excel in user experience. By integrating the intelligent voice assistant DuerOS, Radish Express vehicles are able to provide personalized services, allowing passengers to control various functions of the vehicle by voice, such as adjusting air conditioning and playing music. In July 2024, Turnip Express passenger satisfaction was a high 4.9 out of 5, with 94.19% of 5 out of 5 positive reviews. Nearly 56.9% of the population is optimistic about Robotaxi and drones.

## 4.2. Business Model Innovation

Baidu's powerful data analysis capabilities enable Radish Express to leverage household travel data, preferences, and feedback to continuously optimize service content and user experience. cumulatively provided more than 7 million orders of driverless cab services, accumulating a large amount of user feedback and operational data. self-driving algorithms to continually improve user experience and vehicle safety.

Unlike traditional online taxi services, Radish Express has realized driverlessness through self-driving technology, which greatly reduces operating costs. Since there is no need to pay drivers' salaries, Baidu Radish Express' operating costs have been reduced by about 30 percent compared to traditional online carpools. Through AI and big data technology, Radish Express can also adjust prices based on real-time supply and demand to optimize revenue while meeting user demand.

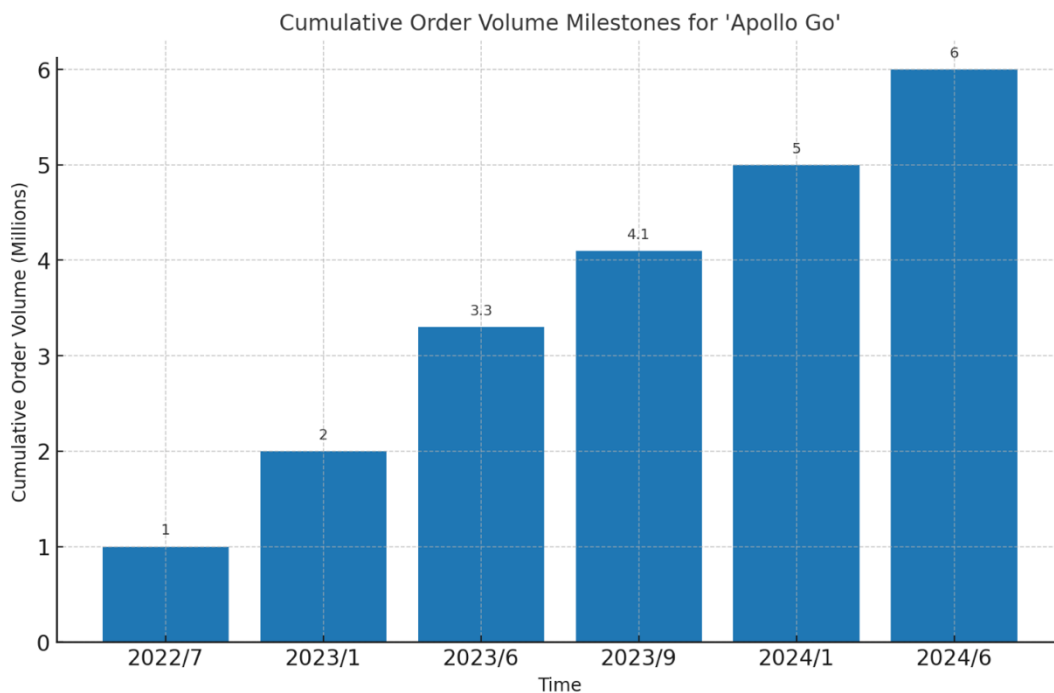
Turnip Express not only provides travel services but also combines driverless technology with smart city construction to promote the intelligence of urban traffic management. For example, Baidu has partnered with the Beijing municipal government to integrate Radish Express's self-driving technology into the city's smart traffic management system. In 2023, the system succeeded in reducing traffic congestion time in downtown Beijing by about 15 percent and improving traffic flow on major roadways.

## 5. Network Effects and Positive Feedback Loops

The network effect for Radish Express is mainly reflected in the mutual promotion between its user base, data accumulation, and service expansion.

### 5.1. User and Order Growth

As of the second quarter of 2024, Turnip Express had accumulated more than 6 million orders and completed approximately 1 million trips in that quarter alone, a 73% increase compared to the same period last year. Additionally, in the first quarter of 2023, Turnip Express completed approximately 660,000 trips, an increase of 236% from the previous year, in Figure 2.



**Fig.2** Cumulative order volume milestones for 'Apollo Go'

### 5.2. Data Accumulation and Algorithm Optimization

As the volume of orders increases, Turnip Express is able to collect more data on actual road conditions. This data can not only help optimize autonomous driving algorithms to improve driving safety and efficiency but also better cope with complex urban traffic scenarios. Currently, the Apollo self-driving platform has accumulated more than 50 million kilometers of self-driving mileage tested, which has led to the continuous iteration of its algorithms and further strengthened the technical strength of Turnip Express.

### 5.3. Service Extension and User Stickiness

With the increase in the number of users, Baidu started from Wuhan and gradually expanded the service scope of Radish Express to cover first-tier cities such as Beijing, Shanghai, Guangzhou and Shenzhen, and plans to expand to 70 cities nationwide by 2027. This service extension not only improves user stickiness but also attracts more potential users, making the whole network effect more obvious.

## 6. Platform Company Attribute Analysis

Through its Apollo open platform, Baidu Radish Express has formed an ecosystem of multiple participants, connecting key players such as passengers, vehicle manufacturers, technology providers, and local governments to build a mutually beneficial and win-win cooperation network. As a typical representative of the bilateral market, it meets the needs of all parties. Relying on data and algorithm-driven, the platform continuously optimizes its services and strengthens its core competitiveness through the analysis of passenger behavior and vehicle data. At the same time, with the expansion of user scale, Radish Express shows an obvious network effect, the increase of users brings more data, which in turn improves the quality of service and attracts more users to participate, forming a virtuous cycle.

## 7. Challenges and Prospects

In the future, Baidu Radish Express is expected to continue to maintain its leading position in the industry based on its technological advantages and rich cooperative ecology. Through the development of 5G, AI, and other technologies, Radish Express' self-driving service will be more intelligent, efficient, and safe, striving to reach the L5 standard and possibly expanding to more new scenarios. However, challenges remain, particularly in terms of public trust and competition in the marketplace. For example, a low-price strategy may face long-term pressure on profitability, especially after government subsidies are gradually reduced. As prices return to normal levels, how to maintain user stickiness will become a major challenge for Baidu. Turnip Express needs to remain agile and innovative in dealing with technological, policy and market uncertainties to remain competitive in the global autonomous driving market.

## 8. Conclusion

Through the systematic analysis of service users, technological innovation, policy support and environmental benefits, the research results show that Radish Express has successfully enhanced user satisfaction and taken a leading position in the domestic intelligent transportation market by virtue of its advantages of high efficiency, safety, and environmental protection. Baidu's deep cooperation with local governments has also further boosted Radish Express' market expansion.

Looking ahead, with the continuous optimization of technology and the deepening of policy support, Radish Express is expected to land in more cities and make continuous progress in user experience, environmental benefits, and business model innovation to further consolidate its leading position in the field of intelligent transportation. At the same time, this will provide an important reference and impetus for the popularization of automatic driving and help the long-term development of the global intelligent transportation industry.

## References

- [1] Baidu Apollo go. <https://en.apollo.auto/apollo-self-driving>, July 2024
- [2] Lanhang Ye and Toshiyuki Yamamoto. Evaluating the impact of connected and autonomous vehicles on traffic safety. *Physica A: Statistical Mechanics and its Applications*, 2019, 526:121009.
- [3] Wenbo Sun, Shian Wang, Yunli Shao, Zongxuan Sun, and Michael W Levin. Energy and mobility impacts of connected autonomous vehicles with co-optimization of speed and powertrain on mixed vehicle platoons. *Transportation Research Part C: Emerging Technologies*, 2022, 142:103764.
- [4] Tianyi Li, Benjamin Rosenblad, Shian Wang, et al. Exploring energy impacts of cyberattacks on adaptive cruise control vehicles. In *2023 IEEE Intelligent Vehicles Symposium*, 2023, 1–6.
- [5] Luis Montoro, Sergio A Useche, Francisco Alonso, Ignacio Lijarcio, Patricia Boso-Segu ´ 1, and Ana Mart ´ 1-Belda. Perceived safety and attributed value as predictors of the intention to use autonomous vehicles: A national study with spanish drivers. *Safety Science*, 2019, 120:865–876.
- [6] Chian Daily <https://global.chinadaily.com.cn/a/202111/25/WS619f1daca310cdd39bc7782b.html>, 2021.