

# Survey and analysis of the market prospects for autonomous vehicle delivery at North China University of Technology

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**Abstract.** The rapid growth of e-commerce has led to an increased demand for campus express delivery. Traditional self-service parcel collection methods encounter challenges such as time conflicts, long retrieval distances, and extended wait times. Autonomous vehicle delivery presents an efficient and convenient solution for campus logistics. This study utilizes a questionnaire to assess the parcel collection behaviors of faculty and students at North China University of Technology (NCUT), their satisfaction with current services, and their acceptance of autonomous delivery. Results reveal significant advantages for autonomous delivery in campus logistics, with over 60% of respondents citing difficulties due to long distances to collection points and around 50% expressing dissatisfaction with lengthy queues. Many believe autonomous delivery can effectively mitigate these issues. Furthermore, nearly 70% are willing to pay extra for autonomous services, especially in adverse weather conditions. The study also evaluates the economic and social feasibility of the delivery system within the campus context, indicating substantial market potential for autonomous vehicles at NCUT.

**Keywords:** North China University of Technology, autonomous delivery vehicle, express logistics, market prospects

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## 1. Introduction

The rapid growth of e-commerce has led to a significant increase in campus express delivery demand, resulting in challenges like scheduling conflicts and lengthy queues that adversely affect the collection experience for faculty and students. Meanwhile, autonomous vehicle technology has matured and is progressing towards electrification and sustainability [1, 2]. Several enterprises have already launched pilot projects for autonomous vehicle delivery in universities [3, 4], yielding initial positive outcomes. Current research mainly emphasizes route optimization and technology deployment, with inadequate systematic analyses of user demand, economic viability, social acceptance, and policy context [5]. In light of this, this study takes the faculty and students of North China University of Technology (NCUT) as the research subjects. It employs a questionnaire survey to investigate and analyze campus express delivery needs. The study further explores the market prospects of autonomous parcel delivery within the university and evaluates the feasibility of implementing an autonomous delivery system at NCUT.

## 2. Overview of autonomous delivery development

### 2.1. International advances in autonomous delivery

Autonomous vehicles are gradually being introduced into urban environments worldwide. In the logistics sector, the application of autonomous driving technology has shown promising results. Technology companies such as Waymo and Nuro have demonstrated the advantages of autonomous delivery vehicles in reducing fuel consumption while significantly improving delivery efficiency through extensive testing [6]. Nuro, a U.S. startup, launched the R-1 autonomous delivery vehicle, adept at navigating urban environments with enhanced safety. In 2020, the R-2 model was introduced, optimized for road transport, featuring a compact design and collision avoidance, achieving safety levels akin to conventional vehicles. In early 2022, BYD partnered with Nuro to create a third-generation fully electric autonomous delivery vehicle, which boasts double the cargo capacity of its predecessor [1, 2]. Overall, the autonomous delivery sector abroad is transitioning from pilot programs to large-scale commercialization. This technology is expected to be widely adopted in logistics, retail, and food service industries, further reducing labor costs, improving delivery efficiency, and driving the development of smart cities.

## 2.2. Chinese advances in autonomous delivery

Since its emergence in 2016, China's autonomous delivery sector has attracted significant interest from government and industry. Meituan initiated its autonomous delivery vehicle project that year, launching a platform in 2018 and piloting operations in Xiong'an New Area. In May 2018, Alibaba and Suteng introduced the G Plus, the first unmanned logistics vehicle with solid-state LiDAR, at the Alibaba Cainiao Global Smart Logistics Summit. Major logistics firms, including Cainiao Logistics, Bond Express, and Suning Logistics, have also developed their own autonomous vehicles and drones, propelling industry expansion [1]. In 2021, Matrix Data Technology Co., Ltd. introduced the Pioneer, an autonomous express delivery vehicle designed with high performance in both delivery efficiency and battery life, making it well-suited for large-scale express logistics operations [2]. These technological advancements and practical applications indicate that China's autonomous delivery sector is gradually maturing and is expected to play an increasingly significant role in the logistics industry in the future.

### 2.2.1. Case studies of campus applications in China

This study selects autonomous delivery vehicles that have already been deployed on university campuses as research subjects. A detailed analysis of their advantages and limitations is conducted (as summarized in Table 1).

**Table 1.** Case studies of autonomous delivery vehicles in Chinese universities

University	Product Name	Strengths	Weaknesses
Zitong Campus, Sichuan University of Culture and Arts	Cainiao "Xiaomanlv"	Flexible and customizable compartment design; maintains stable performance under extreme weather conditions such as thunderstorms, high temperatures, and snow; energy-efficient with low power consumption.	Maximum speed is limited to 20 km/h, making it suitable for short-distance deliveries but less efficient for long-distance transportation; limited payload capacity, only suitable for lightweight and small-batch deliveries.
Guangzhou Institute of Technology	SF Autonomous Delivery Vehicle	High payload capacity, meeting the demand for large-scale deliveries; integrated intelligent interaction system featuring facial recognition and voice interaction, enabling contactless delivery.	Large size limits maneuverability in narrow environments.
Tongji University	Xingshen Intelligent Autonomous Vehicle	Supports contactless delivery, reducing the risk of infection; equipped with L4-level autonomous driving capabilities; adopts a modular vehicle-compartment separation design, enabling deliveries of not only food but also parcels, takeout, books, and teaching supplies.	Collects large amounts of data during operation, including information on campus personnel and environments, necessitating robust data security and privacy protection measures.

## 3. Survey and analysis of campus express delivery demand

### 3.1. Statistical analysis of survey data

The data for this study were obtained from a questionnaire survey conducted at North China University of Technology (NCUT) between February 10, 2025, and March 2, 2025. The survey targeted faculty and students of the university, focusing on key issues such as parcel collection demand, satisfaction with existing services, and attitudes toward autonomous delivery vehicles. The questionnaire consisted of 20 items and was distributed using a random sampling method. A total of 227 questionnaires were distributed, with 216 valid responses collected, yielding an effective response rate of 95.2%. The data collection process strictly adhered to academic ethical standards to ensure the authenticity and reliability of the information.

#### 3.1.1. Statistics on parcel collection patterns

Among faculty and students, 32.41% reported parcel collection exceeding 10 times monthly. Additionally, 28.24% collected parcels 3–6 times, 25.46% 7–10 times, and 13.89% 1–2 times monthly. Regarding collection preferences, 80.56% favored self-service, while 5.56% utilized free collection by others, 9.26% chose paid services, and 4.63% had no specific preference. The predominant collection time was after class, preferred by 43.98% of respondents. Meanwhile, 32.41% had no fixed preference,

19.91% preferred post-meal collection, 1.85% between classes, and another 1.85% collected immediately upon receiving a pickup code.

In terms of parcel size, small packages (e.g., books, storage boxes) scored highest at 3.92, followed by extra-small items (e.g., phone cases, hair clips, pens) at 3.18, and medium parcels (e.g., backpacks, clothing) at 3.12. Large parcels (e.g., beverage and snack boxes) and extra-large parcels (e.g., mattresses, office chairs) received significantly lower scores of 0.9 and 0.02, respectively (see Equation 1).

$$\text{Average composite score} = \frac{\sum(\text{Frequency} \times \text{Weight})}{\text{Total respondents}} \quad (1)$$

### 3.1.2. Satisfaction with existing delivery services

Regarding satisfaction with on-campus express delivery services, 5.09% of respondents reported being very satisfied, 41.2% were relatively satisfied, 26.85% were neutral, 20.83% were somewhat dissatisfied, and 6.02% were very dissatisfied.

The main issues encountered during parcel collection were long distances to pick up points (62.04%), long waiting times during peak hours (55.56%), and time conflicts (53.24%). Other common concerns included complex pickup procedures (40.28%), difficulties in transporting large parcels (36.11%), and adverse weather conditions (22.22%). Additionally, 17.59% of respondents cited limited pickup point operating hours, and 17.13% mentioned poor pickup environment conditions as issues.

### 3.1.3. Acceptance of autonomous delivery vehicles

Regarding the acceptance of autonomous delivery services, 53.7% of respondents expressed strong acceptance, 28.24% were relatively accepting, 12.5% were neutral, 2.78% were somewhat resistant, and 2.78% were completely unwilling to accept the service.

Regarding payment for autonomous delivery services, 69.44% of respondents were willing to pay, while 30.56% were unwilling.

Among those willing to pay, 46% were willing to pay between 1–3 CNY per delivery, followed by 31.33% who preferred a cost below 1 CNY. Additionally, 20% were willing to pay 3–5 CNY, while only 2.67% were willing to pay more than 5 CNY per delivery.

## 3.2. Survey data and market prospect analysis

### 3.2.1. Analysis of faculty and student parcel collection patterns

32.41% of faculty and students collect parcels more than 10 times per month, while 25.46% collect parcels 7–10 times per month. This high frequency of parcel collection indicates a substantial demand for express delivery services on campus. Autonomous delivery vehicles can effectively alleviate the pressure on parcel lockers and pickup stations, particularly for those who collect parcels frequently, as the mobility and flexibility of autonomous vehicles can significantly reduce the time cost associated with frequent trips to pick up locations. Additionally, for individuals with lower collection frequencies, autonomous delivery can still provide a more convenient and accessible alternative.

In terms of collection preferences, autonomous delivery aligns with the majority preference for self-service collection, effectively functioning as a "mobile self-service pickup station." It also offers a more economical and convenient alternative for those who rely on others for pickup or use paid collection services.

Autonomous delivery vehicles can effectively meet diverse pickup time preferences, enhancing convenience and satisfaction. For the largest group (43.98%) preferring post-class parcel collection, these vehicles can schedule deliveries during these times, enabling faculty and students to retrieve parcels near dormitories or teaching buildings, thus minimizing travel to fixed pickup points and reducing wait times. For the 32.41% with no fixed preference, the flexibility of autonomous delivery allows for parcel collection at any campus location and time, significantly improving autonomy. Additionally, for the 19.91% who prefer post-meal collection, temporary delivery stops near dining halls facilitate convenient retrieval, further decreasing the time cost associated with collection.

In terms of parcel size preferences, small parcels received the highest composite score (3.92), followed by extra-small parcels (3.18) and medium parcels (3.12). In contrast, large and extra-large parcels had significantly lower scores (0.9 and 0.02, respectively). These results indicate that faculty and students tend to purchase and receive small, extra-small, and medium-sized parcels, which are characterized by their compact size, lightweight nature, and ease of transport and storage. When selecting autonomous delivery vehicle models, priority should be given to smaller vehicles, as they offer lower procurement and operational costs while being better suited for the narrow pathways and dense pedestrian traffic commonly found on university campuses. These vehicles should also have optimized internal storage compartments, featuring multiple small lockers and medium-sized storage spaces to accommodate the most frequently received parcel sizes efficiently.

### 3.2.2. Acceptance of autonomous delivery

Table 2 presents faculty and students' acceptance of autonomous delivery services. The data indicate a high level of acceptance for autonomous delivery on campus, highlighting its potential as an emerging service model. However, a small proportion of respondents remain hesitant, suggesting that efforts to promote autonomous delivery should consider the psychological and practical concerns of different user groups to ensure broader acceptance and adoption.

**Table 2.** Acceptance of autonomous delivery services

Acceptance Level	Strongly Accept	Relatively Accept	Neutral	Slightly Reject	Completely Reject
Number of Respondents	116	61	27	6	6
Proportion (%)	53.7%	28.24%	12.5%	2.78%	2.78%

Statistical analysis indicates that over half of faculty and students find current parcel collection services inadequate due to lengthy distances to pick up points, prolonged waiting times during peak periods, and scheduling conflicts. Additionally, intricate pickup procedures and challenges in transporting large parcels are prevalent issues. These insights underscore the primary shortcomings of the existing self-service pickup model in campus delivery services, focusing on distance, time, process complexity, and handling challenges.

Autonomous delivery vehicles can transport parcels directly to designated locations, such as dormitories and academic buildings, thereby minimizing the travel distance for faculty and students to fixed pickup points. Moreover, by dispersing pickup demand across various locations, autonomous vehicles mitigate congestion and long queues during peak hours. Their flexible scheduling capabilities enable users to arrange deliveries at their convenience, effectively avoiding conflicts with classes, meetings, or other obligations.

Currently, the parcel collection process requires faculty and students to present both a parcel pickup code and a personal identification code, with different platforms using non-interoperable identity systems, complicating the process and increasing queue times. Autonomous delivery vehicles, equipped with QR code scanning or facial recognition technology, can streamline the pickup procedure, enhancing efficiency while improving the overall user experience.

### 3.2.3. Analysis of willingness to pay

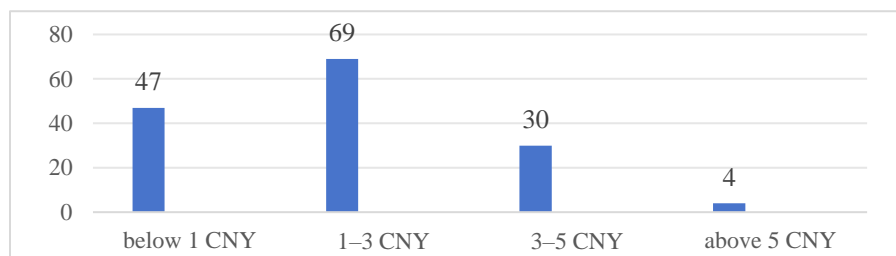
The survey results indicate that 69.44% of faculty and students are willing to pay for autonomous delivery services, while 30.56% are unwilling to pay. The overall findings suggest a relatively high willingness to pay, with most respondents recognizing the value of autonomous delivery services and considering the added convenience worth a reasonable fee. This indicates that autonomous delivery has strong market potential within university campuses.

However, few respondents are more price-sensitive and less receptive to new technologies. These individuals may be concerned about the potential risks associated with autonomous delivery and thus prefer more familiar and reliable methods [7].

Among those willing to pay:

- 46% are willing to pay 1–3 CNY per delivery,
- 31.33% prefer a fee below 1 CNY,
- 20% are willing to pay 3–5 CNY,
- Only 2.67% are willing to pay above 5 CNY (as shown in Figure 1).

Most of faculty and students prefer to pay less than 3 CNY, indicating that cost-effectiveness is a key consideration. Additionally, since students generally have lower consumption levels, pricing remains critical. A subset of respondents (20%) is willing to pay 3–5 CNY, likely reflecting higher expectations for service quality. However, the proportion of respondents willing to pay more than 5 CNY is minimal, suggesting that most individuals tend to be cautious about spending and prefer lower-cost options.



**Figure 1.** Payment preferences for autonomous delivery services

## 4. Feasibility analysis of autonomous delivery systems

### 4.1. Economic feasibility analysis

Autonomous delivery vehicles operate continuously, enhancing delivery efficiency and accommodating larger parcel volumes. This reduces dependence on human labor, lowering courier and temporary staffing costs. Furthermore, these vehicles minimize the need for parcel lockers and pickup stations, resulting in decreased maintenance expenses and land use. Survey data reveals that 69.44% of faculty and students are willing to pay for these services, with acceptable delivery costs between 1 to 5 CNY. Although initial investments in vehicle acquisition and infrastructure are necessary, long-term savings from reduced labor costs, service fees, and improved operational efficiency can offset these expenses [8]. Furthermore, introducing autonomous vehicles on campus can enhance the institution's social image and reputation, attracting more talented faculty and students and increasing the university's intangible assets. Considering all these factors, the implementation of autonomous delivery vehicles in campus environments is economically viable.

### 4.2. Social feasibility analysis

Survey findings indicate that 81.94% of faculty and students support the implementation of autonomous delivery systems. The deployment of autonomous delivery vehicles can also fulfill educational objectives, offering a chance to incorporate relevant coursework into the academic curriculum and positioning it as a university-centric initiative. Furthermore, it can function as a research platform for experimental projects, aiding faculty and students in disciplines such as autonomous navigation and route optimization. Interdisciplinary collaboration in universities can promote student involvement in the research and development of autonomous delivery vehicles, nurturing multidisciplinary talent. Additionally, these vehicles can be leased to research labs and student organizations, facilitating student participation in innovation projects and competitions [9]. During low-demand periods, such as summer and winter vacations when campus parcel volume declines significantly, unused autonomous vehicles could be rented out to nearby residential communities to provide delivery services. Since these vehicles have accumulated extensive operational experience on campus, where they navigate complex road environments, they would be well-suited for simpler residential roads, demonstrating strong adaptability.

## 5. Conclusion

Through an in-depth analysis of faculty and student parcel collection demands at North China University of Technology (NCUT), this study identifies a high volume of parcel collection requests concentrated within specific time periods, putting significant pressure on existing delivery services. Empirical data reveals significant consumer dissatisfaction with existing last-mile delivery infrastructure, primarily attributed to suboptimal distribution point accessibility, excessive wait times during high-traffic periods, and temporal logistics constraints. Although most faculty and students hold a positive attitude toward autonomous delivery, some remain price-sensitive regarding delivery fees. Further analysis confirms that autonomous delivery systems are feasible both economically and socially, offering substantial improvements to campus logistics services. This study provides scientific evidence and practical references for the implementation of autonomous delivery vehicles in university settings, while also offering data support and market insights for the continued advancement of intelligent delivery technologies. Study limitations include insufficient exploration of charging infrastructure optimization and route planning specifics. The scope is restricted to parcel delivery, excluding other autonomous vehicle applications. Further research should address infrastructure optimization and broader use cases.

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