Combining the intelligent design of the subway in the field of express logistics

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Short Abstract: development of the intercity subway rail transit system in Shanghai in 2030, the subway has become a way to solve many problems in the express logistics industry. This paper proposes a design that combines the intelligent design of the subway in the express logistics field. There are many problems in the express delivery industry, which greatly improves the transportation efficiency and can bring a considerable comprehensive income.

Key words: subway, logistics system, express delivery base station

1-Introduction

At present, China's traditional logistics industry is highly intelligent and the distribution of facilities and equipment is not balanced. At the peak capacity for delivery, courier companies often can't deliver courier on time, there are cases of overloaded transport trucks and excess storage in warehouses. The courier's transportation work is overloaded, and in the trend of intelligent intelligence industry, major express companies and The robot companies are working hard to develop artificial intelligence products to realize automatic delivery of express delivery, such as drones and driverless trucks [1]. Intelligent and automated express delivery methods are becoming the development trend of the express delivery industry. However, the concept of related systems on the market is still in its infancy, and no specific and highly feasible specific transportation mode has been proposed. Therefore, we propose a design that combines the intelligent design of the subway in the field of express logistics.

2- Overall structure and running process

2.1 System Overview

The system is based on Shanghai in 2030. It is assumed that the development of the Shanghai urban intercity subway rail transit system in 2030 is extremely perfect, and the subway stations are densely distributed and reasonable. The system uses the relatively complete urban/intercity metro system in the future city to complete the construction of express transportation lines and storage sites, including:

A courier transport vehicle ,which in this paper we call ‘A’ that shares the line with the subway, equipped with a smart cargo box to replace the traditional truck and realize express delivery;A courier storage base station ‘B’, coexisting with some subway stations, as a site for temporary storage of express delivery; A small delivery vehicle ‘C’ equipped with a smart container for picking up and delivering goods to customers in the service area near the base station.

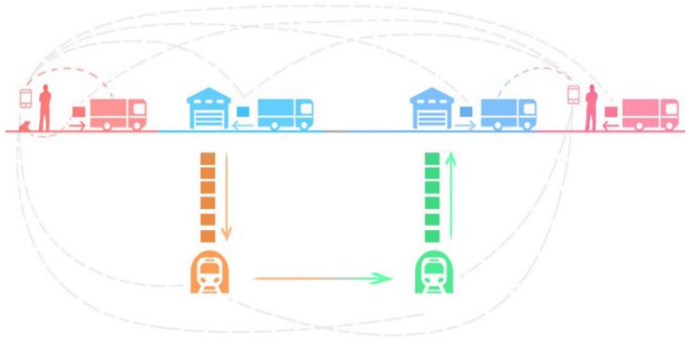

Figure 1 Express transportation line

2.2 Feasibility analysis of subway transportation mode

In this mode of transportation, long-distance express transportation in the city uses underground transportation instead of traditional ground transportation. Some scholars have done relevant research on the application of underground logistics systems in urban distribution. For example, Guo Zhanquan [2] analyzed the composition of Beijing freight, and considered that more than 75% of the goods are suitable for underground transportation. The prospect of building an underground logistics system. Some studies have specifically targeted Beijing [3], Chongqing, Shanghai and other cities to analyze the feasibility of transporting goods by subway. Comprehensive literature review, underground subway transportation has many advantages. In terms of express transportation, the transportation speed is fast, punctual and safe, the express delivery operation is strong, the cargo safety is high, and the adaptability to bad weather is strong, and the subway is convenient for commuting. Personnel pick-ups reduce the "last mile" transportation pressure of express delivery [4]. In terms of social benefits, it can reduce ground traffic congestion, improve environmental pollution problems, reduce the occurrence of safety accidents and save urban land resources. At present, there are few discussions about using the subway as a city logistics system. However, with the increase of congestion in large cities and the improvement of the subway system, the possibility and feasibility of the subway to undertake certain logistics tasks is increasing [5]. If you want to use subway freight transportation, the city should plan as early as possible. When planning the subway, select the appropriate station according to the demand of freight distribution, and build it into a passenger and cargo station to save the cost of renovation [6] [7] .

2.3 Underground courier operation plan

The following is an analysis of the underground courier operation plan of the logistics system from the two perspectives of day and night [8]

1) Sharing underground track lines with subway vehicles during the day, specifically divided into the following i and ii schemes

i) Separated cars

The underground express train is separately set up with the power system, and the transportation, loading and unloading work is carried out at the running time interval of the two trains. The transportation process is as follows: the express delivery vehicle is loaded at the originating station B1, runs and stops at the base station cargo platform; C's door is opened, and the loading and unloading is carried out in the form of a cargo module within 30 seconds;C's door is closed, and the transport vehicle A goes to the base station located at the next subway station B2; The express delivery is transported by elevator to the base station storage sorting warehouse; the passenger subway and the underground express train of the same subway station do not stop at the same time. The daytime operation plan is shown in Figure 3. The loading and unloading process is only an example. For two-line parallel lines, the station distribution and the loading and unloading mode of the specific loading and unloading cargo change.

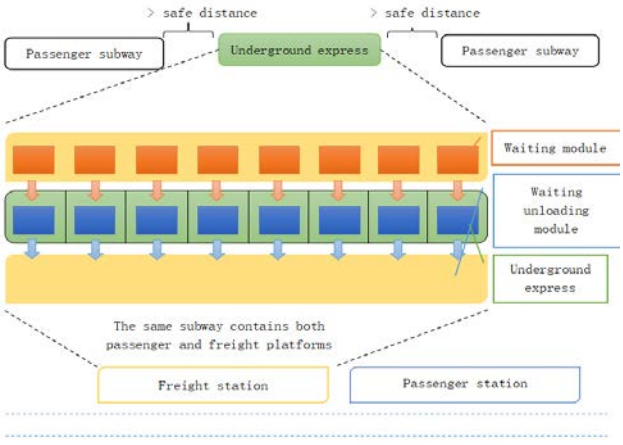

Figure 2 Daytime plan i transport process

The underground transport vehicle is operated during the running time of the subway. The speed of the underground

transport vehicle, the stop time of the platform and the running time interval are the same as those of the original subway, and the subway platform is expanded. Directly use the power supply system of the subway and the parking space of the subway. At the same time, the operation time of each truck and the number of trips of the truck are determined by the traffic volume of the day, and real-time adjustment is made through the electronic master control system and APP feedback [9].

In order to operate a courier in the subway operation interval, it is necessary to consider whether it can meet the safe operation of underground vehicles. Train safety operation interval control (to prevent train rear-end, etc.) is mainly controlled by the signal system ATP train automatic protection subsystem. The safety distance is calculated based on data such as line speed limit, line grade, vehicle structure speed and train automatic control characteristics to ensure that the subsequent train can be safely stopped before the previous train position. The trains in the latter column can receive the specific position of the front train and the distance between the two trains through the signal system. When the rear train is about to reach the minimum safety protection distance from the preceding train, the train will automatically decelerate until the train stops to prevent the collision from happening [10]. According to the regulations, the minimum safe distance between the two trains is 180m.

As shown in Table 1, the running timetable of Shanghai Metro Line 2 shows that the minimum time interval for the subway running during the peak time period is 3 minutes.

Line 2 interval time				
Monday – Thursday				
Name	Time	Interval Time(8 carriages)		
		Guanglan Road-Songhong Road	Songhong Road-Tujing Dong	Guanglan Road-Tang town
Morning peak	7:00-9:30	3 min	6 min	12 min
Normal time	9:30-17:00	4 min	8 min	/
Evening peak	17:00-19:30	3'30 min	7 min	14 min
Other time		4-8 min	6-12 min	/

Table 1 Shanghai Metro Line 2 Operation Timetable

It is preliminarily estimated whether the underground express train can be used to ensure the safe distance of the subway operation in the interval between the two passenger subways. The Shanghai Metro Line 2 is also taken as an example. The basic parameters of the train No. 2 are shown in Table 2:

Type	AC02	AC05	AC08	AC02a	AC17
Shape					
Designed speed (km/h)	80	80	80	80	80
Train-frame(part)	6	6	8	8	4/8
Length (m)	–	140	23.54	–	23.54
Width (m)	3	3	3	3	3

Table 2 Basic parameters of the Shanghai Metro Line 2

It can be seen that the time interval between the two subways on Line 2 is about 3 minutes, and the design speed is 80km/h. The minimum interval between the two subway lines is about 4000m, which is much larger than the minimum safe distance of 180m. Assuming that the length of the single-car train of the underground express train is about 20m, and the length of the train is about 160m， if placed between the two passenger subways, it can still ensure a safe distance of 1920m from the front and rear trains. Under such an estimate, it is more feasible to run an underground express train between two subway vehicles [11]. Of course, the specific discussion also needs to be combined with the comprehensive evaluation of the subway track, the actual running speed of the subway, and the train carrying situation.

ii) Cars added to current trains

The underground express train is connected to the subway vehicle to transport, load and unload cargo during the daytime. The transportation process is as follows: two cars are added to the original group. The overall size of the two cars is similar to that of the passenger car; the courier car is loaded with the cargo base station in the subway station, and then follows the subway operation, wherein the express car does not separately design the power system; At the same time as the subway stops at the platform, the express train arrives at the base station cargo platform, the door opens, and during the subway stop at the subway station, the fully automatic modular loading and unloading of the cargo is realized, and then the door is closed and the subway continues to operate; the cargo

module is transported to the base station. Fully automatic sorting and loading by express delivery by the base station. Figure 4 shows the daytime transportation plan ii.

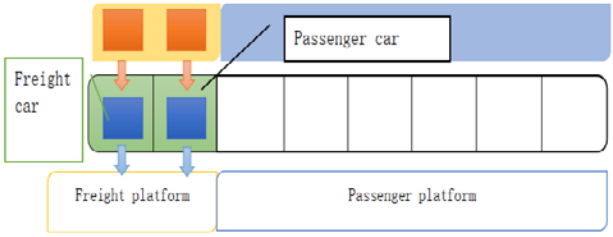

Figure 3 Daytime plan ii transportation process

According to the "Code for Design of Subways" GB 50157-2013, the trains used for international urban rails can be of three types: A, B and C [12]. The widths of these three types of train compartments are 3m, 2.8m and 2.6m respectively. Among them, the railroad line that uses the A-type or B-type train as the transport carrier is called the subway, and most of them use the 5-8 trains for grouping. Therefore, in the case of subway vehicles not fully compiled, it is possible to consider adding two or more sections of freight cars, and most of the stations have reserved grouping space to facilitate vehicle parking.

2) Cargo transportation after the subway stops at night, achieving 24-hour operation

This logistics system adopts the night-time freight express train in the 2030, when the maintenance technology is continuously improved. However, the main task of night transportation is to process the backlog of the previous day, so it only plays an auxiliary role. The scheme is as follows:

After 22:00 in the evening, the overall subway passenger traffic began to drop significantly. Through the early communication of the daily work plan, the underground express delivery vehicle can carry out cargo transportation without affecting the subway maintenance. At the same time, it can also cooperate with the maintenance company. One of the good tools for the exchange of resources or devices between different maintenance sites [13]. In addition, through intelligent system control, the underground express delivery vehicle can also be placed on the maintenance section by reasonably arranging the delivery time. For the repaired road sections, the underground freight transportation system can be started after the maintenance is completed, and the maintenance quality can be checked in advance by the underground transportation trucks to ensure the safety of the railway rails and reduce the probability of no early warning faults/partial stoppages, and at the same time improve Freight efficiency.

In summary, for the long-distance transportation plan in the city, with the continuous emergence of ground traffic congestion, the increasing emphasis on environmental protection issues, and the development of e-commerce, the necessity of adopting underground logistics systems will gradually be reflected. At the same time, logistics facilities planning should be carried out as soon as possible when new subways are built, which can reduce construction costs as much as possible and realize the coexistence of passenger and freight transportation.

2.4 Freight base station express short-term storage

According to the distribution of subway stations and the needs of logistics operations, select some existing subway stations and build base stations to freight. The existing stations will be rebuilt so that the two stations of the subway station have relatively independent operating warehouses, and a dedicated freight passage is established. The goods are transported through the newly constructed freight elevators dedicated to freight transportation. . For new subway lines, it is necessary to consider the logistics needs and design a subway station with a direct connection to the base station. At the same time, according to the characteristics of the large flow of people in the subway, express delivery cabinets can be set up in the subway station, which is convenient for white-collar workers who use the subway for daily commuting to conduct self-delivery of express delivery, further alleviating the pressure of short-distance distribution on the ground. The service area is divided by the base station, and the short-distance regional distribution scheme is designed.

2.5 Short distance regional distribution plan

Traditional express delivery industry often uses goods to reach the distribution point, and notify customers to pick up the documents by SMS or telephone. In the process, such as the user's pick-up time mismatch, courier's labor intensity, low efficiency, express "last mile" problem, etc. Contradiction, therefore, the logistics system adopts a new short-distance distribution scheme to solve the above

contradictions: the service area is divided by the base stations located in each subway station. In each service area, there are several ground delivery vehicles responsible for the corresponding regional express delivery. The distribution on the ground is equipped with a smart cargo box, which runs periodically along the fixed line at a low speed; when the user's express arrives at the base station in the service area, or when the user needs to send the mail, the mobile APP can make an appointment to pick up or send the time. To make express delivery truly consistent with user needs.

2-System Advantage Analysis

At this stage, there are three main types of traditional logistics methods. The first one is the traditional logistics method based on sea, air and ground freight. On behalf of enterprises, there are Yuantong, Zhongtong, SF, Shentong and Yunda. The second is to store goods and letters in large public places such as schools and companies, and users can send them by QR code. The third type of company represented by JD has its own unique logistics vehicles and related personnel, which are rare and similar to the first logistics system.

For the transportation methods we propose, these three categories are potential competitors, and we will name them IDS for the time being [14]. The following is a graphical comparison of IDS and traditional logistics methods. We have selected five aspects, namely, intelligence, speed, safety and usage, experience and environmental protection, cost, and the best, medium and worst with "+", "S" and "-". As can be seen from the following figure, the IDS system shows great advantages in all aspects.

					1	2	3
					Express Companies	Intelligent Carbinets	IDS
Intelligence	Informatization	Information Entry			S	-	+
		Express Inquiry			-	S	+
		Privacy Protection			-	S	+
		Information Timeliness			-	S	+
	Sorting				-	S	+
	Storage				-	+	+
	Transportation				-	+	+
	Delivery				-	+	+
Quickness	Sorting				-	S	+
	Storage				-	S	+
	Transportation				-	S	+
	Delivery				+	-	+
Safety & Usage Rate	Package Failure Rate				-	S	+
	Delivery Error Rate				-	+	+
	Full Storage Rate				+	S	-
	Full Transportation Rate				+	S	-
	Equipment Utilization Rate				+	-	S
	Network Distribution Rationality				+	-	-
	Special Cases	Rural Area			+	S	-
		Number Crest			+	-	+
		Number Trough			+	-	S
Experience & Environment	Convenience	Expressman	Pickup		S	-	+
			Delivery		-	S	+
		User	Mailing		S	-	+
			Receiving		+	-	S
	Flexibility	Expressman	Pickup		S	-	+
			Delivery		-	S	+
		User	Mailing		+	-	S
			Receiving		-	+	+
	Comfort	Expressman	Pickup		-	S	+
			Delivery		-	S	+
		User	Mailing		S	-	+
			Receiving		S	-	+
	Brand				-	S	+
	Packaging Recycling				-	S	+
Cost	Human				-	S	+
	Equipment	Trasportation			+	S	-
		Plant Construction			+	S	-
		Network Construction			+	S	-
S+					13	5	28
S-					20	13	7
SS					6	21	4
					-7	-8	21

Figure 4 SEM analysis chart

Not only that, IDS also solves the contradictions in the traditional express delivery industry. Traditional logistics often uses goods to reach the distribution point, and then notify customers to pick up the documents by SMS or telephone. The following types of problems often occur in this process:

If the courier only waits for a short time, the delivery time is not compatible with the user's available time, and the user experience is poor. After missing the time, it is necessary to delay the re-delivery and increase the labor intensity of the courier.

If the location has a fixed distribution point, the user can pick up the time flexibly, but the courier needs to wait and deliver for a long time, with high labor intensity and low efficiency.

If the location uses the courier delivery method, it will reduce the unnecessary waiting time of the courier, and enable the user to flexibly select the time to pick up the goods, but the cost of the courier company is not improved very well. And the plan we thought out may not be carried efficiently in fact due to cost reasons.

In this mode of transportation, these problems have been effectively solved. The unmanned transport vehicle equipped with a smart container greatly reduces the use of human resources and reduces the work intensity of the relevant personnel. The pick-up time is controlled by the user, the operation is better and the user experience is improved. Therefore, under the guarantee of rich urban road traffic, the comprehensive social benefits brought by this mode of transportation are very considerable.And due to the new delivery system,the infrastructure construction and the to guarantee the normal working state daily,the IDS can also bring jobs and new different working chances for people,which can bring financial improvement to our society.

3-Conclusions

Our urban logistics intelligent design mainly has three parts:combined with the subway system and the existing mature rail transit network in the big city; proposes an unmanned delivery vehicle equipped with smart containers on the ground; and interacts with the delivery vehicles and the underground logistics delivery carrier. The designed and constructed base station realizes the high-efficiency distribution of express delivery in the city, and the personalized on-ground express delivery mode. Compared with the existing express delivery mode, it has the advantages of high efficiency, high resource utilization and large resource utilization. Through the design of the system, the project design has been successfully achieved, and the difficulties and contradictions faced by the traditional express industry have been solved. It has certain reference significance in the future construction of large-scale rail transit networks [15].

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