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High-speed Railway Intelligent and Efficient Security Screening Diversion System

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Abstract

With the rapid development of national railway construction and the continuous improvement of people's consumption levels and concepts, high-speed rail has become the preferred mode of transportation. However, the time-consuming nature of security checks at high-speed rail stations has gradually emerged as an issue. To address the low efficiency and lengthy duration of these checks, this paper proposes an automatic shunt security check method. This method constructs a security shunt system that allows for simultaneous checks of baggage and passengers in their respective channels.The security check process is divided into two main parts: shunting and security checks, specifically consisting of a one-time shunt and two security checks. Passengers can scan a code in the lobby or input their identity information to unlock a trolley for loading their luggage, after which they enter their designated security channels. When both baggage and passengers pass the security checks, they converge at the platform entrance, where passengers can scan the code or input their identity information to access the train and retrieve their luggage. If baggage fails the first security check, it will be sent for a second check; if it passes the second check, it will be transported to the platform entrance. If it fails again, it will enter a baggage waiting area for manual inspection and processing. Similarly, if a passenger fails the first security check, they will undergo a second check, and if they fail this as well, they will be directed to a waiting area for manual processing.During the shunt security check process, passengers can monitor the status of their baggage and security checks in real time through a mobile app. This automatic shunt security check system effectively addresses the long wait times for security checks and the potential loss of luggage. This research is significant for improving the efficiency of security checks at high-speed rail stations.

Keywords

Shunt Security; Timesaving; Theft Prevention; Efficiency.

1. Introduction

In recent years, my country's railway operating mileage has continued to grow. As of the end of 2023, the national railway operating mileage has reached 155,000 kilometers, of which the high-speed railway operating mileage has exceeded 42,000 kilometers. According to the Integrated Transportation Network Plan for Urbanized Areas (2021-2035) [1], my country will continue to strengthen the construction of comprehensive transportation networks in urbanized areas during the 14th Five-Year Plan period. By 2020, the three urban agglomerations of Beijing-Tianjin-Hebei, the Yangtze River Delta and the Pearl River Delta will have basically established an efficient intercity

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transportation network, with one-hour travel between adjacent core cities and between core cities and surrounding node cities. The urbanized areas have gradually improved the intercity transportation network framework. Today, the transportation time between most core cities and between core cities and surrounding node cities has been shortened to 1 to 2 hours. As the convenience and coverage of high-speed rail continue to expand, more and more people choose high-speed rail as their main mode of travel.

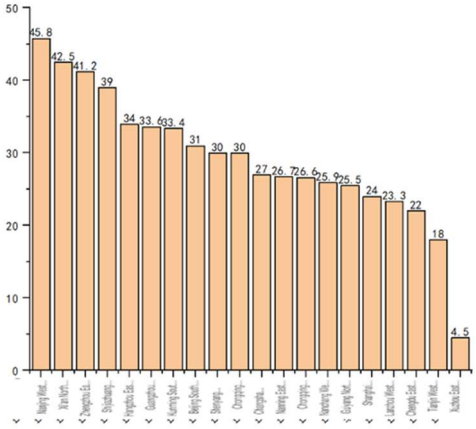

Figure 1. Construction Scale of Stations in China

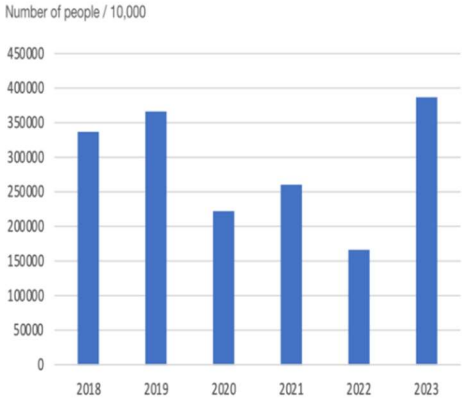

Figure 2. Number of National Railway Passengers Dispatched in 2018-2023

2. Analysis of Existing Issues in High Speed Rail Security Inspection

2.1 The Security Check Process is Time-consuming and Inefficient

At present, the high-speed railway security check method for passengers is a single person by person security check, specifically by passing through the security check machine and passing through the security check door. For example, in Guangzhou station, it takes 15 seconds for each passenger to carry luggage for security check. Under normal circumstances, the security check queue is about 10 minutes. However, due to the mismatch between the speed of security check and the passenger flow at some stations, if the security check is not upgraded, it will affect the passenger organization of some stations to varying degrees. Furthermore, high-speed railway stations themselves adopt flow restriction measures to control queue time, and some stations even have a total queue time of 30 minutes (or even more than 30 minutes) at some entrances and exits. As the passenger volume of high-speed rail continues to increase, the speed and time consumption of manual security checks remain unchanged. The problem of time consumption in manual security checks is becoming increasingly prominent. Due to the time-consuming process of security checks, passengers must queue up in advance for security checks. High speed railway stations often see five or six staff

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assigned to each security checkpoint, responsible for guiding entry, monitoring X-ray security machines, and further investigating suspicious items [2].

For example, during the National Day holiday in 2023, at the South Station of Beijing High speed Railway Station, there are a total of 18 security checkpoints and 34 security channels. When passengers' luggage passes through the security checkpoint, the computer screen will display colors such as yellow, green, red, brown, and orange. The on duty security personnel need to closely monitor the screen, identify key luggage, and require passengers to cooperate with the unpacking inspection. During this process, security personnel may feel exhausted from mechanical movements, which in turn affects work efficiency and increases the duration of security checks [3].

2.2 Risk of Missed Detection of Prohibited Items

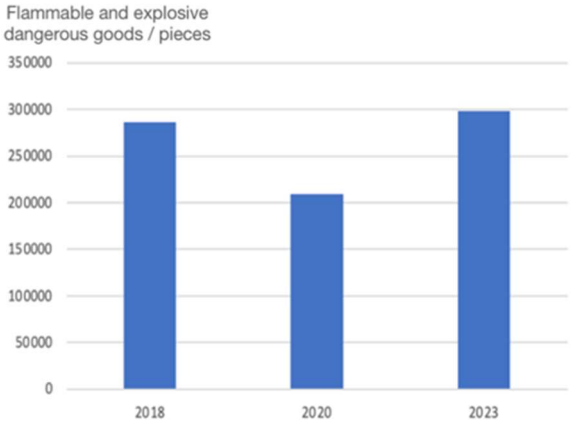

Figure 3. Statistics on the Number of Flammable and Explosive Dangerous Goods Seized in Recent Years

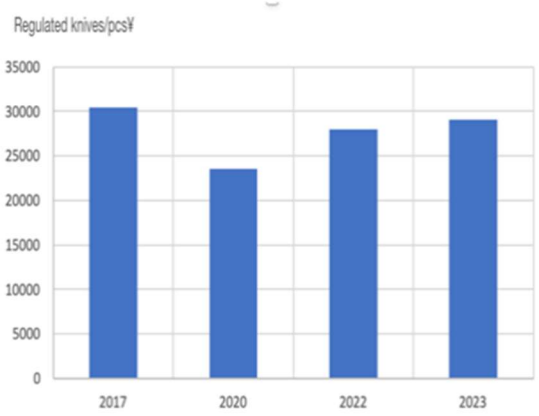

Figure 4. Number of Controlled Cutters Seiz in Recent Years

Figure 3 shows the statistics of the number of seized flammable and explosive dangerous goods in recent years. It can be seen from the figure that the number of seized goods in 2018 was 286393, in 2020 it was 208984, and in 2023 it was 298377. Figure 4 shows the number of seized controlled knives in recent years. From the figure, it can be seen that the trend of the number of seized controlled knives has decreased, but still exists [4].

From the above data, it can be concluded that the risk of missing prohibited items is a serious issue that must be taken seriously in high-speed rail security checks, as it directly affects the safety of passengers' lives and the stability of public order. Once prohibited items are brought onto the train, it may cause serious safety accidents and cause huge losses to passengers and society. Ensuring that prohibited items do not enter the train is the top priority of high-speed rail security checks. As an

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important means to improve the efficiency and accuracy of security checks, the significance of diversion lies in the reasonable setting of security check channels to divert passengers according to different needs, thereby reducing waiting time in line and improving the efficiency of security checks. At the same time, diversion can also conduct more targeted inspections, reduce the risk of missed detections, and ensure that prohibited items are not brought onto the train.

3. New Type of Diversion Security Inspection System

Although intelligent methods and facial recognition assisted verification systems are used in high-speed rail security checks [5], Shortened the time for manual security checks, but did not achieve true full automation and intelligence. People still need to queue up for security checks. This system proposes to use automatic sorting security checks to save waiting time and improve the efficiency of high-speed rail security checks. The comparison diagram of the two security check methods is shown in Figure 5. Due to the preference for convenience and speed in the diversion security check method, which can create a good security check environment for passengers, with the continuous advancement of high-speed rail technology, diversion security check technology will have potential value.

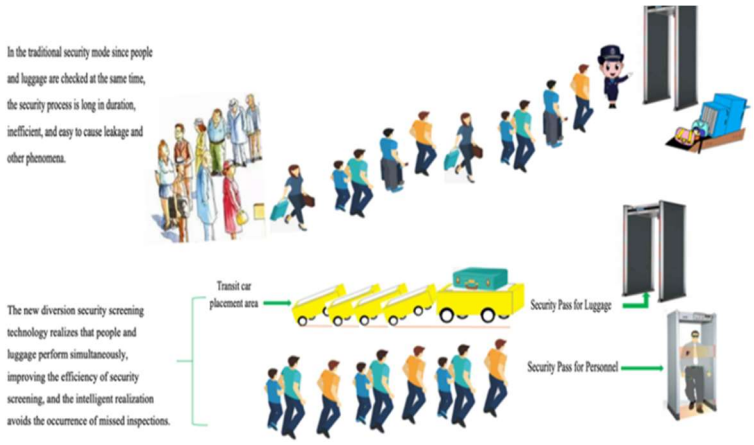

Figure 5. Comparison diagram of security check mode

3.1 Flow Diversion Security Check Process

This security check system includes a waiting hall diversion car placement area, luggage channel, personnel channel, secondary security check channel, platform diversion car placement area, return channel, and diversion car. The specific distribution diagram is shown in Figure 6. The diversion vehicles in the waiting hall are distributed in the lobby. After passengers enter the lobby, they can scan the code or enter their identity information to open the diversion vehicles and load their luggage. They then enter different security channels with the diversion vehicles for security checks. When both luggage and passengers pass through security checks, they converge at the platform's shunting car placement area. Passengers scan the code or enter their identity information to open the shunting car and collect their luggage for boarding; If the luggage fails the first security check, it will be sent to the second security check. If the second security check passes, it will be transported to the platform diversion car placement area. If the second security check fails, it will enter the luggage waiting area and be manually inspected and processed; Similarly, when a passenger fails the first security check, a second security check will be conducted. If the second security check fails, the passenger will enter the waiting area for manual processing. When passengers retrieve their luggage from the platform's shunting car storage area, the shunting car is transported to the return channel and sent to the shunting car storage area in the waiting hall, waiting for its next use. During the sorting and security check process, passengers can view the real-time baggage movement and security check status through the mobile app.

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The shunting vehicle is equipped with a display screen, camera device, card slot, and car cover: the display screen can display the information of the homeowner. Camera device that can record the facial information of the homeowner and save it to prevent theft/misplacement of luggage [6]. Card slot, insert ID card, read information. The car cover can be used to retrieve luggage, and the diversion car is shown in Figure 7. The diversion vehicle is equipped with a Beidou satellite positioning device [7] , Connecting to the passenger's mobile client and synchronizing with the client through a regular socket server can solve the problem of establishing a communication connection [8]， Passengers can observe the location of the luggage car at any time from their mobile phones [9]. If the luggage has not passed through a security check, the Beidou satellite positioning device sends a message to the passenger's mobile phone through the mobile client, informing them of accurate information for real-time monitoring [10].

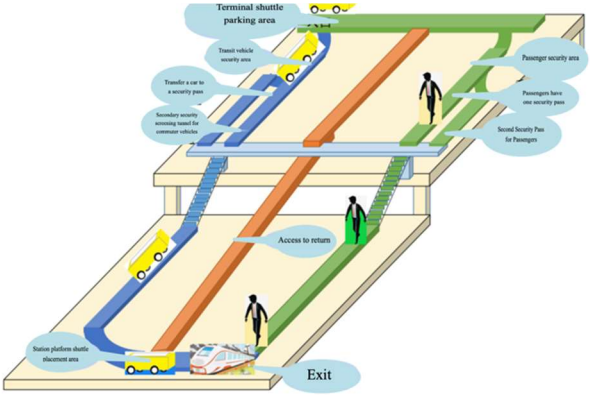

Figure 6. Distribution of security check

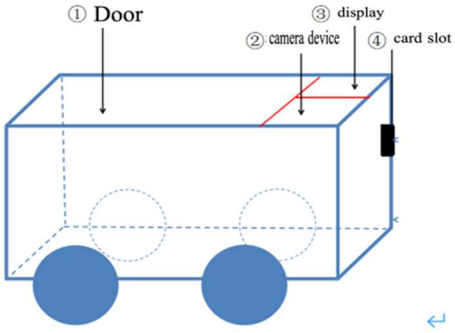

Figure 7. Diagram of diverting vehicles

3.2 Specific Implementation Plan

Firstly, after checking in at the waiting hall, passengers proceed to the sorting vehicle storage area for luggage loading. Identity recognition: Passengers put their ID cards into the card slot, and the induction device on the shunting car obtains information. The information recognition device displays the obtained identity and boarding information on the display screen [11]， Passengers check the information and confirm it, then use a camera device for facial recognition. After double checking the information and confirming it is correct, they proceed with the operation.

Secondly, after completing the luggage loading, passengers will be sent to the cargo channel by the diversion vehicle, and then enter the personnel channel for individual security checks. If the vehicle (person) does not pass the first security check, it will enter the second security check process: specifically, if the person does not pass the first security check, a second security check will be conducted, the alarm device will be turned on, and the staff will be notified that a passenger has entered the second security check channel. If the second security check passes, it will be sent to the

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platform diversion vehicle placement area. If the second security check fails, it will be sent to the passenger waiting area, where a dedicated person will be responsible for security check; If a person passes through security check at once, they will arrive at the platform diversion car placement area and wait to pick up their luggage; If the luggage does not pass the first inspection, it will undergo a second security check, with the alarm device activated. The luggage will pass through the cargo second security check channel. If the luggage passes the second security check, it will be sent to the platform diversion car storage area. If it does not pass the second security check, the luggage will be sent to the luggage waiting area, where a dedicated person will be responsible for security check; If the luggage passes through security check at once, it will be sent to the platform diversion car storage area.

Finally, after the luggage is sent to the platform diversion car placement area, it is unlocked by both the passenger's ID card and machine facial recognition. The luggage is taken out, and the passenger boards the car. The diversion car then returns to the waiting hall diversion car placement area through the return channel for the next transportation. The specific process is shown in Figure 8.

If there are special circumstances where passengers are eager to go through the security check process, they should make a mark on the passenger's security check diversion vehicle, and then walk in the security check channel after passing the security check to speed up the security check.

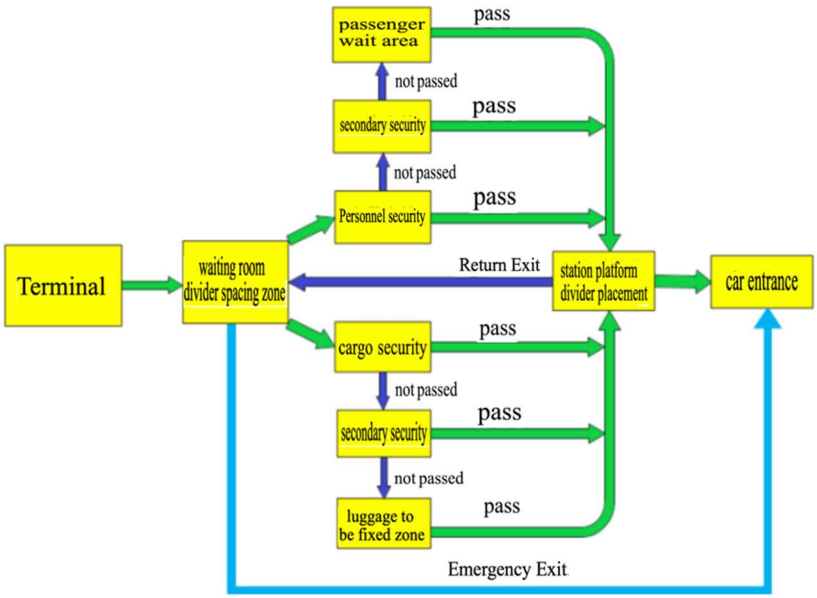

Figure 8. Diagram of the Process of Shunted Security Check

4. Conclusion and Prospect

In order to meet the needs of social and economic development, railways in various countries have carried out large-scale modernization and technological transformation. The common trend of railway passenger transport development in various countries is high-speed and high-density, expanding or adopting double decker passenger cars. At the same time, transportation organization work has been reformed, actively adopting high-tech, and new breakthroughs have been made in heavy load, high-speed transportation, and information technology. The development of railways is currently on the rise, but there are still the following problems in the process of railway development: high-speed railway security checks are manual, time-consuming, and inefficient; During the security check process, due to prolonged work hours, inspectors are prone to fatigue, which can result in missed detections and pose a danger. In this process, people are more pursuing an efficient lifestyle, so it is necessary to make changes on the basis of modern manual security checks. The effectiveness of this system in security checks can be relatively improved.

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The diversion security check method proposed by this system is an automatic diversion security check method for luggage and passengers using the diversion method under the operation of machines. This method constructs a security separation system to separate luggage from passengers for security checks. By combining machine and manual security checks, passengers and their luggage are inspected, which can reduce missed detections, shorten people's waiting time for security checks, and improve the efficiency of security checks.

Acknowledgments

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