Simulation Process Design for Scheduling Mode of Railway Container Terminals based on Flexsim

Xiaoqian Nie¹, Li Wang¹,*
¹School of Traffic and Transportation, Beijing Jiaotong University, Beijing, China

*Corresponding author e-mail: liwang@bjtu.edu.cn

Abstract. Rail mounted gantry cranes (RMGCs) are the key resources of railway container terminals. In this paper, in order to improve the operation efficiency of rail mounted gantry crane and reduce the waiting time of container trains and trucks, rail mounted gantry crane is taken as the research object, and the operation scheduling mode of rail mounted gantry crane is taken as the research point. Based on Flexsim, a 3D simulation platform is built to simulate different operation scheduling modes of rail mounted gantry crane in railway container central station. Next, assuming data and setting evaluation indexes, different loading-unloading modes are compared by simulation. Finally, the optimal mode is selected by analysing the data.

1. Introduction

Under the influence of the "One Belt And One Road" strategy, trade between countries has been strengthened, so the transportation of cross-border goods has also increased. The two main modes of cross-border transportation in international relations are sea and rail transport. Therefore, multimodal transport plays an extremely important role in cross-border transportation.

At present, the prominent contradiction of multimodal transport lies in the connection between different transportations. Containers, because of its integration assembly, have effectively alleviated the connection problem of multimodal transport, which is conducive to the development of multimodal transport. It can be seen that raising the level of railway container transportation and promoting the development of One Belt And One Road strategy are impending. The key to improve transportation efficiency is to optimize the loading-unloading mode of rail mounted gantry crane, to minimize the waiting time of container trains and collectors, and to make the containers run more orderly and efficiently in the railway container terminals.

In the past, many scholars studied the operation mode of rail mounted gantry crane for container transportation. Dai Huafeng [1] used the eM-plant simulation platform to find out the potential law of the distribution ratio and the optimal layout of arriving containers by comparing and analyzing the operation results of different models with different parameters. Li Jianzhong [2] and others specially discussed the dynamic optimal configuration of the rail mounted gantry cranes, taking the shortest free time of the crane as the objective function. Wang Li [3] established the optimal scheduling mode of rail mounted gantry crane, determined the optimal container loading-unloading sequence, and shortened the loading-unloading time of rail mounted gantry crane.

At present, most scholars has focused on loading-unloading mode in port, and the research on the loading-unloading mode of RMGCs in terminals is only theoretical. Therefore, this paper will use Flexsim for simulation of different loading-unloading modes to choose the preferred mode which can improve operation efficiency and reduce train waiting time.
This paper is mainly divided into two parts. The first part mainly introduces the function layout and operation process of the railway container terminals. The second part simply describes the simulation platform’s construction and simulation process.

2. Functional Layout and Operation Process of Railway Container Terminals

As an important node of railway container transport network and container multimodal transport network, railway container terminals are the hub of inland distribution and regional logistics center.

2.1. Functional Layout

According to the functional layout of railway container terminal, it can be divided into three functional areas: main operation area, auxiliary storage area and service area.

2.1.1. Main Operation Area. The main operation area is the nuclear area of terminal’s production and operation. It is mainly responsible for the train’s arrival and departure, loading and unloading, arrival and departure storage, arrival and delivery of containers and other related operations.

2.1.2. Auxiliary Storage Area. Auxiliary storage area is a container storage area outside the main yard, which is used to store containers of different properties except ordinary heavy containers. The loading-unloading equipment of auxiliary storage area mainly includes reach stacker and forklift truck.

2.1.3. Service Area. The service area is composed of facilities and equipment outside the main operation area and auxiliary storage area.

2.2. Operation Process

The objects of storage and loading-unloading operation in railway container terminals can be divided into arrival container, send container and transfer container. Operation process is as follows.

2.2.1. Arrival Container Operation Process. The arrival container is a container that runs through the container train to railway container terminal waiting to be picked up. After the container train enters the loading-unloading line, according to the area where the train containers are located, unloading operations will be carried out by the RMGCs in the corresponding area of the main operation area.

2.2.2. Send Container Operation Process. The sending container refers to the container waiting to be loaded by container trucks. Most of the sending containers are directly transported to the railway container terminals by RMGCs to the main yard for temporary storage and waiting for loading.

2.2.3. Transfer Container Operation Process. Transfer container refers to the container which is unloaded at the main operation yard through the container train, waiting for loading.

3. Simulation Process Design based on Flexsim

The loading-unloading mode of RMGCs studied in this paper consists of six operation modes, which are composed of three groups of different variables: single operation line or multiple operation lines, fixed range or flexible range and single loading-unloading or synchronous loading-unloading mode.

In the study of operation modes of RMGCs, the main reasons why I choose Flexsim for simulation are as follows.

(1) The research objects of Flexsim are complex multi-objective systems. It can output the running results of different parameter combinations of many targets for comparison by analysts and select the better parameter combinations.

(2) Because Flexsim can provide vivid graphical animation and complete performance report.

(3) Flexsim can provide a large number of feedback information related to various schemes through model operation. It can also compare the advantages and disadvantages of different schemes in a relatively short time, and choose a best model.
(4) Using Flexsim can improve the utilization rate of resources, reduce the waiting time and queue length, and distribute resources effectively.

It can realize visualization for different loading-unloading operation modes, dynamic display of 3D effect, and vivid simulation results. So I choose Flexsim to simulate. Simulation results of Flexsim can achieves are shown in Figure 1.

![Simulation results of Flexsim](image)

**Figure 1. Simulation results of Flexsim**

### 3.1. Construction of Simulation Platform

1. Firstly, determine the types of resources that need to be added to the interface, and set the corresponding resource parameters and attributes. According to the requirements of different modes, different number and location of entity models are added.

2. After the layout of entity models are determined, assume the same precondition data. According to the system operation process, the logical relationship between the state variables and different resources of each part of the workshop is analyzed, and establish the simulation model of the loading-unloading line of the rail container terminal.

3. After confirming the rationalization of the model, begin the simulation. At the same time, collect the graphic data records and statistics of the selected resources, and observe the statistical data in the process of the model operation.

4. Finally, according to the statistical data, design algorithm to analyze the data, set up some evaluation indexes, establish a reasonable evaluation system, and compare the production and operation efficiency of different modes, so as to select the operation mode with higher efficiency.

Construction of Simulation Platform is shown as follows.

![Construction of Simulation Platform](image)

**Figure 2. Construction of Simulation Platform**

### 3.2. Simulation Process

The following is the simulation process that I designed. The flowchart is shown in Figure 3.

Step 1: Input the assumed initial data so that all modes are under the same precondition. And set the same simulation days, then go to step 2.

Step 2: Generate container train and set initial parameters, then go to step 3.

Step 3: Start simulation. When the train arrives, assigns a loading-unloading line.

Step 4: Judge whether the loading-unloading line is free. If yes, go to step 5. Otherwise, go to step 6.

Step 5: Determine the unloading position or the loading position of the train, load and unload according to the system loading-unloading requirements, then go to step 7.

Step 6: Repeat step 4.

Step 7: Collect and process data, and analyze the results.
Step 6: Queue until the loading-unloading line is free, then go to step 5.
Step 7: Judge whether the loading-unloading operation is completed. If yes, go to step 8. Otherwise, update area storage information, and roll to next period, then go to step 5.
Step 8: Train departure.
Step 9: Judge whether the simulation time is finished. If yes, then go to step 10. Otherwise update area storage information, and roll to next period, then go to step 2.
Step 10: Collect data for analysis, choose a better loading-unloading mode. Simulation process is stopped.

Figure 3. Simulation Process
4. Conclusion
With the rapid development of multimodal transport, the level of railway container transportation is urgently needed. The emergence of containers has changed the traditional mode of transport of goods and played an important role in international and inland trade in the transport of goods. As an important platform for the development of container railway transportation, the production and operation efficiency of railway central station has an important impact on the transport quality and comprehensive efficiency of the whole railway container transportation network and multimodal transport system. As one of the key resources in the railway container terminal, the optimization of RMGCs’ scheduling mode is very important. Therefore, this paper studies the loading-unloading operation mode of RMGCs in railway container terminals to find out the optimal operation mode by Flexsim simulation. It is hoped that this mode can provide support for the production and operation practice of the railway container terminals and provide ideas for improving efficiency of railway container terminals.

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