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# The Research of Railway Freight Statistics System and Statistical Methods

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## Abstract

*EXT is a JavaScript framework for developing Web interfaces, this paper describes the Ext framework and its application in railway freight statistical and analyzing system and Statistical methods. The paper also analyzes the design, function, implementation and so on of the system in detail. As information technology and the requirements of railway transportation organization and operation continue to improve, railway freight statistical and analyzing system improves obviously in the index system, decision analysis and other aspects, better meeting the work requirements. It will play a more important role in the railway transport organization, management, passenger and freight marketing.*

**Keywords:** railway freight statistics, statistical methods, EXT framework, computer information management system

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## 1. Introduction

Ext JS is a JavaScript development framework, this powerful JavaScript library provides reusable objects and components, simplifying Ajax development and improving client interface impression [1], [2]. By using this framework, we can make use of the Web tier for the development of object features, such as reusability and inheritable and so on. The core idea of this framework is through JavaScript to dynamically create page mark elements, making the page more flexible [3].

### 1.1. Ext Widgets Component Introduction

Widget's original meaning is "small devices". In Ext framework, it means web page UI controls. Like html, Ext has a basic button and some unique components of itself. Here are a few characteristic components of Ext frequently used.

Grid: It is the most frequently used and most popular component in Ext framework. It is a form, the form data source can be in various forms, may be memory data, can also be obtained by accessing the background database, just requiring some simple configuration. Grid has a good package of some ordering, what we need to do is to choose interface. It is also very easy to realize pagination, with just configuring a few parameters.

Treepanel: Navigation of general management system will be by a tree to play, Treepanel's function is to provide a template, you only need to add a navigation to root of the tree and add second-level navigation to corresponding first-level navigation [4]. It can be classified infinitely and meet any demand.

Layout: It provides users with a variety of layout formats, such as accordion Layout, form Layout, column Layout and so on. The most commonly used is border Layout, it can achieve the east, south, west, north and middle of five regions, so that you can use it for the layout of the management system, which eliminates the trouble of developers to define the frameset, and also it has achieved a folding function, so it is convenient.

### 1.2. Ext and Background Interaction

As we have had a rich, powerful, beautiful front page, the question now is how to interact with the background data effectively. Ext doesn't exclusively contact with any server language, so to any language background, it can use Ext in front page. Next we will discuss interaction of Java and Ext.

In Ext the request is set mainly through url property of the Action object set. Ext can use the JSON and XML as the data transfer format, by contrast, we find that JSON is more convenient; also it meets the definition of Ext way and have smaller data size. Our main concern of application system is data processing. If all the data of each request does not need to return to the page, then you can increase the user experience, this is where the role of Ajax [5], [6].

## 2. System Design

### 2.1. System Structure

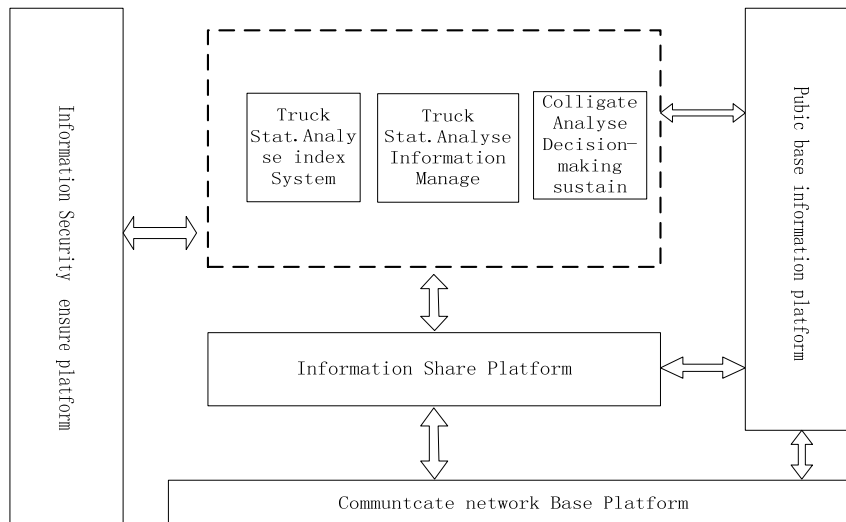


Figure 1. Freight Statistical System Framework

In Figure 1, freight statistical and analyzing Index System, information analysis management and comprehensive analysis decision support compose the application layer of the freight statistical and analyzing system [7]. The three parts plays as the realization layer of application of the system, at the same time, freight application system provides a strong function for railway production to exploit potentialities and improve efficiency, which can be used for decision-making of statistical analyst. Outside the dotted part means the public and basic platform of railway informationization. Data between different platforms can be shared and exchanged. These platforms work together to protect the railway production. At the same time, railway information security platform provides hardware support for these production and application.

Communications network platforms: railway's wide and high-speed communication network fully satisfies the massive data transmission from station, train dept, bureau to Ministry of Railways [8], [9]. By the railway communication networks, we can also transmit audio systems, documentation, software and other products in high-speed. Information sharing platform: through a unified specification, realize information share between freight system and other systems. Publicly basic information platform: by maintaining the basic coding, railway spatial information, transport infrastructure information and other public information, provide basic information services to freight statistical and analyzing systems. Information security platform: it is the safe production system to protect railway production and application network. It is through the hardware to provide a solid guarantee for production and application systems. Railway portal: Through information dissemination and data display railway application system shows the railway production information and data. Freight statistical and analyzing system is an integral part of the portal, and it publics important railway production data by intranet everyday.

## 2.2. Network Configuration

The system is divided into the Ministry of Railways, Railway Bureau, the station levels, all levels of data are in two-way data transmission through the railway freight system software [10]. The current data transmission is via FTP software, system network configuration is shown in Figure 2.

## 2.3. System Composition

Freight management information system is constituted by the receiving module, the data input and manipulation, querying, summarizing, verifying, printing, freight statistics, system maintenance modules, as shown in Figure 3.

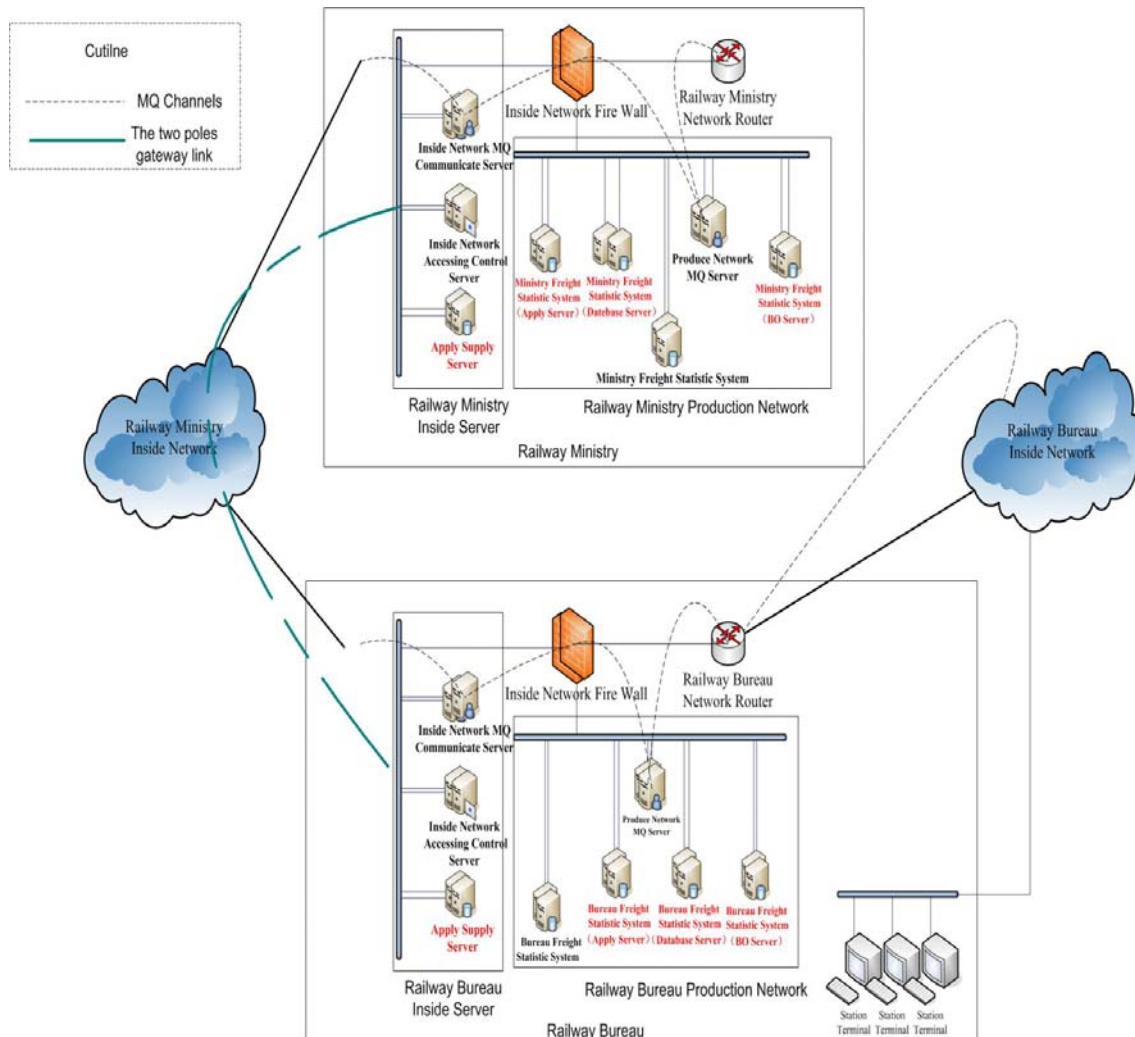


Figure 2. Freight System Network Framework

## 3. System Function

### 3.1. Receiving and Transportation Module

We establish uniform data monitoring and management system of the whole railway to make freight statistical and analyzing system at all levels in real-time monitoring to avoid the emergence of problems. Monitoring and management subsystem monitors the information according to the unit, forms batch, file receiving status, and then send the information back to users. Meanwhile, we develop a unified report template, request statistics data from the station, train dept, Railway Bureau and then we gather the information and make form in database.

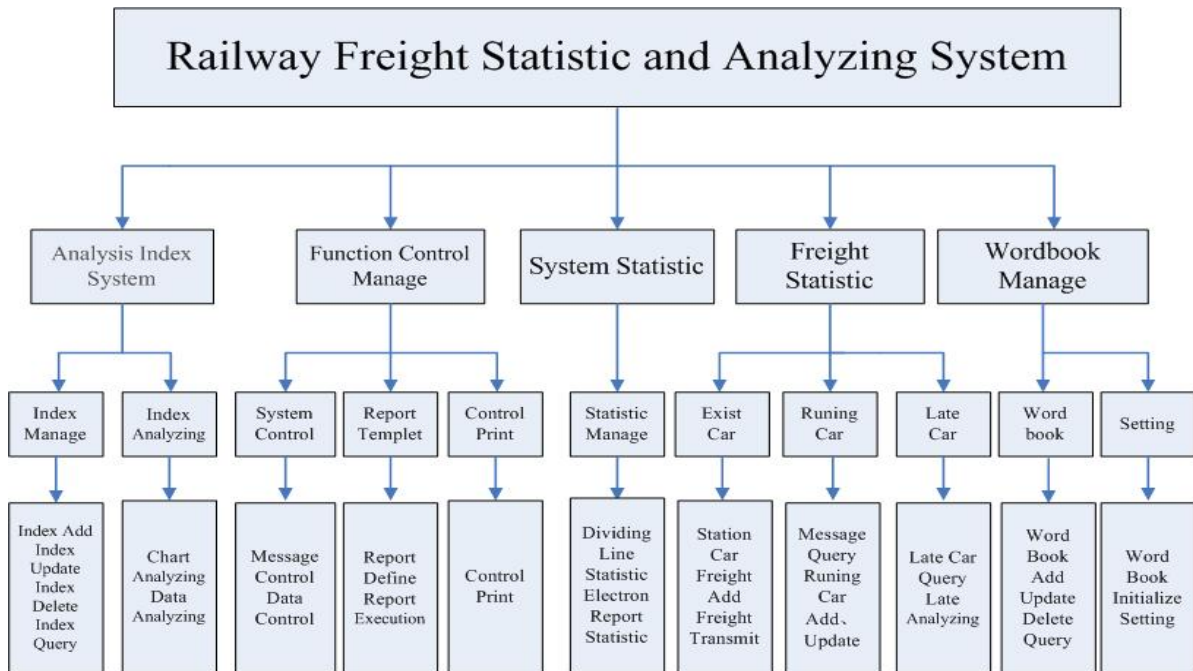


Figure 3. Railway Freight Statistic System Function Frame

### 3.2. Data Manipulation Module

Data manipulation module mainly includes data entry, query and data summary validation. We input daily freight statistical data to the system in accordance with the table name, and YT41 statements is processed as a special report, separately input [11]. We can conduct single table query or multi-table query on the data of database and we also can conduct comprehensive inquiry on report, and ATIS. The data from station or train dept will be summarized and checked. When we make sure it is correct, it will be put into the database.

### 3.3. Printing Module

After data is summarized to database, the system will call BO report through the program and print data generated daily. According to system settings, you can print the appropriate number of copies and the report style. In the print module, to the data, you can conduct querying, printing, saving and so on.

### 3.4. Freight Statistical Module

We can compile the data of In-transit trains and whether it is on time, and then automatically process the data and generate indicators. Freight statistics module includes modules of station to the train, in-transit vehicle management, the station reporting and so on.

### 3.5. System Maintenance Module

It is by dictionary set and dictionary maintenance to ensure that the system technical maintenance of ministry, bureau and station is uniform. By uniform maintenance, we make the statistics reliable, complete and standardized [12].

## 4. System Implementation

### 4.1. Using EXT Architecture

System uses the Java language as a system processing program and uses EXT framework as data show platform, also using Oracle database stored procedures as logic processing system. At the same time, it uses BO 6.5 to develop statistical reports. It achieves the separation of service code and view code, reducing complexity and maintenance difficulty of the system [13].

## 4.2. Environment of the System Operation

Client: PC computer, with Windows 2000/Windows 2003/Windows XP operating system and IE 6.0 (or above) browser. Local area network: railway local area network, TCP/IP agreement. WEB server: AIX operating systems, BEA WEBLOGIC 10 environment. Database server: Operating system is AIX, using Oracle 9i or Oracle 10g as database management system.

## 4.3. Performance Requirement of the System

Regardless of network and other factors, the average individual response time should be 10 seconds, with statistics up to 50 seconds.

Systems development uses B/S mode, and the user can directly manipulate, query and take statistics by the browser, it should ensure that at least five users uses the system simultaneously.

## 4.4. System Security Demands

Network security: We use network security device to isolate outer net and intranet, and in intranet, we manage production network and office network in different segments. The system needs to run in production network in the railway.

System security: We use the user name, password, authentication policies. Using EXT JS encryption for user's password, storing encrypted string in the database and irreversible encryption algorithm ensure the security of user's information [14].

Data security: We use database authorization mechanism to control the user's permission to database. The permission includes two kinds and they are permission to check and permission to modify. Only the user who has the corresponding permission can conduct the corresponding operation.

## 4.5. The Technical Characteristics of System

Freight statistical system Modular, plug-ins, parameter design, has good versatility, while implementation of strict authentication and establishing security mechanism have good security, scalability and maintainability, which optimizes the system and improve operating efficiency.

Freight statistical system uses a web page, concentrating the complex computing in the minicomputer, which makes the system more secure, stable and reliable. Front page uses the WEB display, simple and intuitive. Users do not need to install the program on the machine, eliminating the trouble of installation, simplifying system maintenance. Authorized users within the railway network can login and use the system.

Freight statistical system make data interface of ticket system, scheduling system, ATIS system, and other related systems unified, normal and optimized, which improve real-time And reliability of data interfaces system. The system has alert system of data rationality and changes, which monitors some indexes.

Freight statistical system extends BO interface, compatible with all versions of BO, which lays foundation for BO upgradation next step.

Freight statistical system set up and improved the data receiving and feedback, the data processing between the Ministry of railways, Railways Bureau and station. It also improved the interfaces with the railway freight system. Statisticians can check the data receiving conditions after reporting, including data integrity, the logical checking results.

## 5. Algorithm Used In the System

### 5.1. Freight Turnaround Cycle

Freight turnaround cycle definition and formula

freight turnaround cycle is the basic index to reflect freight utilization efficiency. The relationship between freight turnaround cycle and workload is as follows.

$$\text{Workload} = \frac{\text{using train}}{\text{freight turnaround cycle}}$$

That is

$$U_{\text{Load}} = \frac{N}{\theta} \quad (1)$$

Subentry analysis of freight turnaround cycle

In regular analysis or thematic analysis, the analysis about factors of freight turnaround cycle and their influence on freight turnaround cycle is called subentry analysis[15]. The formula of subentry analysis is as follows.

$$\theta = T_{\text{Carry}} + T_{\text{Technique}} + T_{\text{Freight}} = \frac{1}{24} \left( \frac{l}{v_{\text{Travel}}} + \frac{l t_{\text{Technique}}}{L} + k t_{\text{Freight}} \right) \quad (2)$$

In formula:

$\theta$  —freight turnaround cycle, d;

$T_{\text{Carry}}$  —Total run time in every section of one turnover, d;

$T_{\text{Technique}}$  —Total transfer time between every technical station of one turnover, d;

$T_{\text{Freight}}$  —Total staying time in all loading and unloading stations of one turnover, d;

$l$  —freight train total turnover distance, km;

$v_{\text{Travel}}$  —Freight train traveling speed, km/h;

$t_{\text{Technique}}$  —transit time, h;

$L$  —Average transfer distance of freight train, km;

$k$  —Local loading and unloading rate of freight train;

$t_{\text{Freight}}$  —stay time, h.

## 5.2. Turnaround Cycle of Three Kinds of Train

Trains of railway transportation enterprise can be divided into work vehicles, transfer vehicles and empty vehicles. We should calculate the corresponding turnover time separately. Freight

The relationship between freight turnaround cycle and the turnaround cycle of three kinds trains is as follows.

turnaround cycle is directly related to the turnaround cycle of the three kinds trains. So in analysis, if we know the turnaround cycle of the three kinds trains, it will be easy to know the freight turnaround cycle.

$$\theta = \rho_{\text{Duct}} \theta_{\text{Duct}} + \rho_{\text{Empty}} \theta_{\text{Empty}} + \rho_{\text{Handover}} \theta_{\text{Handover}} \quad (3)$$

In this formula,  $\theta_{\text{Duct}}$ 、 $\theta_{\text{Empty}}$ 、 $\theta_{\text{Handover}}$  mean the turnaround cycle of work vehicles, transfer vehicles and empty vehicles.  $\rho_{\text{Duct}}$ 、 $\rho_{\text{Empty}}$ 、 $\rho_{\text{Handover}}$  mean the proportion of three kinds trains which is calculated by workload of every kind train divided by total workload.

The relationship between freight train static load and freight train variety static load is as follows.

$$P_{\text{Static}} = \frac{1}{\frac{\rho_{\text{SendCoal}}}{P_{\text{StaticCoal}}} + \frac{\rho_{\text{SendOil}}}{P_{\text{StaticOil}}} + \dots} \quad (4)$$

In the formula,  $P_{\text{StaticCoal}}$ 、 $P_{\text{StaticOil}}$  mean freight train variety static load, t/train;

$\rho_{SendCoal}$   $\rho_{SendOil}$ , we use the ratio of freight train variety amount and total freight amount to represent the freight train variety amount proportion.

It is clearly that freight train static load is not only related to freight train variety static load, but also related to the proportion of freight train variety amount.

Table 1. The formula of freight turnaround cycle and workload for different categories of trains factors formula

factors	formula
Work vehicles turnaround cycle	$\Delta\theta_{Duct} = \frac{\Delta\theta_{Duct}}{2} (\rho_{DuctFact} + \rho_{DuctTotal})$
Empty vehicles turnaround cycle	$\Delta\theta_{Empty} = \frac{\Delta\theta_{Empty}}{2} (\rho_{EmptyFact} + \rho_{EmptyTotal})$
Transfer vehicles turnaround cycle	$\Delta\theta_{Handover} = \frac{\Delta\theta_{Handover}}{2} (\rho_{HandoverFact} + \rho_{HandoverTotal})$
work vehicles workload proportion	$\Delta\theta_{\rho_{Duct}} = \frac{\Delta\rho_{Duct}}{2} (\theta_{DuctFact} + \theta_{DuctTotal})$
empty vehicles workload proportion	$\Delta\theta_{\rho_{Empty}} = \frac{\Delta\rho_{Empty}}{2} (\theta_{EmptyFact} + \theta_{EmptyTotal})$
transfer vehicles workload proportion	$\Delta\theta_{\rho_{Handover}} = \frac{\Delta\rho_{Handover}}{2} (\theta_{HandoverFact} + \theta_{HandoverTotal})$

**5.3. Freight Train Everyday Traveling Distance**

Freight train everyday traveling distance and freight turnaround cycle are both indexes to reflect the efficiency of freight train, and both of them are related to freight train total turnover distance. The relation of freight train everyday traveling distance, freight turnaround cycle and freight train total turnover distance is as follows.

$$\text{freight train everyday traveling distance} = \frac{\text{total turnover distance}}{\text{total turnover time}} \quad (\text{km/d})$$

That is

$$S_{Car} = \frac{1}{\theta} \tag{5}$$

Freight turnaround cycle

$$= \frac{1}{24} \left[ \text{total turnover distance} \left( \frac{1}{\text{velocity}} + \frac{\text{transit time}}{\text{transit distance}} \right) \right] + \text{stay time in station}$$

That is

$$\theta = \frac{1}{24} \left[ 1 \left( \frac{1}{v_{Travel}} + \frac{t_{Technique}}{L} \right) \right] + T_{Freight} \tag{6}$$

**6. Conclusion**

Railway freight statistical and analyzing system, closely around the needs of railway transportation and production organization and management, uses advanced experience as a source of reference and adopts more scientific methods to improve the efficiency of statistical analysis and the overall standard of statistical work, which promotes the rapid development for

the railway business. Railway freight statistical and analyzing system is in test in each Railway Bureau now, and next step, we will take the actual needs of railway transportation and production into consideration adequately to improve the system for the early application in railways.

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