A management information system for mine railway transportation equipment

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Abstract: Good equipment management is essential for the day to day management of an enterprise. Targeted at production operation of the railway transportation department of a mining group and aimed at mine railway equipment management, we have established a management information system for the equipment in the entire process of the life cycle of equipment. The project deals with basic data about equipment, initial management, maintenance, operation and even disposal, based on a C/S and B/S structure. We adopted an object-oriented approach, dealing with software engineering, information engineering, economic and organizational measures. Thus, effective monitoring and control of the operation of railway equipment and its status in the entire process has been achieved.

Key words: mine railway; transportation equipment; management information system

1 Introduction

The railway of a mine is a transportation system which consists of a number of different types of assets such as locomotives, a permanent railroad bed and communication & signals (c & s) etc. Compared with other industries, it has many specific characteristics, including complicated and changeable production conditions, abundant and extensive equipment and a mass of mobile devices. As well, there are continuous changes in the use of the equipment. The safety of production of the enterprise depends on real-time monitoring of equipment to ensure it is in good working order[1]. For these reasons, the dissemination of information about railway equipment management by means of modern management is indispensable.

At present, most of the software of the equipment management system developed in our country is for general purposes, which makes it difficult to meet the personal and particular need of the mining industry. Especially for the mine railway where its equipment management system has special and very distinct mining characteristics, railway management is very different from equipment management in other industries. Mine railway equipment management is required to comply strictly with the “Equipment Management of Regulations for Coal Industry Enterprises” and the “Overhaul and Maintenance Regulations for Railway Equipment”, in order to carry on with its dynamic management of equipment, with regard to plans, purchase, acceptance, operation, maintenance and disposal and to maintain monitoring the entire life cycle of its equipment.

2 Main target and function of the system study

For our investigation, we have, delved into development technologies, the practical environment and robustness of the system, its running performance and its hardware needs. In our system design we have adopted the idea of a three-tier structure: i) the façade layer (also called the interface layer) offers a visual interface to the user, who can enter and obtain data through this layer. The interface, simultaneously, provides the user with a certain amount of security; ii) the logic layer, the bridge between the façade layer and data layer. It responds to requests by users from the façade layer, executes tasks, acquires data from the data layer and transfers necessary data to the façade layer; iii) the data layer defines and maintains the integrity and security of the data, responds to requests from the logic layer and accesses the data.
2.1 Main target of the system

The aims of the system are as follows:
1) Realizing electronic management of railway equipment in the entire mining area and setting up statistical databases for the equipment.
2) Using computers to comply with statistical accounting demands about mass data and produce various required reports to provide evidence for daily routine management and decision making in the enterprise.
3) Providing related accurate, timely and complete information for the people who are engaged in the provision of transportation, dispatch and command.
4) Implementing real-time dynamic management of railway equipment, effectively improving the capacity and work efficiency of equipment management and enhancing the utilization ratio and service life of the equipment. It provides powerful support for scientific decisions about equipment management in order to achieve highly efficient production, it ensures the safety of railway transportation and finally it promotes production benefits[2].

2.2 Main functions of the system

The main functions of the system are as follows:
1) In view of the massive amount of information and the constantly changing state of the mine railway equipment, an integrated management information system of equipment (EMIS) has been established. It consists of a universal equipment management, equipment management of the locomotive depot, a permanent railway bed equipment management, c & s equipment management and vehicle equipment management. This EMIS contains a great deal of information and covers a wide range of aspects, involving production, technology, management, etc.
2) Given the “Equipment Management of Regulations for Coal Industry Enterprises” and “Overhaul and Maintenance Regulations for Railway Equipment”, a related function module is established to carry out tracking and issuing warnings. At the same time, an actual dynamic management of equipment process, relating to plans, purchases, acceptance, contracts, maintenance and disposal, is carried out[3].

3) Introducing modern management methods and making use of network charts and critical path techniques to optimize the maintenance procedures of locomotive and vehicle equipment.
4) Based on a unified database, the system adopts both C/S and B/S mode. The C/S mode is adopted for the department which has to deal with large amounts of exchange and input of data and needs frequent, routine maintenance. The B/S mode is used for the management layer which queries and browses information about equipment management. Users can choose either mode according to their own situation.
5) Based on the web of EMIS with its unified database, statistical inquiries, uploading and downloading of reports, data, images, etc. are provided. As well, the function of graphic navigation, which is aimed at the permanent railway line and signaling and communication equipment of the electrical department, by web, is realized.

3 General structural design of system

3.1 Components of the system

Based on the LAN and the C/S & B/S structures, the system includes both a WEB and a development information system. The components of the system are shown in Fig. 2.

3.2 Structural constitution of equipment management

Considering the characteristics of universal and proprietary equipment in a mine railway, a universal equipment management model and proprietary equipment management model has been developed. These models include systems for the following purposes: permanent railway equipment management, electronic equipment management, locomotive equipment management and vehicle equipment management. Some advanced functions are controlled by a server.

Every station and depot has both universal and proprietary equipment:
1) Universal equipment includes basic universal and special equipment, unified by the universal equipment management model.
2) Different stations and depots have different special equipment: the permanent railway depot includes lines (main lines, tracks), sleepers, switches, crossroads, bridges and culverts. The electronic depot includes communications, signals and power. The vehicle depot largely includes vehicles while the locomoto-
tive depot is mainly concerned with locomotives[4].

3.3 Module of each subsystem design

By using a structural design method, each function has its own module. The subsystem is divided into functional models, which cannot only be independent, but are also connected to the database.

For example, the functional structure of the universal equipment subsystem is shown in Fig. 3.

![Functional structure of universal subsystem](image)

Fig. 3 Functional structure of universal subsystem

4 Graphic management and data-flow analysis

4.1 Graphic management

Graphic management largely consists of a station layout and a synthetic line chart of the permanent railway depot. It enables direct and convenient answers to queries and requests for statistics from all the line equipment of the permanent railway depot. It can also manage the tracks, switches and rails at the station. The synthetic line chart collects almost all the information of the line, which includes steel, sleepers, bridges, culverts, curves, slopes, subsidences, subgrades, ballast, etc.

Graphic management cannot only manage at the local level, but also obtains dynamic, detailed information when asked about a specific line from the web by the B/S structure and the WEB.

4.2 Data-flow analysis

In terms of the practical workflow of a permanent railway depot and the structural design of the database, the concise data flow diagram is shown in Fig. 4.

![Data-flow diagram of EMIS of permanent railway depot](image)

Fig. 4 Data-flow diagram of EMIS of permanent railway depot
5 WEB modular function and technology implementation of website

5.1 Modular WEB function

1) Homepage: as the window of information transmission to the public, it includes a brief introduction of the company, related departments, contact details, and so on.

2) Login: through the login model, the relevant specialized personnel can be identified in order to distribute user rights and allow pertinent information browsing and arranging.

3) Information Publication: it enables each related station, depot and manager to transmit information or arrange work. As a result, it forms an information platform to show the situation of each station and depot.

4) Browsing Navigation: according to the investigation and needs, it enables browsing and submit queries of each station and depot by a graphic approach. This method is simple and direct, i.e., it is convenient to use.

5) Search and Query: it enables integrated requests for information and reports, as well as steel information, signal controller information, cable status and so on. It relies on the condition of each inquiry to answer different calls in order to meet the need of the user. For example, one may request the reason for the replacement of a certain signal lamp.

6) Exit: use log off to prevent ultra vires operations.

5.2 Technology implementation of website

The operational principle of the website is shown in Fig. 5.

6 Conclusions

1) This system, with its distinct characteristics of a mining environment, is designed and developed in full consideration of the specific needs of users of the Lu’an mining railway and specifically matches the management characteristics of the Railway Transport Company of the Lu’an Group.

2) Using SQL server as its platform, the system is developed by VB.NET. The interface of this software is user-friendly and is easy to use.

3) With the application of the system, labor intensity has been greatly reduced and working efficiency improved. It not only improves the efficiency and level of EMIS of the mine railway, but also increases the economic benefits of transport management.

4) This system has been in use by the Railway Transport Section of the Pingdingshan Coal Mining Group and the Railway Company of the Lu’an Mining Industry Group Co., Ltd. So far, it has operated normally and produced satisfactory results.

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References


