Chapter 64
Research on the Design of Railway Passenger Traffic Decision Support System

Zhuomin Wei and Hongchao Song

Abstract Considered the insufficient usage of railway passenger traffic information system, we use data mining, online analytical processing, knowledge management and other technologies to develop a railway passenger traffic decision support system. This paper stated the model components and functional module of the decision support system.

Keywords Decision support · Railway traffic · Data mining · Knowledge management

64.1 Introduction

With the implement of railway ticket sale system and real-name ticketing system, multiple ways of getting tickets such as sale windows, phone booking and Internet sales so on, make the railway ticket's getting more and more convenient. Also, the diversification of ticket sale ways makes the related working changes a lot. In this condition, many useful customer information data stored in the databases of railway stations and centers, but have not be analyzed for the improvement of railway passenger service. The railway information systems at present try to solve the problem of railway passenger transport capacity's shortage, and improve the services of railway passenger system. These systems considered only the optimization of the train operation plan but not marketing and decision. The current railway passenger service system has several problems:

1. The system can't divide different influences to railway traffic by different customer groups such as students, migrant workers, travelers and so on.

Z. Wei (✉) · H. Song
College of Information Engineering, Capital Normal University, Beijing, China
e-mail: pinkie_618@163.com

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Without this consideration, the prediction of passenger flow volume will be inaccurate.
2. Ticket data contains much new information, for example, customers' name, passengers' ID number, way of purchase, tickets-getting location, etc. This information can be used in customer clustering, and these analyses will be helpful to solve the difficulty of getting tickets.
3. Railway traffic changes with time, the information system cannot make real-tine analyze. And that brings a lot of problems of station resources' allocation and passenger flow's management.
4. The railway passenger information systems have been built, and have many customers' personal information. But have not been used to supply personal service [1].

To solve the problems we mentioned above, we designed the Railway Passenger Traffic Decision Support System (RPTDSS) with the technology of data mining, data warehouse, knowledge base, information management and online analytical processing (OLAP) so on. The system can analyze the operation data in different time with suitable method to meet with different needs, the analyze result will turn into the corresponding management decision support information [2]. In addition, the system can record customer's behaviors and analyze customer demand and consumption rules, which will help the management section to provide personalized service [3, 4]. RPTDSS makes full use of tickets data, gives more scientific and comprehensive decision support to the railway transport organization sector.

64.2 Architectures of RPTDSS

The main section of RPTDSS is the decision support information hierarchy system, the processes of the hierarchy system includes data collection and preprocessing, data storage and management, data processing, information representation and so on. For the ticket information contains much information, the data storage sector is divided in two branches according to different demands: database processing hierarchy system and warehouse processing hierarchy system. In the processing of database, the model base and model base management system can select proper model based on different command, after the treatments and analyses of the given data, we can get the support decision information we needed. In the processing of warehouse, the data comes from various data resources are divided into different subjects, these data saved in warehouse after data preprocessing, OLAP use the information in warehouse to establish a decision support assumption in multi-angles, and display the result in the form of tables and graphs. In addition, RPTDSS contains the knowledge base hierarchy system, this system will storage the discovered knowledge from database and warehouse, and the system will help us in decision optimization and knowledge sharing. The architectures of RPTDSS are showed in Fig. 64.1.

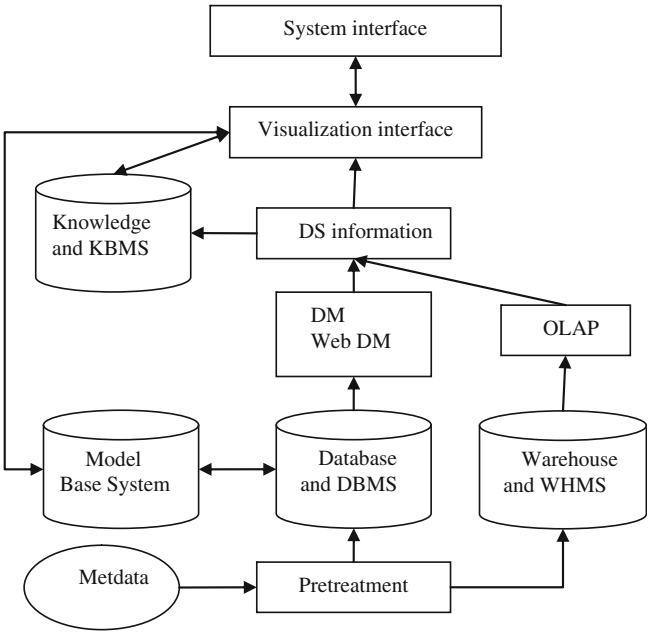

Fig. 64.1 The architectures of RPTDSS

64.2.1 Database and Database Management System

The storage of data is a basic problem of decision support system. Database and database management system are used to keep and operate the date in RPTDSS. The data contains train data, ticket data, passenger data and so on. Every kind of data includes many items and these data all need a data form to store the original data and processed data. The database management system can operate the data in database by the usage of data definition language (DDL) and data manipulation language (DML) [4].

64.2.2 Warehouse and OLAP

Warehouse is built for the fore-end query, and is the basic of online analyze. For this reason, the shortage of warehouse must be efficient; the processing of data needs to be precise. The central problem of warehouse is the storage and management of data; the first step of designing is the definition of system subjects. The warehouse of RPTDSS has five subjects, they are ticket subject, passenger subject, passenger flow subject, transport capacity subject and train schedule subject. Every subject contains fact tables and dimension tables, fact tables are used to store the

measure of fact and the code value of dimension, and dimension tables are used to save the metadata of dimension [5]. The dimension tables can contact with the fact tables by the linkage of key words in dimension tables and foreign keys in fact tables. The original data is processed according to different subject for further analysis.

OLAP can imitate the users' multi-thinking model to make multidimensional analysis. The data in RPTDSS is very complex and contains various kinds of information, so the decision analysis needs multi-thinking of various sides. OLAP can switch between different angles to make comprehensive analysis [6], and turns the results into the information that is needed by railway passenger transport decision makers.

64.2.3 Knowledge Base and Inference Engine

The knowledge base of RPTDSS is used to keep and manage the decision-related knowledge. The system knowledge base has the knowledge from experts of railway passenger transport, and also has the knowledge got from the processing of data mining and OLAP. The store of knowledge base is lamellate: the low-level is fact knowledge, middle- level is rule, and the high-level is policy. The knowledge in these three levels is interdependent. Inference engine is the realization of knowledge reasoning in computer field. It contains two parts: reason and control. Inference engine selects the appropriate control strategies according to the semantics of those knowledge, got new rules and knowledge after reasoning and consistency test [7]. Inference engine gives more scientific decision support to railway decision maker.

64.2.4 Model Base System

Model base system is used to manage and maintain models; it contains model base and model base management system. Model base system is an important part of the decision support systems [8]. The model base in RPTDSS has various kinds of data-mining models such as mathematical models, data processing models, image models, report models, spatial analysis models, etc. These models are stored by a certain structure; we need a model dictionary to index and descript the corresponding model files. Through the model dictionary, we can pick up the models we needed by model name, modeling method, model function and other model information, then we can make further operation such as visit, update, compose and soon. In addition, model base management system can compose several basic models in order structure or choice structure or looping structure, in this way, data base management makes data processing more flexible.

64.3 Function Modules of RPTDSS

Railway Passenger Transport Decision Support System adopts several technologies such as: information management, data management, data mining, behavior analysis, knowledge reasoning, visualization, etc. The system fully dig out the knowledge from information of tickets and customers about passenger flow, customer behavior and other railway field, and reflect to the user in the form of report or graphic. RPTDSS can provide a scientific decision support to the manager of railway transport. To realize the functions of RPTDSS, the system is divided in seven parts, each function modules have several child functions, and all these functions will be helpful to the work in railway system and the improvement of railway services. The function modules of RPTDSS are showed in Fig. 64.2.

The descriptions of function modules of RPTDSS are showed as below.

64.3.1 The System Management Module

This module is used to manage the information and permission of system users; managerial staff can view the daily operation conditions of RPTDSS, and maintain the daily operation of the system.

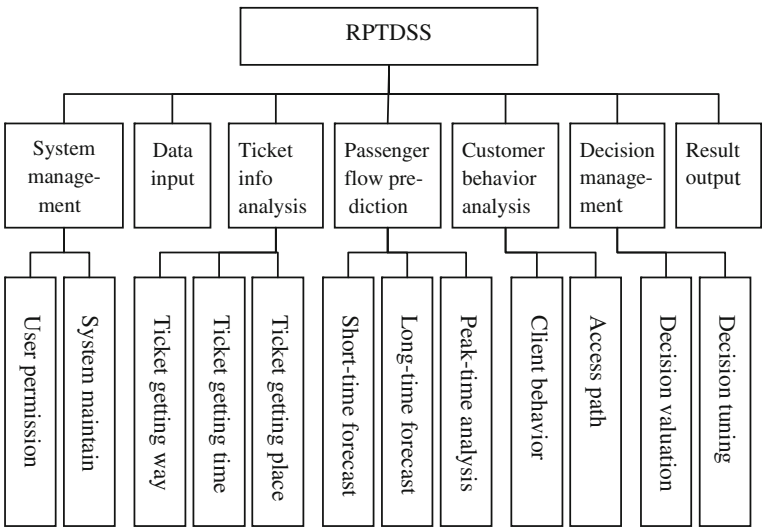

Fig. 64.2 The function modules of RPTDSS

64.3.2 The Data Input Module

The main purposes of this module are collecting the input ticket information and building a suitable database to store the entered information for the further processing. This module can also collect the analysis result of other system to assistant the decisions' making.

64.3.3 The Ticket Information Analyze Module

The function of this module is mining the sales information from ticket information, these information supply decision support for ticket the resource allocation of ticket sale system. This module contains ticket-getting way analysis, ticket-getting time analysis, and ticket-sale location analysis so on. Ticket-getting way analysis is used to count the amount of tickets getting in each way, and according to the result and change trend to adjust the distribution of ticket system resource. Ticket-getting time analysis is used to calculate the proportion of the daily ticket-sale volume in ticket presale period. The result will help the railway manager to adjust the presale period. Ticket-sale location analysis is used to analyze the ticket sales distribution of a train in different station and different time, and it will be helpful to adjust the distribution of tickets' amount in station.

64.3.4 Passenger Flow Analysis Module

The main task of this module is the analysis and prediction of railway passenger flow, the prediction can divide into two parts: long-time prediction and short-time prediction. Otherwise, this module also provide peak time prediction, it can calculate the length of peak time and daily passenger flow volume. These analysis and prediction will be helpful to railway work organizers in transport plan's making.

64.3.5 Customer Behavior Analysis Module

This module is based on the user base of online sale system; it contains customer purchasing power analysis and access path analysis. Customer purchasing power analysis can get customers' preferences in train and seat type through the analysis of customers' trade records. It provides the foundation of personal service. Access path analysis is used to optimize the structure of website, and improve the user experience of the website. Customer behavior analysis give advice to the ticket sector and website operation sector, and it is the basic of personal services.

64.3.6 Decision Management Module

This module is used to record and manage the decision method and plan, it makes evaluation of the performed decision method and gives tuning recommendation. This function gives the system user a visual feedback of the decision.

64.3.7 Result Output Module

This module can output the analytical result of the function modules we mentioned above, this function provides two form of analytical result: report and figure, the railway manager will get paper-based materials. It makes the communication between different sectors more convenient.

64.4 Conclusion

Nowadays the reference of railway passenger transport decision is only the decision makers' experience [8]. The decision support is not very accurate and reliable. To change this situation, this paper adopts several technologies such as data mining, database, and knowledge base management so on to develop a decision support system called Railway Passenger Traffic Decision Support System (RPTDSS). The system concludes ticket information analysis, passenger flow prediction, customer behavior analysis and other auxiliary functions. This system can supply scientific support decision information to the railway transport manager; it is meaningful to the improvement of railway passenger service. Now the design work is complete, but design's turning into practical application still need further research.

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