SYSTEM STUDY ASSISTING DECISION-MAKING PLAN OF USING VEHICLE IN CHINESE RAILWAY

(System Study Assisting to Adjust Empty Vehicle Distribution Plan)

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Abstract: According to the actuality of Chinese railway, based on AI and DSS technology, this passage gives comprehensive discussion of Chinese Railway Decision–Support System of plan in using vehicles (CRDSS) about development goals, functions, structures, model, algorithms models, etc. And the real data of empty vehicle adjusted plan, adopted by the railroad suboffice of Jinzhou, has carried on the instance analysis.

Key Words: plan in using vehicle, specialist system, decision-making support

1. INTRODUCTION

To improve the utilization ratio of the railway transportation vehicle has been one of the important goals that the railway transportation enterprises of every country in the world are pursuing all the time. Statistics show that the rate of vacant vehicles running is 45% on average in American railway and 32.5% in China, especially the highest rate reaching 64.5% in local suboffice of railways. Obviously, an effective way to make full use of vehicles is to make a good plan in using railway vehicle, especially empty vehicle, to reduce the number of running empty vehicles. In China, 70 percent goods are transported in railway. Now more than 500,000 vehicles are running in Chinese railway, and most of them are shared by all railway network of China. So considering the fact and character of Chinese railway transport, making a rational scientific plan of using vacant vehicles is an important question demanding immediate solution.

The railway plan of using vacant vehicles means: based on analysing the requirement forecasting the communications and transportation, to satisfy changing transport needs, a best vehicle distribution scheme is chosen to guide transport and production department to transfer vacant vehicles to places needing them in the rail network. In economic market, to make a plan of using railway vacant vehicles involves social economic development, transport demand structure, transport resource distribution and enterprise benefit, etc. Not only is it a complicated engineering system, but also a typical half-structure or none-structure decision-making problem. Also it involves regional distribution analysis of multiple kinds of vehicles, a large amount of data processing in railway network, restriction of ability of one point in network and equipment, as well as transport rules and regulations, dispatcher orders

and the influence of other uncertain factors. Craft-based model under planned economic systems can hardly meet the need; on the other hand, the computer-assisted decision-making system, based on advanced technology such as AI and DSS, has developed rapidly and become an important direction of the studies in this field. Considering the characteristics of Chinese railway transportation and combining with achievements of many years, this paper carried on the comprehensive discussion of the decision-support system of Chinese railway vacant vehicles on the basis of AI and DSS technology.

2. THE GOALS AND FUNCTIONS OF CRDSS

2.1 General Goal of System Development

Based on the advanced AI and DSS technology, combined with the status quo of Chinese railway, CRDSS aims to develop the decision-support system for making vacant vehicles use-plan. It provides a modern tool and scientific foundation for a tertiary railway vacant vehicles use-plan of China Ministry of Railways, 12 local railway bureaus and more than 50 railway suboffices. It can realize the full use of railway transport equipment, optimize vehicle resource distribution, reduce vacant vehicle rate, and eventually raise efficiency of transport production.

2.2 Basic Function of the System

2.2.1 Function of Dealing with Basic Information and Maintenance

Establish the synthesis database and knowledge database of vacant vehicles adjust-plan in the whole world: Supporting import the data of railway network status, transport needs and vehicles dynamic status, supporting renew and save data.

2.2.2 Function of Automating Vacant Vehicles Use-plan and Supporting Adjustment

On the basis of getting the necessary dynamic data and relative knowledge information, through the results made by adjusting expert system for intelligent reasoning and optimize model of networks, reconciled to simulation law of vacant vehicles, decision-making processes and environment, automatic to finish prediction scheme analyse, sector balance flow and calculate and vacant vehicles application plan calculate to turn into the scheme. And supporting the scheme that produce, providing convenience dialog window or artificial to change and revise.

2.2.3 Function of Optimized Flow in Railway Network

Provide many kinds of ways for optimizing and disposing method with vacant flow for networks. Support multi kinds of the vacant flow assigning and comparative analyses. It cannot consider the macroscopical flow that network ability restrains on the way is disposed and the detailed flow that network ability restrains on the way is disposed.

It also supports statistics of a large amount of data relating to the fact of flow of vacant, and offers the essential data for the appraisal of the planning scheme.

2.2.4 Function of Decision-Support System in Appraising Scheme

Offer diversified forms of appraising models and analyzing data, as well as function to support decision-making for the vacant adjustment. It mainly includes: analysis to use vacant vehicles, appraise to extent for satisfying the transport needs, analysis to rate of finishing plan between suboffices, comparative analysis to result of all kinds of scheme, statistical analysis to network limit (the bottleneck), appraise and analyse to sector ability, analyse to flow of most short route, analysis to arrange vehicles and analysis to appraise substitute.

3. CRDSS DESIGN OF SYSTEM MAIN MODEL AND ALGORITHM

3. 1 The Structure and Realization of CRDSS System

Model of CRDSS systematic architecture is composed of empty car distribution intelligence optimizing module, database maintenance module, explanatory module, knowledge acquisition module and man-machine interface form module, etc. Among them, empty car distribution intelligence optimizing module consists of knowledge database, synthesis database, model method database and expert system model.
In the below, there is a figure of model architecture of CRDSS system.

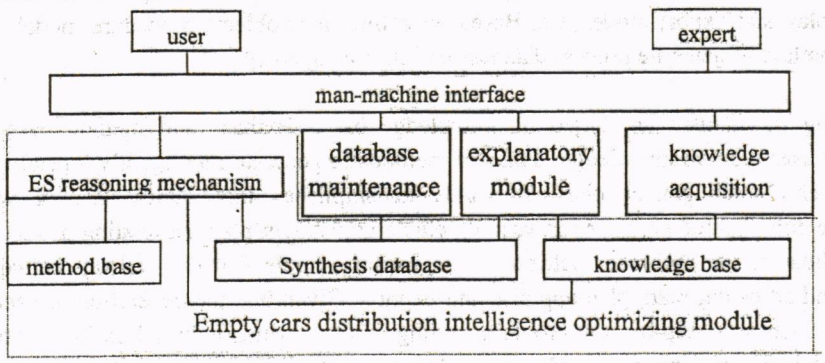

Figure1. the model architecture of CRDSS system

Synthesis database of adjusting vacant vehicles is used to save the information about railway stations, basic states of networks railway and sectors, transport demand of the railway freight and states of vehicles use. It mainly includes information of railway networks, information of railway ability, information of sectors, information of stations, dynamic information of vehicles' demands, information of rest vehicles, information of enterprises' vehicles and information of vehicles' category. Considering the character of basic data category and the needs of importing TMIS (railway management system) data, synthesis database selects the creating model of relevant database and ways to generate, manage and maintain database.

Knowledge database is used to save a variety of knowledge needed by making plan of vacant vehicle adjustment. It mainly includes describing statement knowledge of vehicles category' substitute, property information of vehicle needs and allocating, branch lines, significant station and consignor person; describing course knowledge of relevant policy, principle, rule, stipulating and dispatchers order; describing the special empirical knowledge of complicated situation and its adjustment scheme; describing the expert knowledge of experience, method, law, etc. Considering the hierarchical structure' character of adjusting vacant vehicles and its varieties, we select combined knowledge express way involved course proform, face objects proform and generate rules. We also adopt the way of getting knowledge passively and the method to produce, manage and maintain the make upses last method at rule, producing types for forms, produce, manage and maintain hierarchical structure knowledge database.

Model method base is used to save all models and methods of the functions in realizing the system. It mainly includes generated model of method in searching the shortest route in railway network, shortest route scheme and short odometers scheme; imply model of nearest distribution method of none-ability restrain in distributing vehicle flow, nearest distribute method of ability retrain in distributing vehicle flow, statistical method of sector vehicle flow and sector balance flow; generated model of vacant vehicle adjustment O-D scheme and sector vehicle flow; deal information model, manual adjust-deal information model and optimize adjust method with proviso are impressed in adjust windows; the plan appraisal and export about method of vehicle running kilometers, satisfy substitute vehicle category amount method, method in calculating rate of vacant vehicles' use, method in calculating rate of ability's use, method in calculating rate of plan accomplish between suboffices, analysis method of bottleneck in railway networks, balance analysis method of picking vacant vehicles, the plan display and export model, etc. Based on calling face-objects procedure model, we choose the method of generate process database and its management.

ES Reasoning mechanism are based on knowledge base, database and method base. It synthetically uses relative knowledge, data and methods to generate intelligently logical unit of vacant vehicle adjustment plan. It mainly accomplishes intelligently dealing with half-structure complicated problems in vacant vehicle adjustment plan, simulating deduction of sector adjust chart, optimize distribution of vacant vehicle flow in railway network, generating and adjusting plan, plan appraise and exports. Given that the generation of vacant vehicle adjustment is a step-by-step problem solving process, which is based on information and the selection of appropriate knowledge, model and method, this expert system reasoning mechanism has used control mode of forward reasoning. Based on original or not original level structure's character of vacant vehicle adjustment knowledge, it also adopts search tactics combined with enlighten type and scope priority type. Calling procedure adopts the face-objects method.

Man-machine interface modules are composed with question-ask orders, database-maintenance orders, information-search orders, information-get orders, information-display orders and control-type orders, etc. In order to satisfy the need of system function and its application, the system has six man-computer options including basic data maintenance,

knowledge base maintenance, plan generation, scheme adjustment, scheme export and system management. This system adopts multi interface forms, such as menu, form, dialog box and windows, etc, for intercourse information between man and computer.

3. 2 Main Algorithm Design of CRDSS System Development

Based on main model and method design, according to system development goals and its functional requirement; we design the algorithm of system function modules and use face-objects DELPHI 5.0 platform to finish the development of the software. It mainly includes: realize importing TMIS (railway management system) data algorithm of basic information's dealing and maintenance, get knowledge and display algorithm, generate and maintain algorithm of relative database and knowledge base, simulate information searching algorithm in generating scheme intellectually, scope priority information searching algorithm, face-objects calling procedure algorithm and reasoning mechanism simulating algorithm based on reasoning forwardly and control theories, realize fast shortest route searching 'Floyd' algorithm in function of distributing vehicle flow in railway network, 'all or none' nearest algorithm based on shortest route's none ability restriction, balance flow reasoning algorithm in sectors and nearest distribute algorithm based on shortest route's ability restriction, realize automatically algorithm dealing in artificial adjustment function and vehicle flow distribute algorithm based on dialoging, realize calculate algorithm in appraising whole state of appraisal decision-support function, calculate algorithm in vehicle using whole result, calculate algorithm in various statistics, analysis algorithm in accomplishing plan, analysis algorithm in balance of vacant vehicle adjustment and bottleneck in railway networks.

In order to meet the demands of basic algorithm, the system is mainly classified and designed as 13 kinds of relevant database information tables: railway network ability information table (Ability.db); scheme backup table (blackcap, bakFac, bakFan, bakFaw, bakFay, bakFaz, bakFag, bakFaq); temporary plan and scheme information table (Fap1, Fac1, Fan1, Faw1, Fay1, Fag1, Faq1); plan and scheme information table (Fap, Fac, Fan, Faw, Fay, Faz, Fag, Faq); original railway network mileage information table(OD_old. db); temporary railway network shortest mileage information table(odp.db, odc.db, odn.db, odw.db, ody.db, odz.db, odg.db, odq.db); railway network shortest mileage information table (OD.db); the shortest route information table (Path.db); temporary shortest route information table (Pathtemp.db); original station's vacant vehicle supply-demand information table (Station_yt.db); the original station's rest vacant vehicle information table (Station.db); section vehicle flow information table (Pflow.db, Cflow.db, Nflow.db, Wflow.db, Yflow.db, Gflow.db, Qfow.db); vehicle category information table (Car. db).

4. THE CHARACTER AND APPLICATION OF CRDSS SYSTEM

4.1 System Character

CRDSS system is the first system adopting advanced expert system (ES) and DSS

technologies in China, which is very useful. During the course of developing, we adopt the improved network optimizing and distributing vehicle flow algorithm on the Delphi 5.0 platform of Borland Company. We also adopt the face-objects structure design and programming method. These guarantee that the system is advanced. The design of synthesis database and knowledge base are accomplished on 'database desktop'. Through configuration of BDE, it can connect to large scale database such as SYBASE and ORACLE. In this way, it can realize information exchange and information share with external system of TMIS (railway management system) and FMOS (freight transport management and production management system). This guarantees the system to have open and expansive characters. By adopting simulated traditional homework course and using Delphi 5.0's powerful function in developing dialogue box, the system has multi friendship man-machine interface, such as windows, page layout, menu, selection box and dialogue box. All ensures that the information exchange between man and machine is easy to operate and clearly displayed, and that the system is able to generate plan quickly and to adjust plan quickly, as well as to facilitate the multi-plan simulation experiment. The system supports analysis prediction of vacant vehicle use plan, generation of plans to be selected from, plan appraisal and adjustment, generation of the ultimate plan, etc. and from basic data, specialist knowledge, route selection, section flow, flow in the interface of suboffices, flow to other countries, O-D amount between stations, vehicle category substitute, station owned vehicle rent, adjustment order execution, ability utilization, vehicle utilization, overall goals, effect appraisal, bottleneck distribution in railway networks, balance of pick and send vacant vehicles, etc, provides large amount of information for the leader to make decisions. This system software can be adapted to railway sub-offices, railway offices and the whole country's vacant vehicle adjustment. It can also connect to TMIS to expand the function of needs in railway freight transport and the analysis of result in executing the plan, and connect to FMOS to expand the function of making vehicle using plan. In this way, it supports the decision-making in drawing up the railway technology plan.

4.2 Practical Application Analysis

Combining the facts, with background of Jinzhou branch office of Shenyang office of railway department in china, we use CRDSS technology to provide an instance analysis of suboffice vacant vehicle adjustment. There are nine sublines including jincheng, yechi, weita, xinyi, gaosin, nanpiao, gouhai, huludao, beipiao under the railway subway of Jinzhou office. It has freight transportation in all over 1500 kilometers in freight transportation mileage, more than 150 freight stations. Below (Figure2)we give a sketch map of freight transportation.

4.2.1 The Setting-up and Maintaining of Basic Database and Knowledge Base

Taking into consideration the present situation of suboffices, we establish the basic information database, including vehicle categories, self-owned vehicles, station supply-demand vehicles information, station rest vehicles, section information, and railway network information. We also have developed the maintenance windows for all kinds of data information. **Vehicle categories information:** the structure of the database includes names of

vehicle categories, vehicle category codes and names of vehicle category base. Among them, the names of vehicles categories are mainly box vehicle, open vehicle, flatcars, drugs vehicle, heavy oil tank vehicle, low weight oil tank vehicle, tank vehicle, keeping heat vehicle and other vehicles. Their codes are P, C, N, W, Y, G, Z, B and Q. Names of vehicle categories are FAP.DB, FAC.DB、FAN.DB、FAW.DB、FAY.DB、FAG.DB、FAZ.DB、FAB.DB、FAQ.DB. **Self-owned vehicles information:** the structure of the database includes start off station code,

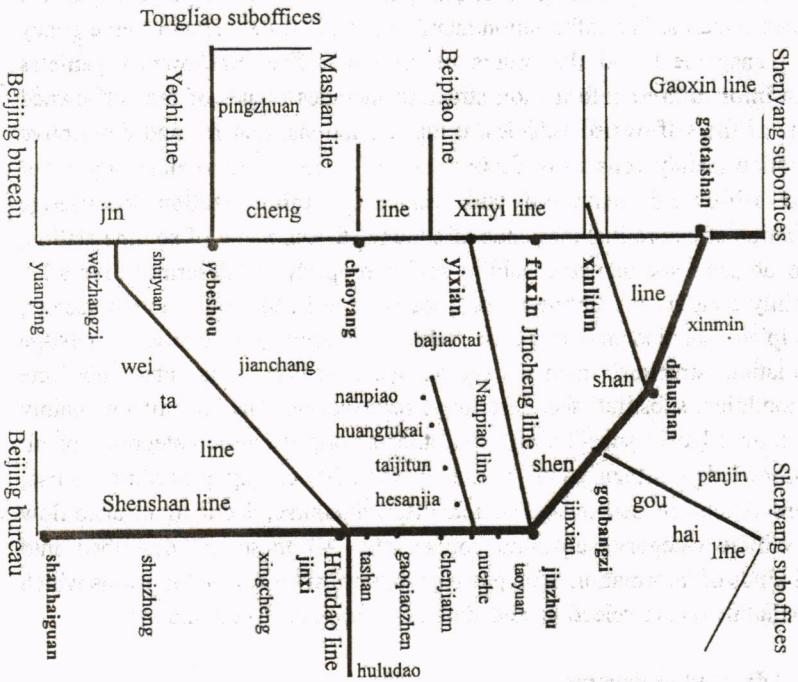

Figure2. the main Freight operation station

start off station name, distributive station codes, distributive station names, give-pick station code, distributive unit, vehicle category and its amount. The information mainly consists of transport coal self-owned open vehicles (average about 100 vehicles a day) from fuxin mine to be emptied in generate factory in the same office, self-owned heavy oil tank vehicles (average about 50 vehicles a day) from daqing oil field of other office to be emptied in Jinzhou refinery oil factory, etc. **Station vacant vehicle supply-demand information:** the structure of the database includes station name, station code, station property, sector station belong to, number of category vacant vehicle, need number of category vacant vehicle, etc. The information mainly consists of supply-demand dynamic information of nine kinds of vacant vehicles in 150 suboffices of own office. **The railway network information:** the structure of the database includes original station code, end station code, section distance (distance between stations), section ability, etc. The information mainly consists of basic railway network data formed in 150 offices. **Sector information:** the structure of the database includes sector name, sector code, sector original station code, sector end station code, direction of sector flow, sector distance, sector pass ability, etc. The information mainly

consists of sector data of 16 sectors Qinhuangdao (Beijing office)-Shanhaiguan, Shanhaiguan–jinxi, jinxi–jinzhou, jinzhou–yixian, jinzhou-goubangzi, goubangzi–dahushan, goubangzi-panjin, panjin-haicheng (Shenyang suboffice), dahushan-gaotaishan, jinxi-yebosho, yebosho-chifeng (tongliao suboffice), yebosho-zhaoyang, zhaoyang-yixian, yixian-buxin, buxin-xilitun, xilitun-gaotaishan and 4 subsectors including mashan subline, beipiao subline, nianpiao subline, huludao subline. **Dispatcher orders knowledge information:** information structure includes station code of sending orders, station name of sending orders, station code of sending orders, station name of sending orders, dispatched vehicle category, dispatched number and descriptive remarks. The information mainly consists of the orders of emergency needs in suboffice management and the orders of railway office. **Self-owned vehicles dispatch knowledge information:** information structure includes owner of the self-owned vehicles, station code of the self-owned vehicles, using regulations, rent fee and descriptive remarks. The information mainly consists of fuxin mine self-owned open vehicles and other suboffice's oil field self-owned heavy oil tank vehicles. **Subline station knowledge information:** information structure includes code of subline station, name of subline station, adjacent station code, adjacent station name, subline station property and descriptive remarks. The information mainly consists of subline relative knowledge in the four subline sectors, such as mashan, beipiao, nanpiao and huludao. **Vehicle category substitute knowledge information:** information structure includes station need vehicle substitute, substitute category, substitute condition, substitute fee, descriptive remarks, etc. The information mainly consists of relative knowledge in substituting each other among the nine categories of all stations. **Original knowledge information:** it mainly includes calling procedure course, executive dispatch orders' course, self-owned vehicle dispatch course, deducing balance flow course of sectors, vehicle category substitute course, etc. All these are described into procedure block. All kinds of information maintenance windows are displayed in forms which have six functions including record selection, add, delete, assure, cancel edit and exit.

4.2.2 Produced and Adjust Plan Scheme

Firstly, if we select menu of 'none-ability plan generate' or of 'ability plan generate' from menu of 'generate plan' in the main menu of CRDSS system main interfaces, according to these options, the system will automatically deal those complicated problems such as category substitute, dispatch orders, self-owned vehicles dispatch, etc, and generate plan scheme. Then through the selecting menu of 'O-D allocates form' and 'railway sector flow form' from menu of 'plan scheme export' in the main menu, we can read the plan scheme and analyze it. If we are not satisfied with it, through the menu of 'windows style adjust' or 'form style adjust' from menu of 'plan scheme adjust' in the main menu of system, we can manually modify or revise the plan scheme.

4.2.3 Appraise and Analyze

Based on created basic database and knowledge base and adopting vacant vehicle dynamic data of Jinzhou railway suboffice from January to June in 2000, this research applies CRDSS systems to conduct a simulative analysis of the monthly vacant vehicle adjustment plan of

railway suboffice. The result shows that the plan scheme generated in CRDSS systems is not only consistent with the actual ones, but also have the function of flow distribution in the weighted edges network, in ability utilizing rate, the pick-send plan accomplishment rate and the plan's vacant vehicle run kilometers, which offers more information about actual sector flow and route selection for makes plan scheme scientific and feasible. So CRDSS system can instead of the traditional man-operating management and greatly shortens the planning cycle and labour intensity of staff planners.

5. CONCLUSIONS

Based on the research of railway vehicle use plan's theories and methods, the passage initiates in China the adoption of the advanced expert system (ES) and DSS technologies to develop the CRDSS application system to provide a modern tool for plan department. Taking into consideration that the vehicle use plan is restrict to transport need, relative policy, transport conditions, expert experiences, etc, the system still has many problems to be further searched, improved and combined with TMIS and FMOS in order to realize the decision-support of railway technology plan.

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