Implementation of Intelligent Decision Support System in India - A Study (With Reference to Railway Empty Wagon Distribution)

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Abstract: *Railway in India is a very complicated and large scale network system. In 2002 the Ministry of Railway of India made a decision to develop a R&D project of Intelligent Decision Support System for the Railway Empty Wagons Distribution plan (REWD-IDSS). This paper, combining the practical R&D project of REWD-IDSS, adopts technological principles and methods of IDSS to develop analysis and research of detail on overall design, implementation method, and systematic prototype development, etc. It develops a goal system of tertiary management mode in which are included the Ministry of Railways, Railway Administration and Railway branch Administration, puts forward the principles proposed which obey decision-making process and performance law in real vacant adjusts plan management coordinate with supported decision-making in overall process of vacant adjusts etc, and selects a structure with parts of problem processing subsystem, database subsystem, model subsystem, knowledge subsystem, and human-computer interaction subsystem, etc.*

Key words: *Railway empty wagons distribution, Intelligent Decision Support System, System Prototype development*

Introduction

The first railway on Indian sub-continent ran over a stretch of 21 miles from Bombay to Thane. The idea of a railway to connect Bombay with Thane, Kalyan and with the Thal and Bhore Ghats inclines first occurred to Mr. George Clark, the Chief Engineer of the Bombay Government, during a visit to Bhandup in 1843. The formal inauguration ceremony was performed on 16th April 1853, when 14 railway carriages carrying about 400 guests left Bori Bunder at 3.30 pm "amidst the loud applause of a vast multitude and to the salute of 21 guns." The first passenger train steamed out of Howrah station destined for Hooghly, a distance of 24 miles, on 15th August, 1854. Thus the first section of the East Indian Railway was opened to public traffic, inaugurating the beginning of railway transport on the Eastern side of the sub-continent. In south the first line was opened on Ist July, 1856 by the Madras Railway Company. It ran between Vyasarpadi Jeeva Nilayam (Veyasarpandy) and Walajah Road (Arcot), a distance of 63 miles. In the North a length of 119 miles of line was laid from Allahabad to Kanpur on 3rd March 1859. The first section from Hathras Road to Mathura Cantonment was opened to traffic on 19th October, 1875. These were the small beginnings which is due course developed into a network of railway lines all over the country. By 1880 the Indian Railway system had a route mileage of about 9000 miles. INDIAN RAILWAYS, the premier transport organization of the country is the largest rail network in Asia and the world's second largest under one management.

Indian Railways is a multi-gauge, multi-traction system covering the following:

Track Kilometers	Broad Gauge (1676 mm)	Meter Gauge (1000 mm)	Narrow Gauge (762/610 mm)	Total
	86,526	18,529	3,651	108,706
Route Kilometers	Electrified	Total		
	16,001	63,028		

Other Interesting facts of Indian Railways

Indian Railways runs around 11,000 trains everyday, of which 7,000 are passenger trains

7566- locomotives	37,840 - Coaching vehicles	222,147-Freight wagons	6853 - Stations
300 - Yards	2300 - Good sheds	700 - Repair shops	1.54 million - Work force

Territorial Readjustment of Zones and In-House Reforms

In order to bring about greater efficiency in administration, speedy implementation of on-going projects, better customer care, reduction of workload on General Managers etc., Indian Railways have decided to create seven new zones by territorial re-adjustment of existing zones. The new zones, having limited financial burden on Railways, will have thin and lean, efficient and modern administrative set up. Two of the new zones have already started functioning.

1. The General Design Target and Development Principle of REWD-IDSS:

The general target, under the environment of TMIS information net work and FMOS data source, is to provide the Intelligent Decision Support System for the timely distribution of empty wagon and assurance of loading job being finished, meeting the needs of transport adequately to realize the efficient exercise of whole railway wagon in India. And to build up REWD-IDSS appropriating to the tertiary management mode for the Ministry of Railways, Railway Administration and Railway branch Administration. The system have the ability to produce plan for empty wagon distribution, to adjust plan of human-machine interaction, to manage and express the output of various information, and also to have the function counting and analyzing the main comprehensive evaluation index in each plan, such as the empty wagon walking-distance, the utilization ratio of empty wagon, bottleneck of route, discharge rate in intersection. All of this aiming at offering modernized tool for scientific decision in the plan and adjustment for the exercise of empty wagon. The basic principles include obeying the rules both in decision-making process and performance law in real vacant adjusts plan management for

tri-grade organization, coordinate between technical plan decision and the external environment condition system of TIMS&FMOS, supported decision-making in overall process of forecasting loading source, vacant adjustment, assignment of route-discharge, plan-working and evaluation of program, fully reflecting intellectual decision support, or reflecting that of system and policymaker integrating, etc.

2. Design and Implement the Overall Structure of REWD-IDSS Model:

2.1 The overall structure of REWD-IDSS model

REWD-IDSS system has picked up the presently mature construction of IDSSII, namely DSS & solution unit of problems & the model structure of Knowledge-base. See Figure 1 and 2.

2.2 Design and Implement the Subsystem of Model Database

There are various models of REWD-IDSS, in accordance with real needs in constructing REWD-IDSS system, we mainly divide the model into mathematics model, data process model, diagram process model and intelligent process model, etc. Math model for the empty wagons distribution: Comprehensive optimal model and algorithm for macroscopic control of loading resource, wagons flow prediction model, empty wagons demand creation model, optimizing model and algorithm of Multi-objective for empty wagons distribution, optimizing model and algorithm of Multi-objective for empty wagons flow distribution. Data process model for the empty wagons distribution: Extraction and transform process model for original data of TMIS (Transportation Management Information System of Railways) and FMOS (Freight traffic Management Operation System of Railways), data process model for empty wagon walk-distance ratio, utilization ratio, work-load evaluation index and assignment index for route flux. Diagram process model: Process model for human-machine interchange graphic display and planning report. Intelligent process model: Knowledge-restriction-based optimal model and algorithm for intelligent decision-making of empty wagons distribution, RGA-based optimal model and algorithm for intelligent flow assignment.

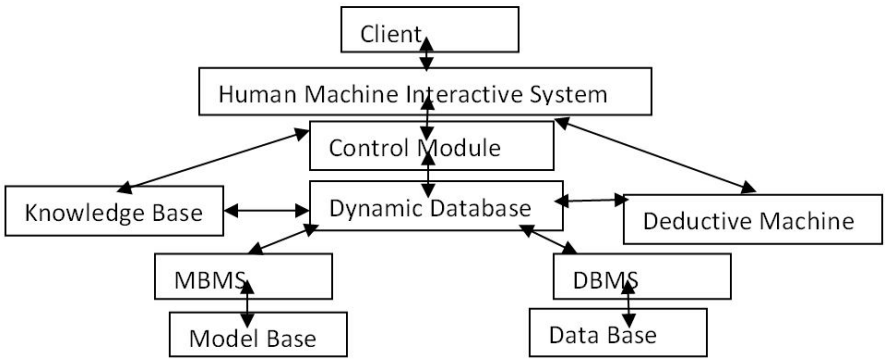

Figure-1 The overall structure of REWD-IDSS

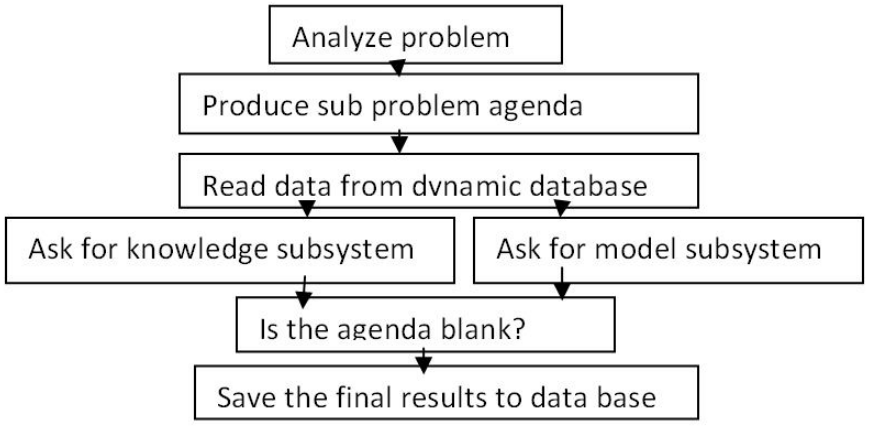

Figure-2 The control process of control module

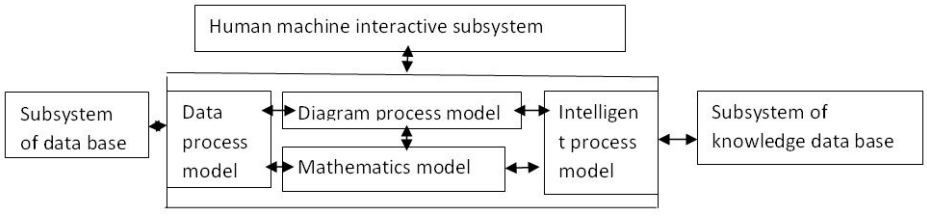

Figure-3 The implemented structure of model database subsystem of REWD-IDSS

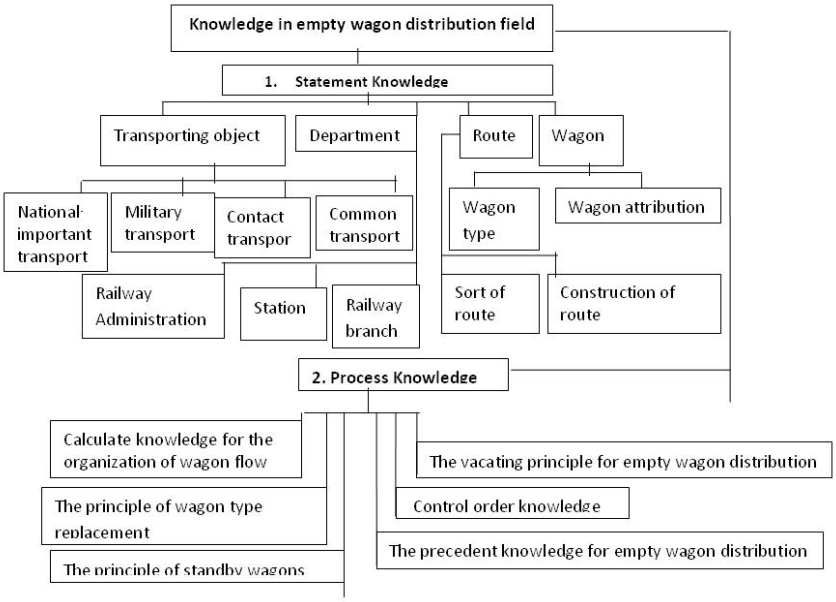

Figure-4 Knowledge in empty wagon distribution

Model database of REWD-IDSS has adopted the storage and design method of categorized unit model. Figure-3 shows the implemented structure of subsystem's model database. The mathematics model in REWD-IDSS adopts the methods of programming (software model) and realizes with C++ or PASCAL so that we can take full advantage of the superiority in speed. The data handle model realized with Oracle database adopts the method of data structure. The intelligent model Proceedings of the adopts the methods of call process. The exiting model developed would be directed used.

2.3 Design and implement the subsystem of knowledge base

The arrangement of knowledge for empty wagon distribution is showed in Figure 4.The statement knowledge mainly include some concepts and

facts, such as consignor, the Railway Transport Department, route, wagon, etc. The process knowledge mainly contain policy of domestic transport adjustment and various technical institution, various rules and control orders for empty wagon distribution, like replacement of wagon type, stand-by wagon, the exercise of decomposed wagon, the utilization of wagons for special purpose, demanding on not existing convection and junction, transport in the shortest route, which are relative to the organization of wagon flow. Besides there are also the rules for wagons flow incorporate calculate in section, the expert and precedent knowledge of empty wagon distribution. The implementing structure of the subsystem of knowledge database for empty wagons is showed in Figure 5, which mainly includes the deductive mechanism, knowledge getting module and knowledge-base. By using the data, function model and knowledge, it can assist making decision intelligently for empty wagon distribution problem, with emphasis on the solution for semi-structural or nonstructural problems.

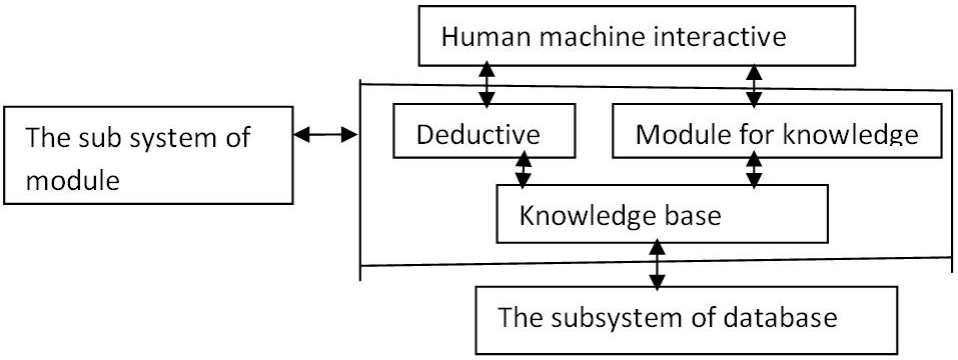

Figure 5 The implementing structure of knowledge-base's subsystem

The establish of REWD-IDSS knowledge repository is adopted the method of knowledge-base, and use the definition of C++ which may derive many sub class according to the category of station. The knowledge of station class with C++ is represented below:

REWD-IDSS

```
Class station {                          //Definition of station
    protected:
        char Name [10];                  //Name of station
        char Name Code [3];              //Code of station
        charManage1 [10];                //Railway Administration
        charManage2 [10];                // Railway Branch
    Administration
        char Rank [1];                   //Rank of station
        char line [10]                   //Name of line
        int number                       //Index Number of station
    public:
        Station ();                       //Constructor function
        ^ÿStation ();                    //destructor function
        Assign ();                       //assign
        Read ();                         //read
        Display ();                      //display
        };
```

The Station class in the represented method is base class, whose member data has attribute such as the name, code, index number of station etc. The constructor function Station () initialize the new object, including the memory allocation, member assigned etc. The destructor ~Station () may clean memory and release object. The member function Assign(), Read(), Display() represent the operation of the object. The design and establish of REWD-IDSS deduction machine are depended on the mixed deduction method combing the positive and reverse deduction and the search strategy with prototype knowledge.

2.4 Design and implement subsystem of database

The implementing structure of database's subsystem for REWD-IDSS is showed in Figure 6. The database of REWD-IDSS is a two-graded database. All of the data from original database, generally, isn't input into the database of REWD-IDSS, however, we in accordance with real need input it. The original database is the large-size database of TMTS & FMOS system. There are great many of relative data documents, such as wagon, train, time table of train, exit of division-bureau, the amount of loaded and unloaded wagons, the direction of loaded wagons and plans for demand on wagons.

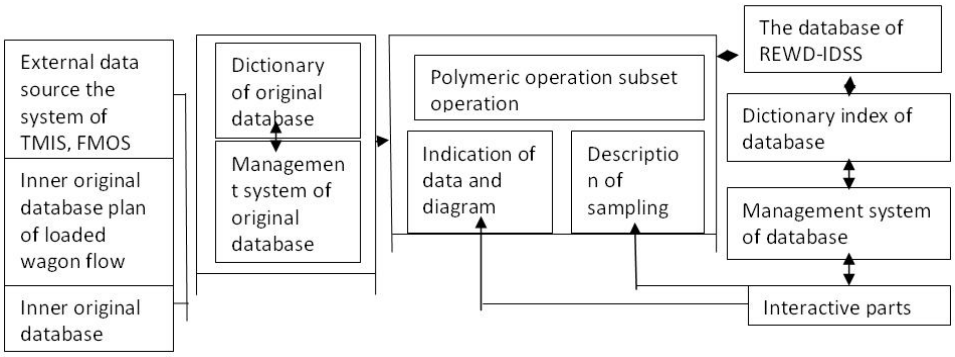

Figure-6 The implementation structure of database subsystem

The basic component part in implementing REWD-IDSS database is showed in Figure 7. Basic database reserves basic data which is directly input or intellectually got from TMIS&FMOS and from management information system for technical planning, meeting the needs of empty wagon distribution. Programmatic database reserves data including program automatic-produced, the middling results and program revised by customers. The reasoning database stores all kinds of dynamic data that are provided during the empty wagons distribution decision-making reasoning. The plan database saves the data which include auto-formed plan, the middle results and the user amending plan and so on. The reasoning database stores all kinds of dynamic data that are provided during the empty wagons distribution decision-making reasoning. Model-dictionary database save the management information of every model of the model database. Data-dictionary database is the set of general dictionaries for the empty wagons distribution such as ministry dictionary, administration dictionary, branch administration dictionary, station dictionary and so on

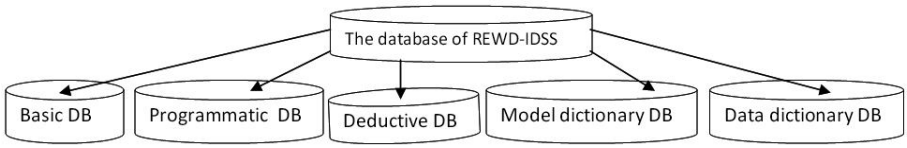

Figure 7 The basic component part of database

REWD-IDSS database's structure of table is below:

1. Data structure of authorizing plan

ID	VARCHAR2(10)	primary key, /*main key*/
Pyc_id	VARCHAR2(10)ÿ	/*mark key*/
LWDW	VARCHAR2(15) NOTNULL,	/*Department*/
NYSLH	VARCHAR2(14) NOTNULL,	/*date number*/
XH	VARCHAR2(1) NOTNULL,	/*index number*/
FZ	VARCHAR2(3),	/*starting station code*/
DZ	VARCHAR2(3),	/*arriving station code */
CZ	VARCHAR2(1),	/*category of car*/
PZCS	NUMBER,	/*number of approving plan*/
PZDS	NUMBER,	/*number of approving ton*/
PM	VARCHAR2(7),	/*name*/
YSTZ	VARCHAR2(2),	/*characteristic*/
FZHZZM	VARCHAR2(10),	/* starting station name */
DZHZZM	VARCHAR2(10),	/* arriving station name */
FJ	VARCHAR2(3),	/* starting station code */
DJ	VARCHAR2(3),	/* arriving station code */
FJM	VARCHAR2(12),	/*starting station name*/
DJM	VARCHAR2(12),	/*arriving station name*/
HZPM	VARCHAR2(20),	/*name of product*/
HZPL	VARCHAR2(20),	/*class of product*/
PZYCFH	VARCHAR2(11),	/*number of approve/
CLBZ	VARCHAR2(1),	/*flag of car */
FFJ	VARCHAR2(3),	/*code of starting administration*/

DFJ	VARCHAR2(3),	/* code of arriving administration */
RC	NUMBER,	/*number of day*/
YS	NUMBER,	/*left number*/
Yxxbz	VARCHAR2(1),	/*null or 1; validate, 0; invalidate */
Bz	VARCHAR2 (20)	/*remark*/

2. Data structure of load and unload of station

ZDM	VARCHAR2(3),	/*station code*/
HZZM	VARCHAR2(20),	/*station name*/
FJDM	VARCHAR2(3),	/*branch administration code*/
LJDM	VARCHAR2(1),	/*administration code*/
CZ	VARCHAR2(2),	/*category of car*/
ZCS	NUMBER,	/*load number*/
XCS	NUMBER,	/*unload number*/
ZXC	NUMBER,	/* last number*/
BZ	VARCHAR2(20)	/*remark*/

3. Data structure of load and unload of railway station

JM	VARCHAR2(6),	/*administration name*/
CZ	VARCHAR2(6),	/*category of car*/
ZCS	NUMBER(6),	/*number of load*/
XCS	NUMBER(6),	/*number of unload*/
ZXC	NUMBER(6)	/*last number*/

4. Data structure of table of empty car

ZDM	VARCHAR2(3),	/*station code*/
HZZM	VARCHAR2(20),	/*station name*/
FJDM	VARCHAR2(3),	/*branch administration code*/
LJDM	VARCHAR2(1),	/* administration code */
CZ	VARCHAR2(2),	/*category of car*/
CS	NUMBER(6),	/*number of car*/
CRBZ	VARCHAR2(1),	/*flag*/
BZ	VARCHAR2(20)	/*remark*/

5. Data structure of routing information of empty car

JLBH	VARCHAR2(7),	/*number of routing*/
FFJDM	VARCHAR2(3),	/*branch administration code*/
FZDM	VARCHAR2(3),	/*station code*/
FJDM	VARCHAR2(3),	/*administration code*/
DFJDM	VARCHAR2(3),	/* branch administration code */
DZDM	VARCHAR2(3),	/*station code*/
DJDM	VARCHAR2(3),	/* administration code */
BZ	VARCHAR2(20),	/*remark*/
QCLC	NUMBER(6),	/*total length*/
BS	VARCHAR2(1)	/*own car 0 car 1*/

6. Data Structure of initial table

ZDM	VARCHAR2(3),	/*code*/
HZZM	VARCHAR2(20),	/*station name*/
FJDM	VARCHAR2(3),	/*branch administration code*/
LJM	VARCHAR2(1),	/*administration code*/
CZ	VARCHAR2(2),	/*category of car*/
CS	NUMBER(6) ,	/*number of number*/
CRBZ	VARCHAR2(1),	/*flag*/
BZ	VARCHAR2(20)	/*remark*/

2.5 Design and realization of the human-machine interactive subsystem

According to the basic demands of REWD-IDSS system construction, REWD-IDSS system will face three kinds of users. The first one is developer and maintainer who are mainly composed of computer technology persons. They update and maintain database, model database and knowledge database through the human-machine interactive subsystem (interface). The second is developer of model and algorithm tool with REWD-IDSS. They construct models of all units, simulate analysis of arithmetic, and amend parameter through the human-machine interactive subsystem (interface).

The third one is final users who are main policy-makers of program workout for the empty wagons distribution in ministry, administration, branch administration. They do practice operation for the empty wagons distribution through the human-machine interactive subsystem (interface). The configuration of realization of the human-machine interactive system for the REWD-IDSS is showed in the Figure 8. For ministry and administration, it was developed by the technology based on Web browser. For branch administration, there are two kinds of design methods of the human-machine interactive system for the REWD-IDSS. The first one is based on browser. The second one uses the interface design function of Delphi 6.0 and adopts the dialogue method that combines menu technology and the function of input and output.

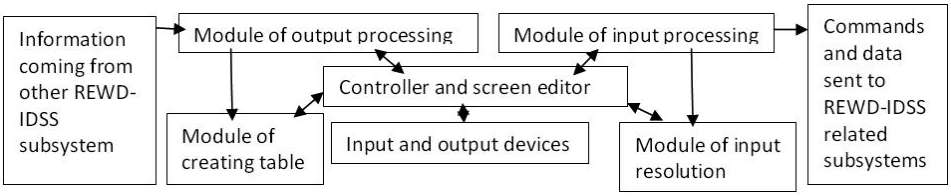

Figure 8 Realization of the human-machine interactive system

3. Analysis of the Development of Systematic Prototype to the REWD-IDSS

The TMIS system of Indian railway is based on the X.25 protocol, which connects the administration, branch administration, and department of railway. It has central Server , ORACLE data system, and 2200 information dots, which may provide exact and completed dynamic information in time including car, engine, container etc. FMOS system is based on the TMIS, which constituted unite shipper, unite station, branch administration, administration, and railway department, whose function is to sustain product management of freightage plan including data collected and car flow plan and data exchanged and finishing analysis and statistic. REWD-IDSS system developed under the TMIS and FMOS is a DDS, whose function is sustain

product manager of railway plan including establishing three grade plan of railway department, administration and branch administration and exchanging data and analyze plan etc. REWD-IDSS system which is showed in the Figure 9 selects a system structure which is composed of client / server (C/S) and browser / server (B/S). The structure of C/S may use independent hardware and many kinds of different system platform. It offers open interfaces that make the expansion and maintenance of system easier and assure the security and integrality of data. The structure of B/S is convenient to the release of information and browse and download of the related departments. It may be used for the exchange of a lot of information that are demanded for the empty wagons distribution plan of all level.

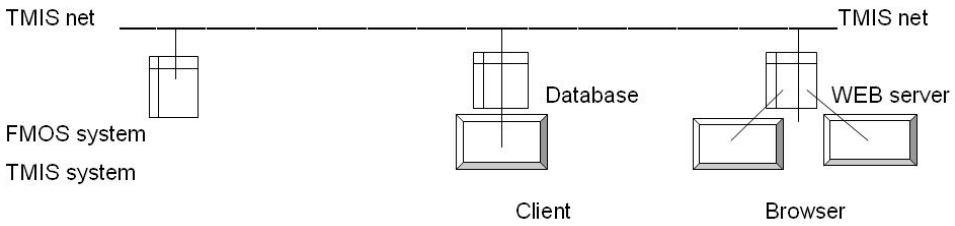

Figure 9 System structures of REWD-IDSS

4. Conclusion

This paper combines the reality of the Indian railway, does research on overall design, implementation methods of REWD-IDSS and the content of systematic prototype development. The research and development of systematic prototype has been finished, some research results have already been used, actual application system will be dropped into to use in 2009.

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