Design and Implementation of Assistant Decision Support System for China's Large-Scale Railway Passenger Station

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Abstract: Combining with the results of key scientific research project for China's railways ministry,based on the characteristics of service management for China's Large-Scale Railway Passenger Station, theories and technical methods were used,such as advanced computer dynamic simulation, artificial intelligence expert system,GIS geographic information system, decision support and system integration.Technical design for dynamic passenger flow organization and intelligent service assistant decision support system were studied,as well as making the scheme and putting forward decision support proposal.

Keywords: China's Large-Scale Railway Passenger Station,Operations management, Intelligent service, Decision support systems, Anologic simulation

1. INTRODUCTION

The amount of distributing volume for large-scale passenger railway station is large, the structure inside station has diversity, customer service equipments are in large quantities ,and the network layout for passengers to transfer is complex. According to the adjustment of the station location, the change of passenger traffic streamline, the increase, decrease or updating of customer service equipment, and temporary traffic control, it is subject of great significance that customer service equipment was optimized to utilize to enhance the level and quality of management for large railway passenger station. According to the actual research of major project of Railway Ministry whose topic is "Management and Intelligent Technology Deepen Study for Large Passenger Railway Station", Anylogic simulation model was built. And taking Beijing south station as example, simulating the organization of passenger flow, optimization scheme of the passenger flow organization is put forward, and hope that it can provide decision support information.

2.REALIZATION PROCESS OF ASSITANT DECISION SUPPORT SYSTEM FOR OPERATIONS MANAGEMENT OF PASSENGER ORGANIZATION

Large-Scale Railway Passenger Station is treated as a complex system, passenger flow organization management solutions ,especially the peak passenger flow organization and management ,is characterized by large traffic and a lot of changes, sending trains more tension, passenger transportation group complex, equipment ability intensity, and also needs each type of work, the overall coordination and cooperation of each process and also needs to the comprehensive utilization of facilities, equipment, more need to carry on the overall coordination and optimized. Previous research has proved that: large passenger traffic organization and management problems are difficult enough to establish mathematical model, and the method through simulation is the effective way to solve the problem of large passenger traffic organization and management.The simulation of passenger activities within the bus by means of simulation, which can acquire the relevant estimated indicators, conduct more accurate quantitative analysis, and improve the traffic organization scheme of pertinence and operability. Therefore, decision support system in large passenger traffic organization and management of development, the innovative technology to embed the simulation software system, using the simulation technology for the simulation of passenger flow organization related problems to find solutions.

Using Anylogic simulation software, the simulation equipment change, the specific situation of streamline , make corresponding plan, deposited in the plan in the library. When there is a situation occurs, the contingency plans in the library can find out the corresponding plan. If the plan in the library does not, it can be drawn by running the Anylogic software. Finally, in decision support advice, we can find the corresponding decision help. Specific research process is as shown in figure 1.

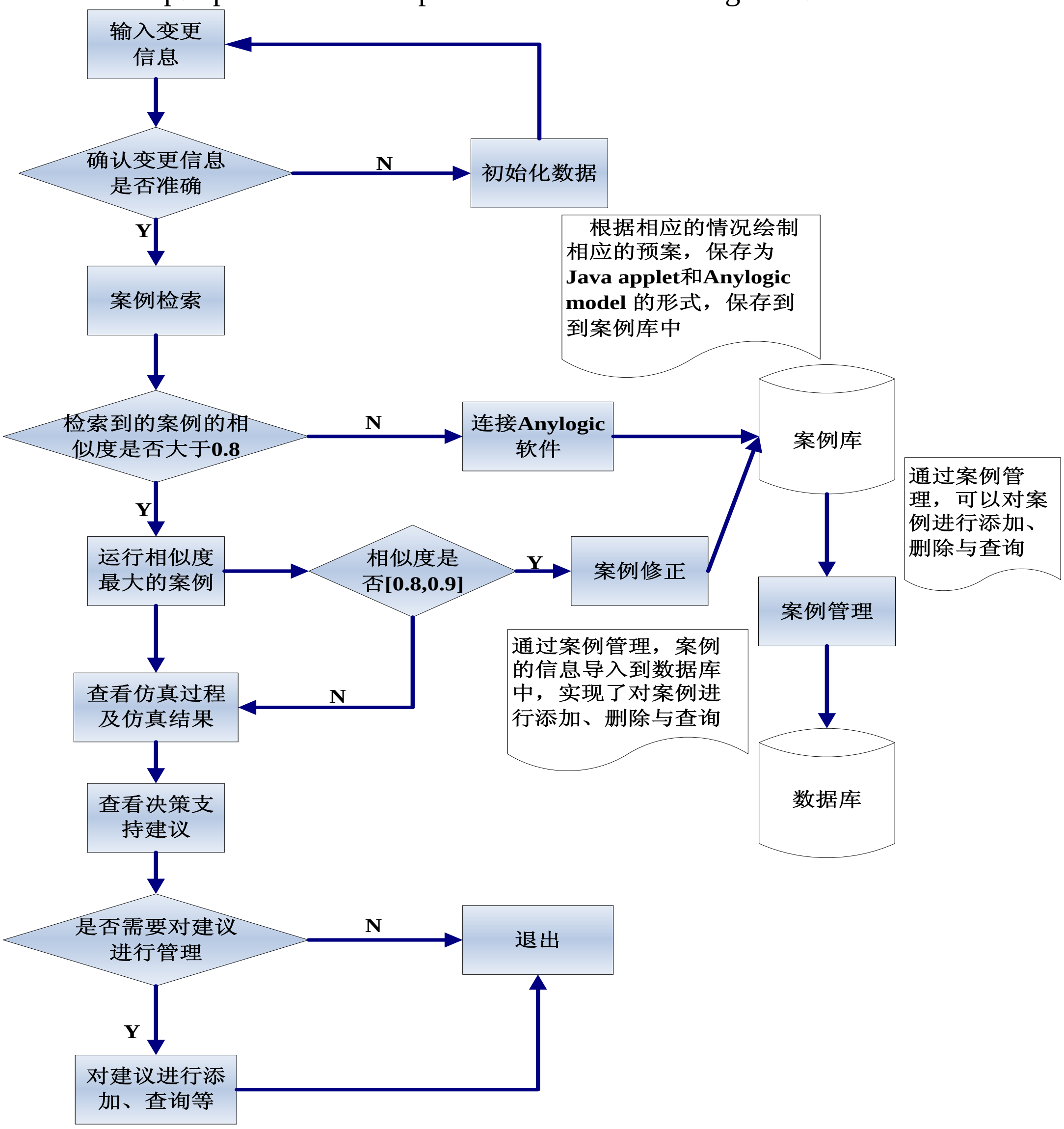


Figure1.development process of management decision support system of passenger organization for Large passenger railway station

3.DESIGN AND IMPLEMENTATION OF PROTOTYPE APPLICATION SOFTWARE SYSTEM FOR ASSISTANT DECISION SUPPORT SYSTEM FOR CHINA'S LARGE-SCALE RAILWAY PASSENGER STATION

BasedAccording to the design of basic function, this system's module of structure mainly includes: Traffic organization scheme condition input module, plan call module library, passenger flow organization plan maintenance module, decision support for module, help module and so on. Traffic organization plan condition input module mainly includes elevated layer data input, data input, initialization data, the underground layer.Overhead layer data input/underground data input includes equipment parameters, passenger flow organization change information, using the pop-up tabular mode;Plans call modules includes, respectively elevated floor plan simulation running and plan of the ground floor of a simulation running and can calls for corresponding plan simulation in any platform by transforming Anylogic model into a Java applet mode;Traffic organization plan database maintenance module includes storage directory, connection Anylogic software and program management ,and Budget management is mainly to add, delete, and query plans; Decision support for modules provides decision support to help advice for the user reference; Help module is to provide the user manual.

Basic function module design and implementation of function is as follows:

3.1 Main Menu for Decision Support System

The drop-down menu of traffic organization scheme of the system main menu window condition input function:enter projects mainly include elevated layer data input, data input, the underground layer initialization data.Main menu for decision support system is as shown in figure 2.

Figure2. main menu for decision support system

3.2 Input Module of Traffic Organization Project Condition

Elevated layer data input menu items mainly includes the equipment parameters、 the passenger flow organization change information.The module mainly realizes related data input of passenger flow for elevated layer and underground layer, function of data initialization is also included.Data of passenger flow organization plan mainly refers to equipment parameters, such as the number of security equipments in each entrance,entrances in the station,and the number of ticket offices.The module also can realize the confirmation to changed parameters.The changed data of passenger organization flow is displayed dialog box with red color.If information is wrong,the user can return to the main menu,and before restarting to change data,it should be initialized first.The menu of elevated layer data input is as shown in figure 3.

Figure3. Elevated layer data input

3.3Simulation Model for Pre-arranged Plan of Passenger Flow Organization

The main function of module call the corresponding pre-arranged plan to similize according to changed information of passenger flow organization.The simulation results include flow parameters,sojourn time and average queue length, etc.While calling pre-arranged plan,judgment for the existence of pre-arranged plan must be made firstly.If existing,then pre-arranged plan can be operated directly,otherwise,dialog popup would be found,in which it is included that plan is not found, please use the Anylogic software to render and then add in.After added, changed pre-arranged plan can be used.Simulation model for pre-arranged plan of passenger organization is as shown in figure 4.

Figure4. simulation model for pre-arranged plan of passenger organization

3.4 Pre-arranged Plan Maintenance for Passenger Organization

It is mainly responsible for the management of the plan,including drawing plan, add plans, query plan, delete plan, etc.Model of Plan library maintenance for passenger organization is as shown in figure 5.

(a)

(b)

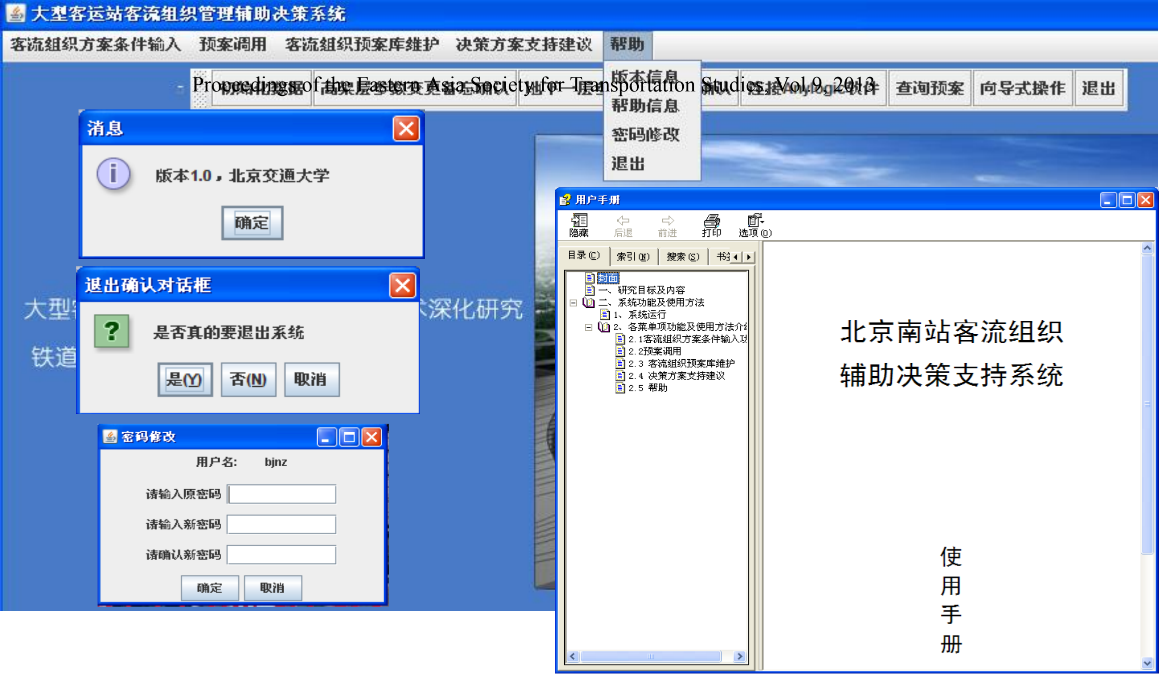
Figure5. Model of Plan library maintenance for passenger organization

3.5 Advice and Help Function for Decision Support

Decision schemes support advice for functional modules can put forward the solution of the corresponding contingency plans, and a proposal for the query, modify, add, and delete according to the results of the simulation plan.

Help function module mainly includes the four parts of version information, helping information, passwords modification and exiting.Decision support functions of advice and help is as shown in figure 6.

(a)



(b)

Figure6. Decision support functions of advice and help

4.IMPLEMENTATION OF PRE-ARRANGED

4.1Simulation Example of Underground Layer for Beijing South Railway Station

Taking underground layer of the station as example, establish simulation and optimization model, analyze the optimization of passenger organization management.

（1）The simulation environment design

There are 8 exits in the east and west sides of underground layer ,4 ticket offices,4 escape routes(the west 1 escape route, west 2 escape route, the east 1 and 2 escape route).There are 7 stops halls in the east side, from south to north it is in order that there are 2 Inter-city stops halls,3 high-speed stops halls,2 common-speed stops halls,2 bus exports in the north and south direction. Simulation environment of Underground Layer for Beijing South Railway Station is as shown in figure 7.

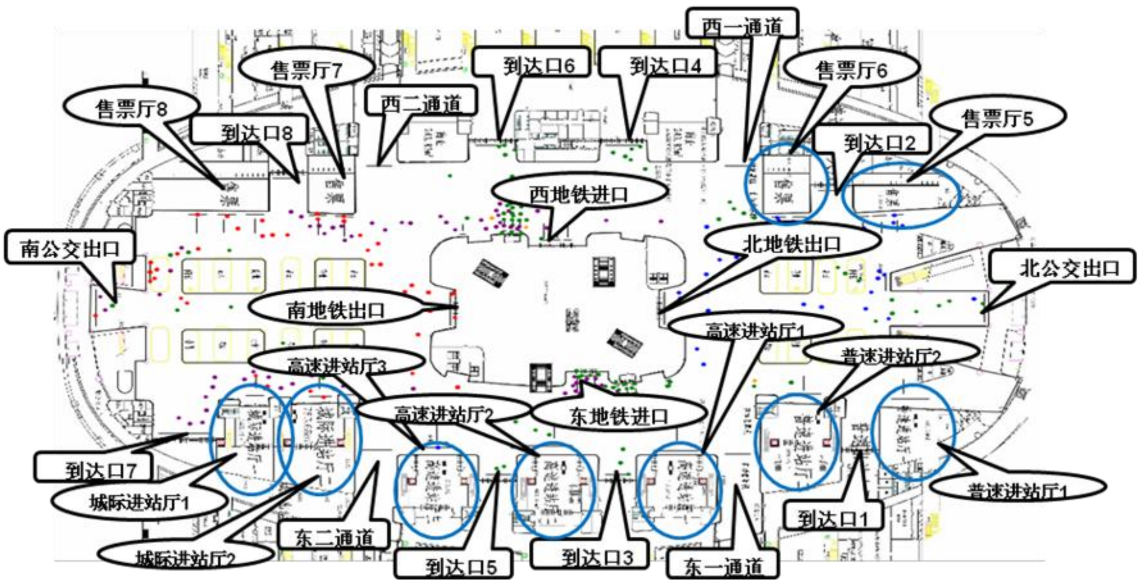


Figure7. simulation environment of Underground Layer for Beijing South Railway Station

（2）The simulation process design

The passenger flow line of underground layer of the station is complicated. It is mainly included stops streamlines, exit streamlines, and transferring streamlines. According to the Anylogic simulation platform, select logic module for each service equipment, set parameters, and establish simulation process chart for passenger flow organization for underground layer of the station[3].Simulation flow line chart of Underground Layer for Beijing South Railway Station is just as shown Figure8.

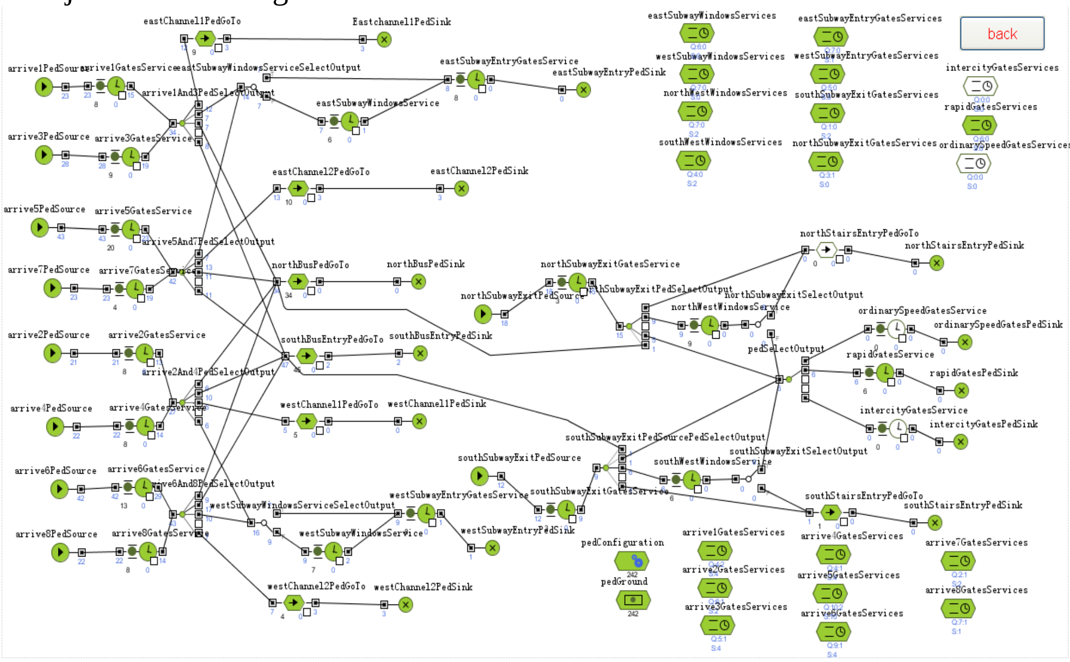


Figure8. Simulation flow line chart of Underground Layer for Beijing South Railway Station

（3）Simulation variables design

It is mainly used to store related data and information collected by simulation system, and provide simulation results indirectly. The simulation variables are set as Figure 9 showed.

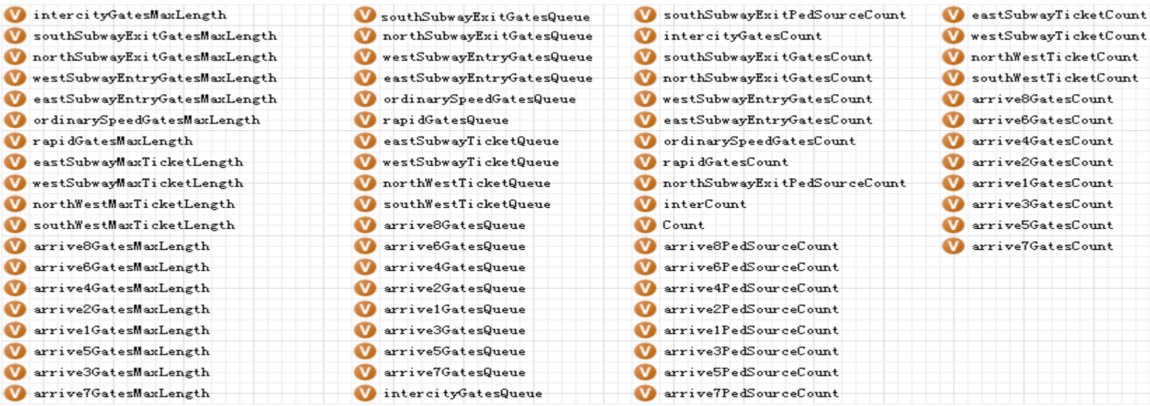


Figure9. Simulation variables design

(4)The simulation process

Take rush hour of 7:00-8:00 as simulation period. According to the situation of trains' arrive(4 inter-city trains of Jingjin,5 inter-city trains of Jinghu, and 2 other ones)[8].According to full load ratio of 120% ,calculate the number of passengers going out is 14621, and take 15000 here. According to the investigation data, the share rates and the number of transferring passengers are as follows: the number of passengers going out through subway station is

15000*27%,through the bus station is 15000*41.4%, taking a taxi and other styles is 15000*31.6%. During this period, the population of passengers getting in the subway station is 1764.Set that all of the equipments are open. The simulation process is shown as Figure 6.

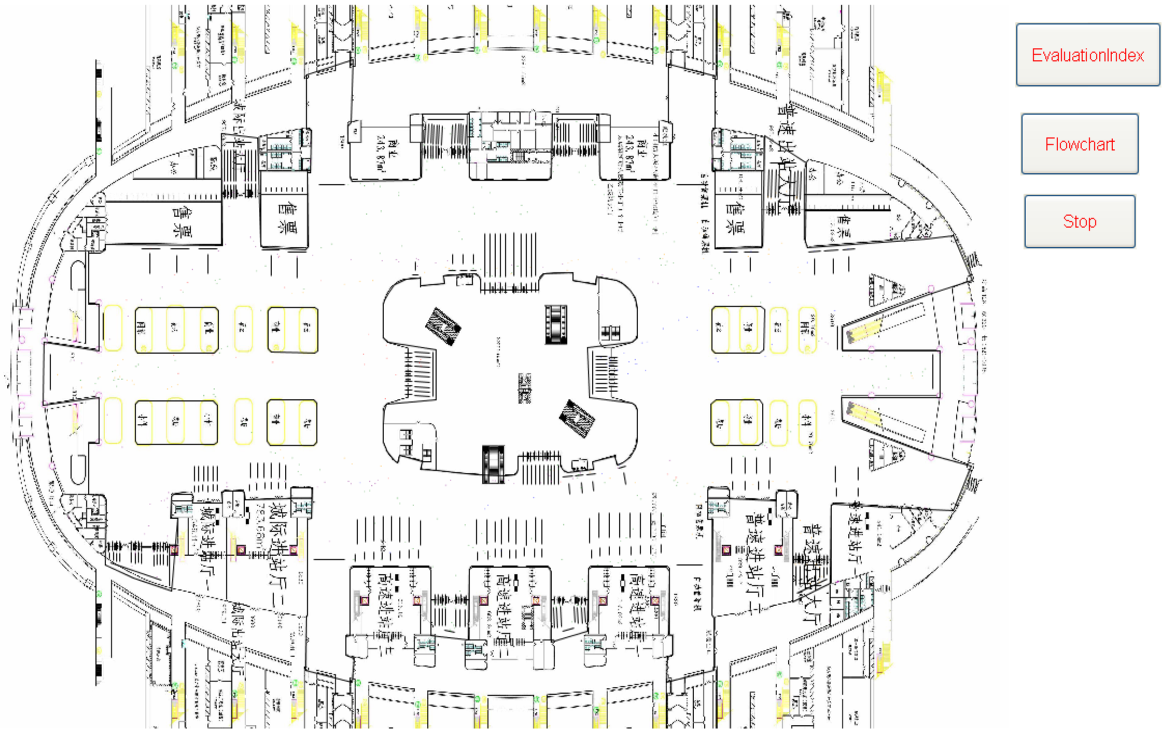


Figure10. Simulation process of Underground Layer for Beijing South Railway Station

(5)The simulation results output

According to the analysis of simulation output data , during the period of rush hours, in the case of that all of the equipments are open, the total number of arriving passengers is 12808. Among that, passengers in common-speed halls of underground layer go out through arriving exits 1and 2 in the speed of 1121 ones per hour .Passengers in high-speed halls go out through arriving exits3,4,5and 6 in the speed of 1545ones per hour. Passengers from inter-city trains go out through exits 7 and 8 in the speed of 1260ones per hour. Ones taking subway go out through southern and northern exits in the speed of 882ones per hour. The average queue lines are no more than ten persons among Each customer service equipment[6]. The simulation results output is just as Figure 11

Flow related parameters (number of passengers arrived)	Average queue length -index (average queue length)	Duration of stay -index
Northwest ticket office:477	Northwest ticket office:4.0	Exit1 to eastern passageway1:1.81
Southwest ticket office:500	Southwest ticket office:4.0	Exit1 to northern bus station1.87
Western ticket office of subway:680	Western ticket office of subway:5.0	Exit1 to southern bus station:5.32
Eastern ticket office of subway:956	Eastern ticket office of subway:9.0	Exit1 to eastern entrance of subway(not buying ticket):2.49
Western entrance of subway:1121	Gate machine of western entrance:2.0	Exit1 to eastern entrance of subway(buying ticket):2.93
eastern entrance of subway:1566	Gate machine of eastern entrance:3.0	Exit2 to western passageway1:1.43
southern exit of Subway:895	Gate machine of southern exit:1.0	Exit2 to northern bus station1.89
Northern exit of Subway:900	Gate machine of northern exit:1.0	Exit2 to southern bus station:5.09
Exit1:1151	Gate machine of Exit1:2.0	Exit2 to western entrance of subway(not buying ticket):2.47
Exit2:1120	Gate machine of Exit2:2.0	Exit2 to western entrance of subway(buying ticket):3.46
Exit3:1559	Gate machine of Exit3:2.0	Exit3 to eastern passageway1:1.27
Exit4:1546	Gate machine of Exit4:1.0	Exit3 to northern bus station3.02
Exit5:1531	Gate machine of Exit5:2.0	Exit3 to southern bus station:3.80
Exit6:1556	Gate machine of Exit6:1.0	Exit3 to eastern entrance of subway(not buying ticket):1.37
Exit7:1243	Gate machine of Exit7:1.0	Exit3 to eastern entrance of subway(buying ticket):2.09
Exit8:1307	Gate machine of Exit8:2.0	Exit4 to western passageway1:1.23
Total number:12808	Gate machine of entrance of inter-city train:0.0	Exit4 to northern bus station3.02
Entrance of inter-city train:99	Gate machine of entrance of high-speed train:0.0	Exit4 to southern bus station:3.89
Entrance of high-speed train:331	Gate machine of entrance of entrance of common-speed train:1.0	Exit4 to western entrance of subway(not buying ticket):1.43
Entrance of common-speed train:126		Exit4 to western entrance of subway(buying ticket):2.28
Total number:556		

Figure11. The Simulation Results Output for Underground Layer for Beijing South Railway Station

Take methods of limiting the number of passengers and changing the number of equipments to optimize passenger organization. Take the of exit1(0)(all Exit gate machines of exit1 close) of underground layer as an example to analyze. According to Anylogic simulation, record simulation data, and take the method of averaging. Average the corresponding indicators through the principle of similar kinds, make "the average queue length is more than 10 people "as the as the basis of evaluating queue congestion. The simulation results of customer service equipments are as follows:

When decreasing the number of gate machines of exit2 from 8 to 2,there is still no congestion that queue length is more than 10 people. When continuing to decrease to 3,average queue length of exit2 is more than ten, and congestion is coming up.The simulation results of the number of passengers are as follows: total number of passengers in each entrance in hush hours is about 11,000.When increasing the number to 15,000,the congestion that queue length is just for 10 people appears In the subway ticket window.

Aiming at the complexity of the passenger organization management, analyze simulation model of passenger organization basing on the method of Anylogic, evaluate the simulation results, and propose optimization scheme of passenger organization

In the case that exit1 is closed, the optimal scheme is that the number of gate machines is controlled to 4.When closing exit1,passengers from common-speed area go out though exit2, and in that case there is no congestion that queue length is more than 10 people. When decreasing the number of gate machines of exit2 to 4,there is still no congestion. When the number is decreased to 3,the population of queuing passengers is immediately increased to more than10.

In the case that exit1 is closed, the optimal number of passengers should be controlled to no more than 15000.For that there will be congestion of more than 10 people queue length when increase the total number from 1.1 to 1.5.

Due to dynamism and variability of management problems of passenger organization, Combining with the actual management of passenger organization, constantly perfect knowledge base of simulation system for passenger organization. provide more aid decision-support for operation and management of passenger organization is the direction of further research.

4.2Simulation Example of Elevated Layer for Beijing South Railway Station

(1)The simulation environment design

Elevated layer customer service equipment is as shown in figure 12.

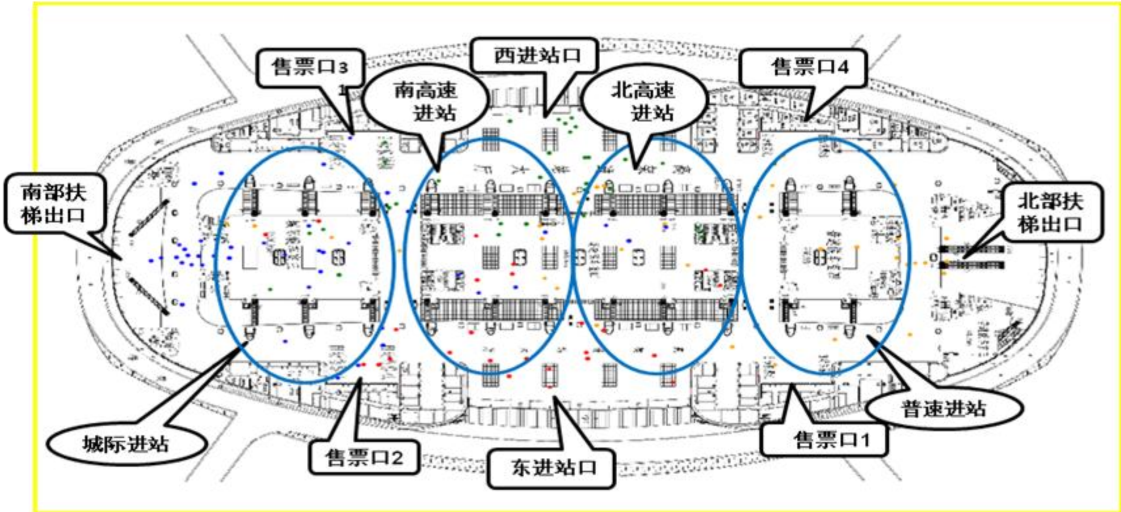


Figure12. Figure for Elevated layer simulation

From figure 11,elevated layer west and east entrance corresponds to four security checkpoints;South and north entrances after two escalator hand each corresponds two security checkpoints; Southeast, northeast, southwest, northwest are four ticket windows; Middle area is waiting hall station,from north to south for normal-speed stops hall, high-speed north hall and south station hall, inter-city train hall at a high speed;Normal station hall has six entrances and 30 gates. High speed station hall has 72 brake machines and12 entrances. Normal station hall has four entrances and 12 brake machine.

(2)Simulation flow network for Elevated level of passenger service

According to the elevated level of main flow line,it can sets all service equipment parameters by using logic module in AnyLogic and constructs elevated layer flow chart of the simulation,and is as shown in figure 13 and 14.

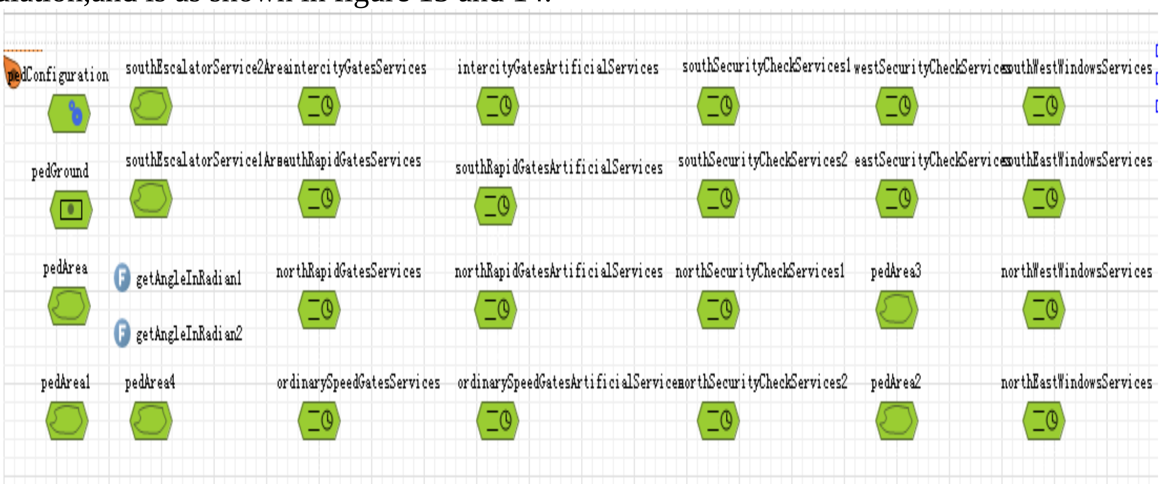


Figure13. Equipment module for Elevated of layer modeling

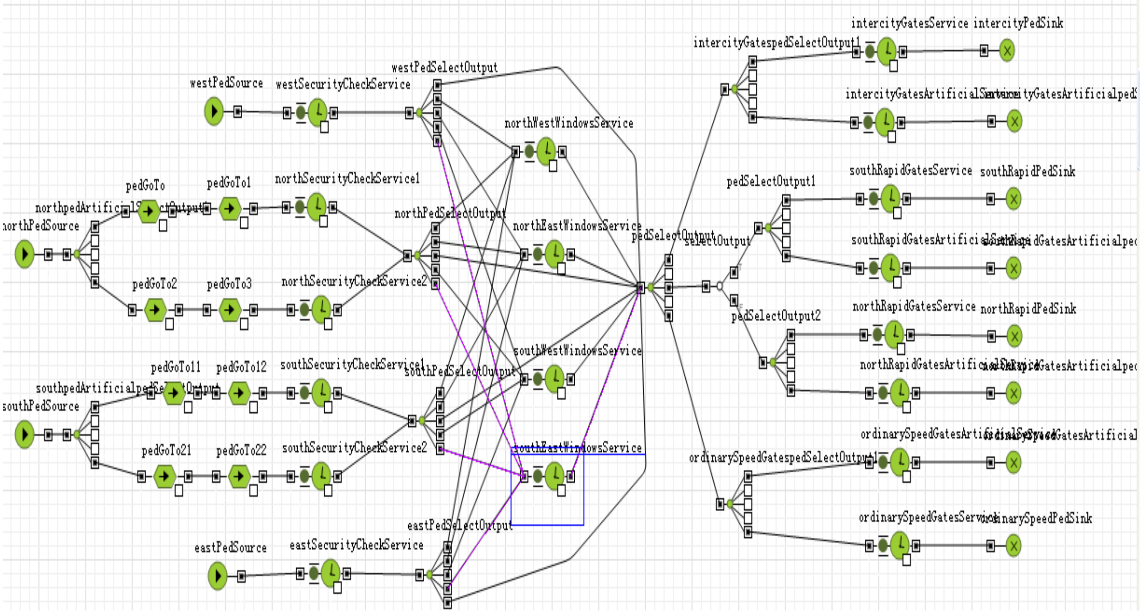


Figure14. Chart of the simulation for Elevated layer

(3)The simulation variables design

This study uses a lot of variables.They are mainly used for storage of simulation system to collect relevant data and information,and indirectly provide model simulation results.

Figure15. The simulation variables for Elevated layer

(4)Simulation animation of Elevated layer

Figure16. Simulation animation for Elevated layer

Just as shown in Figure16, the right represents the north in figure.Orange represents the passenger flow, which is from the north staircase; Blue represents the escalator up passenger flow which is from the south; Green represents the passenger flow which is from the west entrance to take a taxi or social vehicles in traffic; Red represents the passenger flow which take a taxi in the east or social vehicles in traffic.

6.Conclusion

Aiming at the complexity of management problems for large passenger organization,Anylogic simulation model for the passenger flow organization was analyzed.Based on the evaluation of simulation result,recommendation of decision support for optimization scheme of passenger flow organization was proposed.Due to problems of dynamic and changeable for the passenger flow organization of large-scale railway station,combining with the reality of management,the knowledge base of passenger flow organization simulation system was constantly improved.More auxiliary decision support was provided for passenger flow organization,which was the further research direction for this paper.

7.References

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