RESEARCH ON THE DEVELOPMENT AND APPLICATION OF VEHICLE-GOODS MATCHING SYSTEM BASED ON SAAS AND CSCW

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This paper analyzes the processing scheme of the vehicle-goods matching system based on the Software as a Value Scoring Service (SaaS) and the Computer Supported Cooperative Work (CSCW) technology, investigates the SAS system for multiple instances of Agent with enhanced learning characteristics. Computer grammar SaaS for vehicle hybrid taboo search ranking is designed and established in conjunction with the current system framework. Finally, an autonomous matching system is built for highly intelligent vehicle ranking & recommendation based on the concept of "checking vehicles and checking goods". This system can efficiently deal with the problem of high empty-load rate in road logistics and transportation and at the same time, reduce the daily operating costs of logistics enterprises. In terms of the overall technical solutions for the road logistics system based on SaaS (Software as a Service) and CSCW (Computer Supported Cooperative Work), we establish the road logistics operating system based on CSCW through the integration of SaaS technology and Web GIS technology, thereby accessing heterogeneous processes and heterogeneous data of different tenants. Practical application demonstrates that the system can reduce the cost of logistics enterprises, improve the operating efficiency of logistics enterprises, and play an important role in improving the comprehensive competitiveness of enterprises.

Keywords: Computer supported cooperative work (CSCW), Software as a value scoring service (SAAS), Vehicle goods matching, Reinforcement, Learning agent

1. Background

The emergence of a large number of vehicle goods matching platforms breaks the previous bidding ranking model of offline transactions among

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acquaintances, allowing shippers to contact truck drivers, and truck drivers will no longer be limited to the supply information release department and the scalper party. Slogans such as searching and ranking a large number of goods on the Internet, no longer returning empty trucks, and improving transportation business seem to indicate that the environment for scoring truck drivers has been greatly perfected. The rise of e-commerce has rapidly promoted the logistics industry development. However, with the rapid development of the logistics industry, our road transportation has exposed many problems: logistics source information release resources have low degree of sharing, and the rate of empty vehicles is high, while the cost of business operations accounts for a large proportion in logistics transportation [1]. In view of the current scoring circumstance, how to reduce logistics and transportation costs has become extremely important. Application of CSCW technology and SaaS technology in road logistics and transportation can efficiently deal with the problems of goods supply information release in road logistics and transportation [2].

2. Basic Principles of SaaS and CSCW Technology

2.1 SaaS for reinforcement learning agents

2.1.1 Basic concepts of SaaS

SaaS is a new software model, a method of deploying software as a scoring service. After the intervention of the Internet, the scoring service provider will deploy this application software on the scoring server of its company [3]. In light of respective needs, customers can also customize the desired application software through the scoring service provider via the Internet. The customer pays the scoring service provider based on the number of ordered software and the warranty period and receives value scoring service provided by the scoring service provider via the Internet [4].

2.1.2 SaaS for multi-agent entities

When building the SaaS system, we chose the method of multi-instance data isolation for SaaS system development, so that developers can get more benefits from the experience of developing traditional architecture software. Fig. 1 shows the architecture of multi-agent entities.

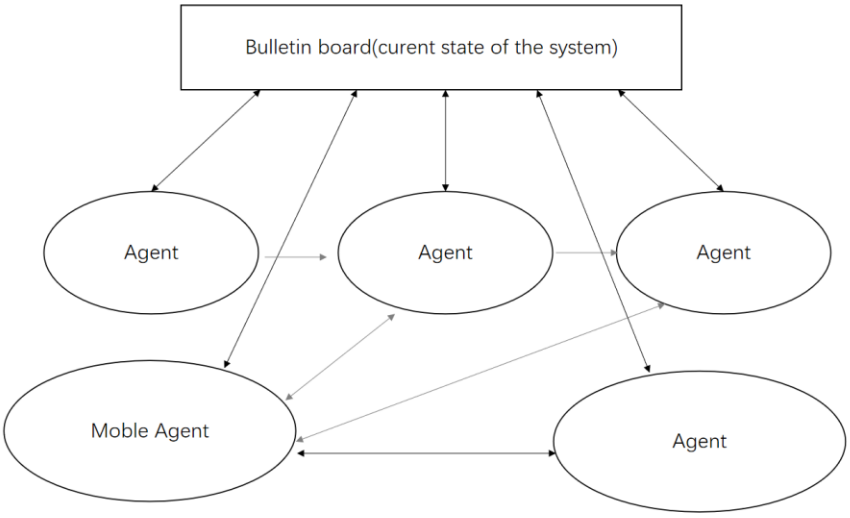


Fig 1: Multi-agent entity architecture diagram

With the agent's help, different network application systems are encapsulated into software entities to provide scoring services for network applications. The interaction, collaboration and coordination mechanism between agents is employed to achieve system integration. Remote users can reproduce the vehicle-goods matching process without the need for the same network environment, thereby speeding up the efficiency of matching information release feedback and communication [5]. The system is suitable for heterogeneous, distributed control and processing of multiple related tasks. With the characteristics of high reliability and modularity, it can be dynamically decomposed by the system. Suitable for the development of vehicle-goods matching system, it demonstrates the advantages of fast response, good flexibility, reusability and scalability.

Using the method of module decomposition, the intelligent ranking recommendation activity of business logic is decomposed into multiple functions in the agent, with different modules for different tasks. These modules possess specialized domain knowledge to deal with specific problems independently. They decompose the task intelligent ranking recommendation into various modules, so that each module can give full play to its computing power and professional knowledge. In this way, the entire system can achieve better performance in intelligent ranking recommendation and efficiency [6].

2.1.3 Reinforcement learning

A functional agent model for reinforcement learning is proposed, which analyzes the correct results by learning empirical knowledge in an unknown environment. Fig. 2 is a structural diagram of functional agent. The agent's architecture model is composed of input, output, exchange, CPU and log system.

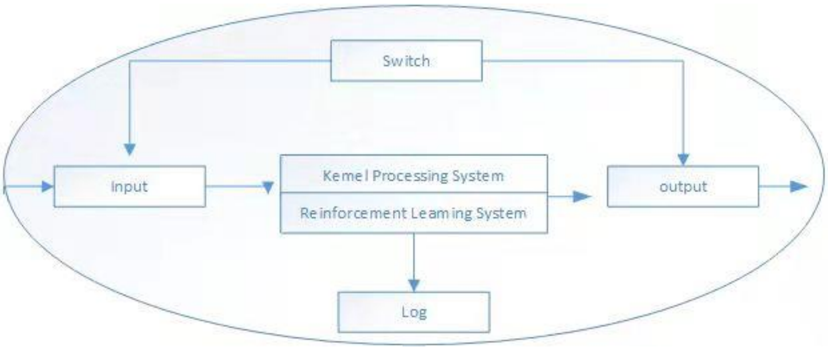


Fig 2: Structure diagram of functional Agent

2.2 Workflow management in CSCW

CSCW is a technology that investigates how dispersed collectives can work together under the support of computer and network technology. The workflow management technology is CSCW. The problem in the workflow is how to let multiple participants complete documents or tasks in accordance with the necessary pre-defined rules for automatic file transfer, thereby supporting business process in the architecture. The workflow structure is shown in Fig. 3. This compilation system provides utility composition and corresponding interfaces for abstract workflow management system, provides a reference plan for the workflow management and improvement, and offers a basic condition for the mutual manipulation of products [7].

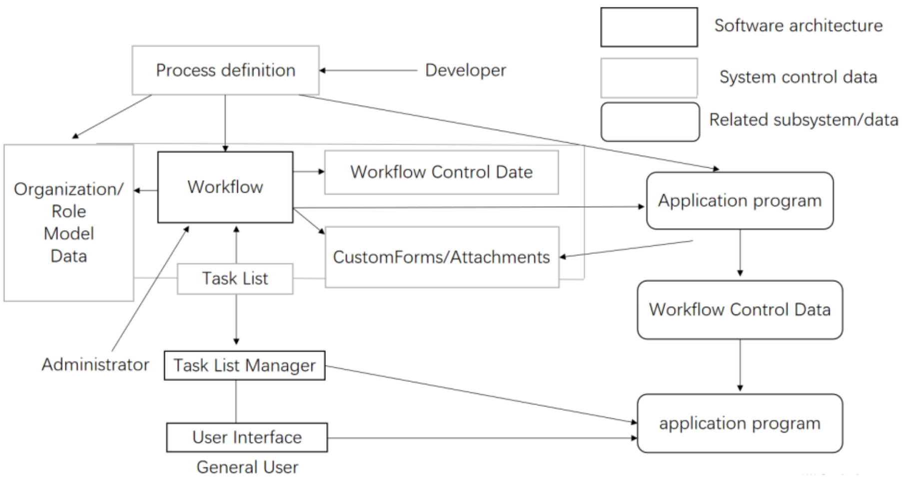


Fig 3: Module structure diagram of workflow system

3. Principal Overview and Frame Structure of Vehicle-Goods Matching System for Road Logistics

3.1 System overview

For the CSCW framework-based vehicle-goods matching system for road logistics, SaaS technology is used. The system is shown in Fig. 4. Where, it mainly provides the following logistics value scoring services: A. Timely and efficient logistics supply information release and search ranking platform, which improves the logistics and transportation effect; B. Highly intelligent ranking recommendation and automated vehicle-goods matching search, which quickly and accurately locates the current vehicle-goods source information release for customers [8].

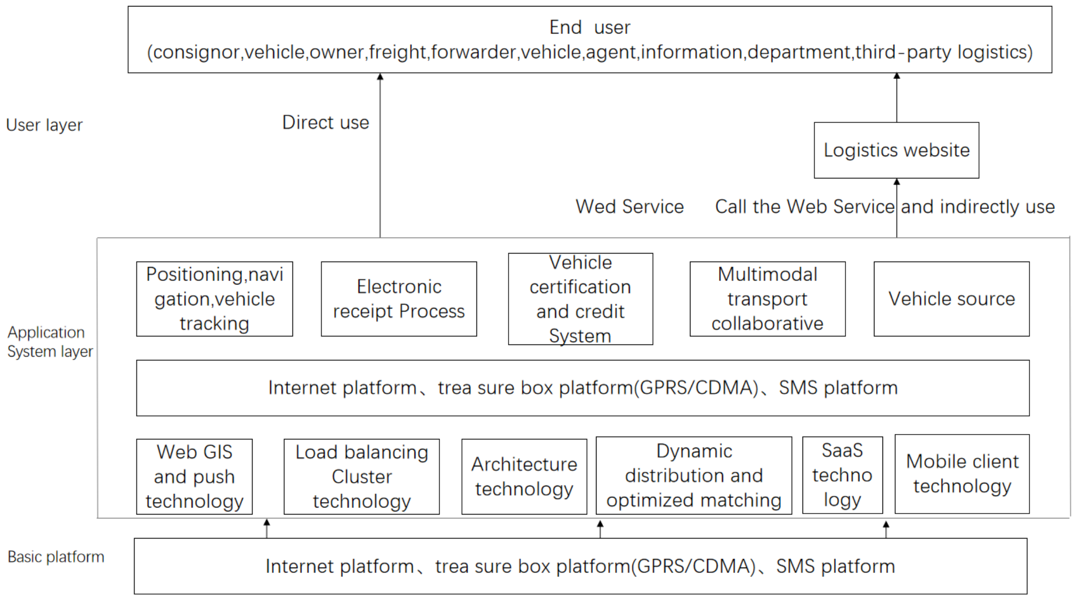


Fig 4: Schematic diagram of the CSCW framework-based vehicle-goods matching system for road logistics

The system provides users with three ways of use: A. Direct use, customers can have direct use through the interface provided by the system; B. Indirect use by calling WebService, users can integrate the various value scoring services provided by the system and existing application software, integrate goods supply information between multiple users through webservices, and call webservices; C. Use webservices to call webservices provided by the system through other third-party logistics websites, integrate one’s own applications, and provide users with value scoring service [9].

3.2 Vehicle-finding bidding ranking mode

Existing logistics websites usually require owners to publish goods supply information on the website, hoping that owners can search for rankings of required goods supply information on the Internet, and take the initiative to contact the owners to conclude transactions. The method of this transaction is not the same as the previous method of “checking vehicles and checking goods”. It presents the following characteristics:

1) Vehicle owners release vehicle, goods supply information on the system, which is generally accurate and reliable, so that it is easy to find suitable vehicle owners;

2) Vehicle owners can set the release of vehicle status and goods supply information (busy/free goods supply information release, location information release, vehicle supply information release, etc.) through the Internet, mobile phone client software, SMS, etc;

3) Vehicle owners can find the vehicle according to the vehicle supply information given by the vehicle-goods matching system, or automatically search for the corresponding vehicle based on the given search matching item;

4) After the matching is completed, the system can inform the vehicle owner through SMS, so that the owner can contact the object who needs the scoring service in a short time to quickly conclude the transaction [10].

The aforementioned new bidding ranking model firmly grasps the initiative of the vehicle owner in the transaction. The vehicle owner releases and updates the release of the vehicle status and source information to ensure credibility of the vehicle, goods supply information provided by the system. By fully understanding the behavior and habits of the vehicle owner, the system offers many access approaches to allow the vehicle owner to change the current status message of the vehicle in a short time, thus greatly improving the system operation performance. The vehicle-goods matching search computer grammar recommended by intelligent ranking can help both users and increase the transaction efficiency.

3.3 Functions of the vehicle-goods matching system

It can search and rank trucks based on date and route, and filter parameters such as transportation mode, model, load, length, and owner’s quote. As long as the user simply enters the required transportation route and the vehicle demand, he can quickly find the relevant released goods supply information of the vehicles that meets his requirements in a short time, which not only reduces the problem of empty vehicle return and empty vehicle waiting, improves the logistics efficiency, but also facilitates the management of logistics companies, increases the goods circulation speed, and saves transportation costs.

3.4 Analysis on process framework of vehicle-goods matching system

The main external entities of the vehicle-goods matching system based on SaaS and CSCW technology are vehicle owners, goods owners and administrators. The overall business flow chart is shown in Fig. 5:

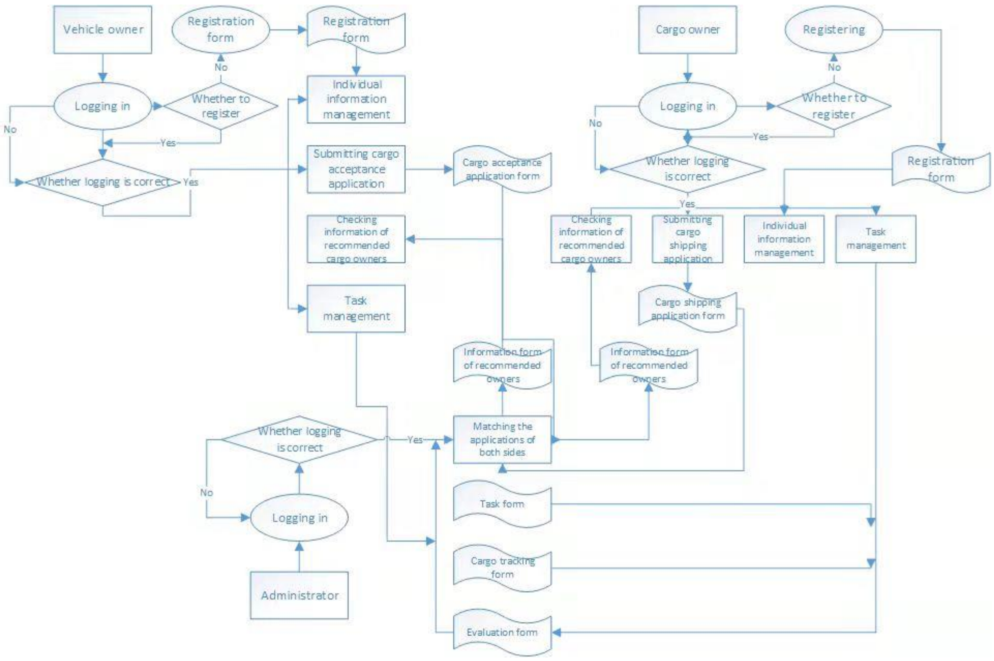


Fig. 5 Business process framework of the system

According to the analysis on business process and all kinds of information involved therein, the data flow of the whole system is analyzed, and the data flow chart of the system is given. Fig. 6 is the top-level diagram of vehicle-cargos matching system based on SaaS and CSCW, which expresses the boundary of the system and the input and output data streams.

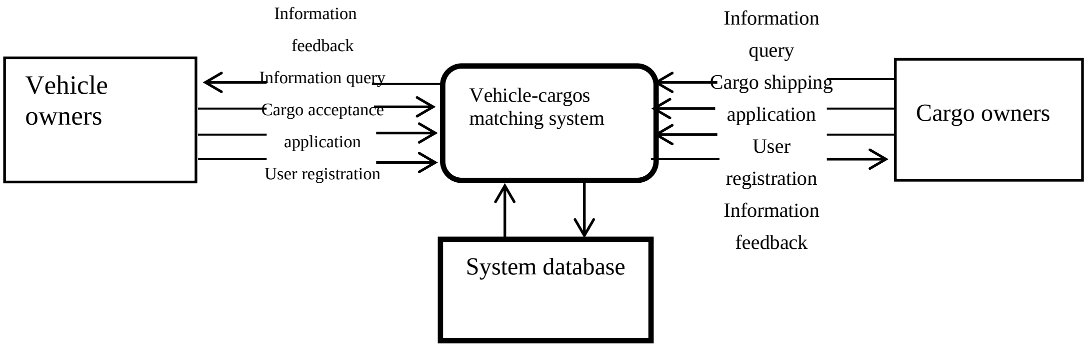


Fig. 6 Analysis diagram of top-level data flow of system

3.5 Cost factors in the vehicle and route involved in vehicle search

Cost factor analysis method: based on the analysis of the relationship between vehicle and route indicators in the vehicle search and its influencing cost factors, the method quantitatively determines the direction and degree of influence of each cost factor on the vehicle and route indicators in vehicle search. The cost factor analysis method can not only comprehensively analyze the impact of each cost factor on the vehicle and route indicators in a certain valued vehicle search, but also separately analyze the impact of certain cost factor on the vehicle and route indicators in the valued vehicle search [11]. The cost factor analysis method is divided into the following categories:

i. Serial substitution method

Suppose that the vehicle and route indicator M in a certain analysis of vehicle search is obtained by multiplying the three related cost factors A, B, and C. The vehicle and route indicators in report period (actual) vehicle search and vehicle and route indicators in the base period (planned) vehicle search are as follows:

The vehicle and route indicators in report period (actual) vehicle search M1=A1 * B1 * C1

The vehicle and route indicators in the base period (planned) vehicle search M0=A0 * B0 * C0

When determining the impact of the changes in various cost factors on the vehicle and route indicator R in the vehicle search, implementation in order is possible:

The vehicle and route indicators in the base period (planned) vehicle search

M0=A0 * B0 * C0 (1)

The first replacement A1 * B0 * C0 (2)

The second replacement A1 * B1 * C0 (3)

The third replacement A1 * B1 * C1 (4)

Analysis as follows:

(2)- (1) →The impact of A change on M.

(3)- (2) →The impact of B change on M.

(4)- (3) →The impact of C change on M.

By integrating the changes in various cost factors, the total impact is: △M = M1-M0.

4. Computer Grammar Design for Vehicle-Goods Matching

4.1 Computer grammar process

Taboo search ranking computer grammar, as an extension of local domain search ranking, is a global evolutionary optimization computer grammar. However, its global optimization ability largely depends on the initial solution.

The taboo search ranking computer grammar is divided into the following five steps:

The first step is to use the parallel saving method to obtain the static initial solution; the second step is to use hybrid taboo search ranking computer grammar to optimize the initial solution; the third step is to determine whether there is a coming dynamic task. If so, it searches for the ranking vehicle owner's quotation path, records the key points and completed tasks, adds the client's taboo list, and then adds it to the dynamic task by saving. If not so, it goes to step 5; goes back to step 2 through step 4; goes to step 4 and step 5 and provides the result [12].

4.2 Static initial solution

Assume that the vehicle owner's quoted path costs of the vehicle in the owner's quote path I and j are s and s, respectively, and the vehicle owner's quoted path cost in the owner's quoted path ij is s, then the owner's quoted path cost saving is s (GI, j), the time opportunity cost saving is f, which represents the change point R of the future vehicle relative to the original vehicle owner's bid path every time it reaches the point J. The specific steps for calculating route cost savings are as follows [13]:

Step 1: Connect each point I and code 0 into a line 0→I→0, set 1, = t;

Step 2: For each task point pair (ij), calculate F and the corresponding storage value s (I, J), so that M={s (IJ), s (IJ) ≥0};

Step 3: Step 3 is to rank in the descending order of S (I, J), the unit is m;

Step 4: In Step 4, if M=0, terminate the computer grammar; otherwise, for the first item s (I, J), study the corresponding (I, J). If the connection conditions are met, the computer grammar goes to step 5; otherwise, the computer grammar goes to step 6;

Step 5: Connect tasks I and j, complete the line connection, update the time when the vehicle arrives at each task r on the original task j route, and enter the second step;

Step 6: In step 6, let m=m-S (I, j), and go to step 3. Through the above computer grammar, a static initial solution can be obtained.

4.3 Insertion of dynamic solutions

The specific computer grammar for calculating the insertion cost of dynamic tasks is as follows:

Step 1: When there is new demand, check the goods supply information release of the route where vehicle K is located, judge the key points on each route, record it as P, and set the current minimum insertion cost C*(I, u, J) to a big number B [14].

Step 2: Search for each row of the ranking and record the set of vehicle owners' quotation paths as R={Rik∈K}.

Step 3: In Step 3, if r=0, go to Step 6. Otherwise, perform the following calculation on each vehicle owner's quotation path r.

Step 4: According to the formula CG (I, u, J) = β2a, calculate the insertion cost C (IU, J) of all adjacent point pairs (I, J) after the key point P, set the maximum number m, and make all point pairs (I, J), C (IU, J) <m. If there is no qualified point pair, then r=r-r, go to step 3. Otherwise, go to step 6.

Step 5: Determine whether the minimum value of the row insertion cost C (I, u, J) is smaller than C*(I, u, J). If it is smaller than c*(I, u, J) =c (I, u, J), set the minimum insertion point pair (I*, J) to (I, J), and the minimum insertion line R*=R, R =R-R. Then, enter the third step.

Step 6: If c*(I, u, J) <B, insert point u between point I and point J, and update the timetable on the R* line, then terminate the computer grammar. Otherwise, go to the next step.

Step 7: In step 7, the depot sends a new vehicle k* to create a new 0→u→0 line, and the computer grammar is terminated.

According to the above computer grammar, dynamic points can be inserted. Based on the existing problems in our road logistics transportation, a road logistics transportation vehicle-goods matching system is implemented based on CSCW technology and SaaS framework. The implementation method of multi-instance agent and reinforcement learning SaaS system is introduced in detail. The key technologies of CSCW and vehicle-goods matching computer grammar are studied [15]. Finally, a new "goods-to-vehicle" bidding ranking mode is constructed for vehicle-goods matching system. For small and medium-sized enterprises, customers do not need purchase professional management software. As long as they rent and use the various value scoring services provided by the vehicle-goods matching platform software, the web scoring service system can complete various value scoring services such as vehicle-goods matching, accurately find the appropriate information about vehicle supply, and implement transportation independently. At this time, there is no need to maintain the system for a long time, which greatly reduces the basic conditions and risks of small and medium-sized logistics enterprises in undertaking the insurance for supply information release [16].

After the system implementation in many logistics companies in Sichuan and Chongqing, the goods transportation time of enterprises is reduced by 20%, and the average cost of each vehicle is reduced by about 10 days. Through the transactions concluded on this platform, the independent communication value scoring server can support addition of more than 6000 mobile final ports, receive messages and process messages delivered by4500 mobile final ports in 6 seconds, thus achieving desirable results. This system can efficiently deal with the problem of high empty-load rate of logistics transportation on highway, reduce the operating cost of logistics enterprises, which demonstrates excellent use and popularization value [17].

5. System Testing and Solution Validation

5.1 The following principles should be emphasized in the test of this new system:

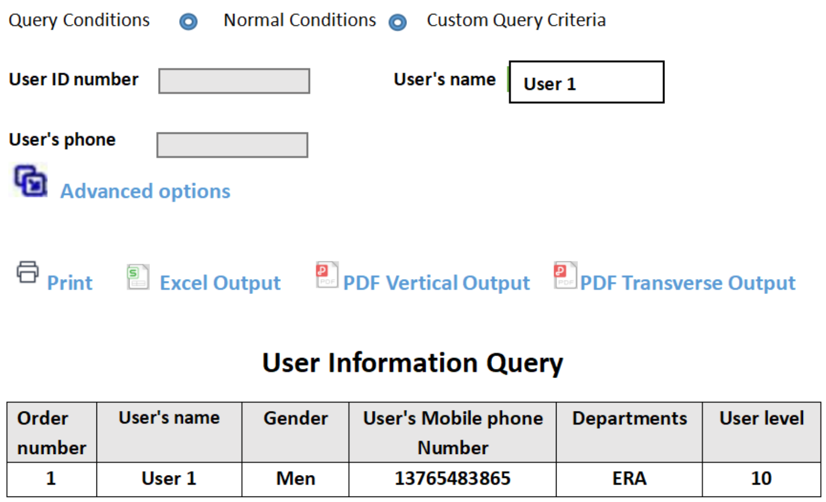
(1) Whether it meets the new requirements put forward by users, and how the implementation effect is;

(2) Whether the new function completely or roughly meets the user's needs, and whether there is any abnormality in the operation process;

(3) Whether the interaction process between the user interface of the new system and the users is concise and clear, i.e. whether a large amount of training is required for the users;

(4) The integration between the new system and the original system, including whether the interface style is consistent or improved, whether the modified database table can be called normally, and whether the storage speed can be improved, etc.

The system testing is generally completed by the system analyst to ensure that all programs and modules can be executed correctly. The test is designed to check the consistency between the query content and the query result. The test results are shown in Fig. 7.



Order number	User's name	Gender	User's Mobile phone Number	Departments	User level
1	User 1	Men	13765483865	ERA	10

Fig. 7 Test results of system query consistency

5.2 Comparison and summary of system test results with other peer software

(1) A three-layer structure is adopted to logically separate and independently package business logic rules, user interfaces and data, so that the system has the

advantages of strong expandability, high safety, strong reusability, easy maintenance and the like;

(2) It has a more complete design idea, contains the workflow required by users, meets the needs of users for work links, ensures the rationality, security and integrity of data, and realizes the reasonable control, operation monitoring and permission control of data, etc.

(3) It has rich functions and is easier to use. The user interface is convenient and intuitive, the workflow is improved, and the query results are accurate and practical, and reasonable and effective statistics are carried out on the query results, which meet the requirements of various query conditions of users.

(4) The computer is convenient to operate and use, convenient to install at the user end, better integrated with the original system, without conflict, has no higher requirement on the software environment, reduces the investment and is convenient to upgrade;

(5) It has strong practicability, makes the logistics information management more standardized and simplified, lightens the administrator's work intensity, improves the work efficiency, and obtains certain economic and social benefits.

6. Conclusion

From the early days of the founding of the People’s Republic of China, road freight industry represents the basic requirement for the rapid development of national value scoring and the primary value scoring industry. According to the statistical bulletin, the total amount of goods transportation in 2020 will reach 47.9 billion tons. The total amount of goods transported on the road has reached 36.8 billion tons, a year-on-year increase of 10.1% [18]. It can be seen that road transportation accounts for the highest proportion among various transportation modes. With the annual growth in the total amount of freight transport in China, the proportion of road freight is also constantly increasing. However, the essential loading rate of trucks is currently less than 60% in China, which is far below the 80%-95% level of prosperous countries. Traditional offline logistics has many shortcomings. It is also very common to find vehicle for people and goods for vehicles [19].

With the rapid development of the Internet in China, Internet + big data and cloud computing have now penetrated many aspects of the transportation industry. The vehicle-goods matching supply information release platform has effectively alleviated the problems that vehicle owners cannot conclude transactions offline or released supply information is imbalanced. It reduces the empty load rate of vehicles and social costs and provides value scoring service for vehicle supply information release on both sides of vehicle and goods. However, it does not support fast and intelligent matching based on ranking recommendations in view of both parties' needs. This paper comprehensively discusses the views of domestic and foreign scholars on vehicle-goods matching from three dimensions: theoretical methods, supply information release platforms and decision-making models. Moreover, it mainly explains the importance of system testing in software implementation, introduces the basic theoretical knowledge such as the purpose and method of system testing, the basic principles and implementation steps of system testing, and finally expounds the testing effect of SaaS and CSCW-based vehicle-cargos matching system. It summarizes the optimization problems of correlation boundaries in recent years, concludes the hotspots in domestic and foreign related research and the current model features, and solves the key issues worthy of attention in the research on the vehicle-goods matching [20].

Acknowledgment

This work was supported by the Hebei Provincial College Science and Technology Research (ZD2019132) and Hebei Provincial Natural Science Foundation (E2019506033).

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