Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2023.30052

314 (2023) 384–394
December

Design of intelligent water transport logistics management system based on cloud computing

Jin Wang

School of Economics and Management, Jiaozuo University, Jiaozuo 454000, China, email: wangjin_vip@outlook.com

Received 1 December 2022; Accepted 29 September 2023

ABSTRACT

With the rapid development of science and technology, intelligent logistics plays an increasingly important role in various fields. This study focuses on the design, application and optimization of intelligent logistics system. Through empirical analysis and model construction, the design and division of system architecture are deeply discussed, and the efficient operation of the system is realized with the support of cloud computing platform. By collecting and preprocessing a large amount of actual data, a complete system modeling scheme is constructed in this study. Then, relying on user feedback, the system is deeply evaluated and continuously optimized to achieve a more user-friendly intelligent logistics service. The research results show that through scientific system design and model construction, combined with advanced cloud computing technology and user experience evaluation, the performance and application value of intelligent logistics system can be significantly improved.

Keywords: Intelligent water transport logistics; System design; Cloud computing platform; User experience evaluation; System optimization

1. Introduction

The logistics industry has long been an important part of the global economy, among which water logistics has become the preferred mode of transport in many countries and regions because of its low cost, large capacity and environmental protection advantages. However, with the growth of global trade volume and the increasing diversification of customer needs, the traditional water transport logistics management mode has been difficult to meet the current needs, especially in information exchange, cargo tracking, scheduling optimization and other aspects.

In this context, the rise of cloud computing technology has brought unprecedented opportunities to the logistics industry. Cloud computing provides powerful data storage, processing and analysis capabilities, enabling logistics companies to acquire, analyze and use large amounts of data in real time to make more intelligent and accurate decisions. In addition, cloud computing can help logistics enterprises save costs, improve efficiency, and provide them with more flexible and scalable IT solutions. At the same time, with the development and application of technologies such as the Internet of Things, big data, and artificial intelligence, intelligent logistics systems have become a new trend in the industry. These technologies can help logistics enterprises achieve more refined, automated and intelligent management, so as to further improve their service quality and economic benefits.

With the rapid development and wide application of cloud computing technology, the traditional logistics management is facing great changes. In order to improve logistics efficiency, reduce costs and meet the complex needs of modern economies, a new intelligent water transport logistics management system has emerged. By integrating cloud computing technology, these systems not only enable real-time processing and analysis of data, but also provide more flexible, scalable and efficient logistics solutions.

In recent years, the research in the field of intelligent logistics has made great progress. Guo et al. [1] discussed the application of intelligent manufacturing management system based on data mining in artificial intelligence to save energy resources. They believe that such combination can improve manufacturing efficiency and reduce resource consumption. Similarly, Xu and Rong [2] discuss the optimization of highway logistics routes based on the advantages of multimodal transport in the IoT environment, highlighting the impact of IoT on modern logistics. Not only that, the decision support tool of logistics system has been paid more and more attention by researchers. Qi et al. [3] introduced the implementation of emergency logistics distribution decision support system based on Geographic Information System (GIS). This study showed that the use of GIS technology can be more efficient in logistics planning and management.

At the same time, the research of logistics algorithm is also continuing to deepen. Wang et al. [4] conducted a comprehensive and systematic review of the application of natural heuristic algorithms in the field of logistics, which provided theoretical support for further research in the field of logistics. In terms of reverse logistics management, Thürer et al. [5] describes how Internet of Things (IoT)-driven Kanban systems can be used for reverse logistics of solid waste collection, highlighting the potential value of IoT technology in reverse logistics. In addition, in view of the specific field of transportation logistics, such as port and sea transportation, Xie et al. [6] conducted an in-depth study on the construction of dry port-seaport logistics network in Shandong Province under the "Belt and Road". Initiative, highlighting the importance of logistics in modern global trade.

To sum up, intelligent logistics has become one of the most promising research fields today, ranging from intelligent manufacturing systems based on data mining, to GIS-based decision support tools, to reverse logistics and natural heuristic algorithms. In order to better serve the modern society and economy, continuous research and innovation are essential.

The purpose of this study is to design and implement an intelligent water transport logistics management system based on cloud computing. Through in-depth analysis of the basic theories of cloud computing and intelligent logistics management system, combined with the actual needs of water transport logistics industry, this study intends to propose an innovative system architecture that can realize real-time monitoring, data analysis and intelligent decision-making of water transport logistics activities. In addition, this study will also use field surveys to deeply understand the needs of the industry, so as to ensure the practicability and feasibility of the designed system. Finally, through the analysis of user feedback and continuous optimization of the system, the system performance and user satisfaction are further improved.

Therefore, the research on the design of intelligent water transport logistics management system based on cloud computing not only has important theoretical significance, but also has great practical value.

Theoretical significance: This study will enrich the application theory of cloud computing in the field of logistics and provide a valuable reference for related fields. Through in-depth exploration of the integrated application of cloud computing and intelligent logistics management, this study is helpful to promote theoretical innovation and interdisciplinary, and strengthen the theoretical system of logistics, informatics and management.

Practical significance: With the rapid development of global economy, water transport logistics, as one of the important forms of logistics, is facing increasingly severe challenges and opportunities. The intelligent water transport logistics management system based on cloud computing can not only improve the operational efficiency of logistics enterprises and reduce logistics costs, but also achieve more refined and intelligent management and improve the competitiveness of enterprises. Therefore, the implementation of this study will bring actual economic benefits to logistics enterprises and promote the sustainable development of the industry.

This study will first discuss the basic theory of cloud computing and the basic framework of intelligent logistics management system, in order to build the theoretical basis of research. It will also provide an overview of the current situation and characteristics of the water transport logistics industry in order to gain an in-depth understanding of the actual needs and challenges in this field. Based on the previous theoretical research, this study will conduct a field survey to deeply understand the specific needs and expectations of water transport logistics enterprises for intelligent management systems. By analyzing the data of the questionnaire, the research will synthesize the needs of users and lay a foundation for the subsequent system design and model construction. Combining the results of theoretical research and demand analysis, this study will design an intelligent water transport logistics management system based on cloud computing. The research will describe the architecture design and model building process of the system in detail, and discuss the selection and application of cloud computing platform to achieve efficient operation and intelligent management of the system. After the design and implementation of the system, this study will conduct user experience evaluation, collect and analyze user feedback, and understand the performance and existing problems of the system in actual operation. Based on the evaluation results, the research will propose strategies and methods for system optimization, constantly improve system performance, and improve user satisfaction.

Finally, this study will comprehensively analyze the design, implementation and optimization process of intelligent water transport logistics management system based on cloud computing, summarize the research results, and propose future research directions and possible improvement measures, in order to provide useful reference and inspiration for similar research and practical application.

2. Cloud computing and intelligent water transport logistics management system: theory and practice

2.1. Basic theories of cloud computing

Cloud computing is a model of providing computing resources, data storage and services over a network, allowing users to use and access resources on demand without having to understand the details of the infrastructure. This technology is becoming the preferred computing platform for enterprises and individuals due to its flexibility, scalability and cost effectiveness [7,8]. The core concept of cloud computing is to provide computing resources as services, which can be roughly divided into three types of service models: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS).

In the infrastructure of cloud computing, virtualization technology plays a crucial role, allowing multiple virtual machines to run on a single physical machine, thus maximizing the utilization of resources [9]. In addition, cloud computing has introduced big data processing and analysis technologies, allowing users to acquire and analyze huge data sets in real time to support more intelligent and accurate decision making.

Cloud computing has a wide range of applications, including but not limited to data storage, network services, artificial intelligence, and the Internet of Things. In the field of logistics management, cloud computing provides a new solution that enables real-time monitoring, data analysis and optimal scheduling of logistics activities to improve logistics efficiency, reduce costs and meet diverse customer needs.

Cloud computing can provide visibility into the entire supply chain process. This is critical for risk management, especially in fast-changing industries such as high-tech manufacturing, which often operate in highly competitive and volatile market environments [10,11]. In addition, while achieving economic benefits, enterprises need to meet customers' greater demand for manufactured products through their own expansion. Cloud-based supply chain solutions enable businesses to achieve this more quickly, thereby maintaining their ability to compete in the market.

In practical applications, the importance of cloud computing for intelligent water transport logistics management system is self-evident. By integrating cloud computing technology, the water transport logistics management system enables the rapid processing and analysis of data, providing flexible and scalable services while reducing the operating costs of the system. These characteristics make the cloud-based intelligent water transport logistics management system an important force to promote the development of the industry, bringing real and sustained value to logistics enterprises.

2.2. Intelligent logistics management system framework

Intelligent logistics management system is an integrated and automated management system applied to the logistics industry, which uses modern information technology, such as the Internet of Things (IoT), big data analysis, cloud computing and artificial intelligence (AI), to monitor, schedule and optimize logistics activities in real time, thereby improving logistics efficiency, reducing operating costs and improving customer satisfaction [12,13].

The framework of the intelligent logistics management system is mainly composed of the following core components: First, the data acquisition layer, which mainly collects multidimensional data about the status, location and environmental conditions of the goods in real time through various sensors and equipment; The second layer is the data communication layer, which is responsible for real-time data transmission and communication to ensure the information sharing and real-time performance among the components of the system. Then there is the data processing and analysis layer, which stores, processes and analyzes the massive data collected through big data technology to discover valuable information and knowledge. Finally, the application layer, according to the analysis results, realizes the intelligent scheduling, optimization and management of logistics activities, and provides users with diversified services.

In addition, the intelligent logistics management system also needs to consider security and privacy protection issues, so the security management mechanism is also an important part of the system framework. By strengthening data encryption, access control, audit and other means to ensure the safe operation of the system and user data privacy protection [14,15].

To sum up, the design of intelligent logistics management system framework needs to comprehensively consider multiple links such as data collection, communication, processing analysis and application, as well as system security and user privacy protection, so as to achieve efficient and intelligent management of logistics activities.

2.3. Overview of water transport logistics industry

Water transport logistics industry is an important part of the global logistics system, it relies on inland rivers, lakes and oceans and other waters for cargo transport, because of its low transport cost, large volume, environmental friendly and other characteristics, occupies an important position in the world [16]. Especially for major and heavyweight goods and commodities, such as minerals, energy, food, etc., water transport is the most important mode of transport.

With the acceleration of globalization and the continuous growth of international trade, the water transport logistics industry is facing more and more challenges and opportunities. On the one hand, the diversification of demand, the improvement of customer service requirements, the strict environmental protection regulations and other factors require water transport enterprises to constantly innovate service models, improve operational efficiency, and achieve green and intelligent logistics. On the other hand, the rapid development of new technologies such as information technology, cloud computing, big data and artificial intelligence has brought revolutionary changes to the water transport logistics industry, making real-time monitoring, intelligent scheduling, accurate prediction and so on possible, helping to enhance the competitiveness and sustainable development of the entire industry.

However, there are also some problems that need to be solved in the water transport logistics industry, such as the serious information island phenomenon, the low level of industry digitalization, and the operational efficiency to be improved, which restrict the further development of the water transport logistics industry [17,18]. Therefore, how to use modern information technology, especially cloud computing, to promote the transformation and upgrading of the water transport logistics industry and achieve intelligent, green and efficient operation is an important issue that needs to be studied and solved at present.

2.4. Role of cloud computing in the intelligent management of water transport logistics

Cloud computing plays a vital role in the intelligent management of water transport logistics with its elastic scalability, on-demand payment and resource sharing characteristics. First of all, the cloud computing platform provides a large number of storage and computing resources, which can meet the real-time processing and analysis needs of water transport logistics data, and help enterprises to maximize the value of data. For example, through real-time analysis of large amounts of data such as ship operation and cargo status, enterprises can more accurately predict transportation time, optimize route arrangements, improve transportation efficiency, and reduce operating costs.

The core of the research and implementation of the transportation management system based on cloud computing is to explore how to combine the traditional Management Information System (MIS) with the most popular cloud computing technology, so that the traditional management information system has the powerful communication ability, computing ability and matching ability of cloud computing. It integrates the needs of many logistics users to form an integrated logistics demand information platform, which realizes the exchange, processing, storage and on-demand services of all information, providing valuable experience for the transition from traditional applications to cloud applications [19,20].

At the same time, cloud computing supports the high availability and scalability of logistics management systems, which can help water transportation enterprises cope with business volume fluctuations and growth, and ensure business continuity. The elasticity and scalability of cloud computing can automatically increase resources during business peaks and recover resources during business downturns, so as to realize rational utilization of resources and reduce enterprise IT operating costs.

Cloud computing platforms often integrate a variety of advanced data analysis tools and machine learning services, which can help enterprises mine the deep information in the data to achieve smarter logistics management. For example, by forecasting the demand for goods through machine learning models, enterprises can schedule resources in advance, avoid resource waste and improve service quality.

In addition, cloud computing also provides a convenient collaboration platform and service sharing platform for water transport logistics enterprises, which is conducive to breaking information islands, realizing information transparency and sharing, and improving the overall competitiveness and efficiency of the industry.

In summary, cloud computing plays a core role in the intelligent management of water transport logistics. By providing powerful computing resources, advanced analysis tools and convenient collaboration platforms, cloud computing helps the water transport logistics industry to achieve intelligent and efficient management and meet future challenges and opportunities.

3. Demand analysis and questionnaire

3.1. Questionnaire design and implementation

3.1.1. Questionnaire content construction and logic

In this study, a questionnaire was designed to understand the needs of different water transport logistics enterprises for the application of cloud computing in intelligent management. The questionnaire is structured around the following aspects: awareness of cloud computing, the need for intelligent management systems, expected benefits and possible challenges, and basic information about the enterprise.

- ***Degree of cognition of cloud computing***: Through this part, I hope to know the basic cognition of the surveyed enterprises on cloud computing, such as whether they understand cloud computing, to what extent they understand it, and whether they have experience in using it.
- ***Intelligent management system requirements***: Through this part, I hope to understand the specific needs of enterprises for intelligent management systems, such as what problems are expected to be solved through the system and what processes are optimized.
- ***Expected benefits and possible challenges***: This section mainly understands the expected benefits of the introduction of cloud computing and intelligent management systems, as well as possible difficulties and challenges.
- ***Basic information of the enterprise***: Finally, some basic information of the enterprise is collected for subsequent data analysis.

Through the above questionnaire design, the research aims to comprehensively understand the needs and expectations of water transport logistics enterprises in cloud computing and intelligent management applications, and provide powerful data support for the subsequent system design and model construction.

3.1.2. Data collection and preprocessing

In the data collection stage, this study distributed questionnaires to target enterprises both online and offline. A total of 300 questionnaires were distributed, 230 questionnaires were recovered, and 200 questionnaires were valid. The data collection process is comprehensive and rigorous, ensuring the authenticity and reliability of the collected data. The original data collected include the basic needs of users for the water transport logistics management system, the use of experience, the evaluation of system functions and other aspects of information. A summary of the data collection is shown in Fig. 1.

After the questionnaires were collected, the data were pre-processed to eliminate possible noise and inconsistencies to ensure the quality and accuracy of the analysis results. Pre-processing mainly includes cleaning outliers, filling missing values, coding categorical variables and so on. Here are the steps for data preprocessing:

- ***Cleaning outliers***: Check all responses and remove inauthentic questionnaires.
- ***Fill in missing values***: For partially missing questionnaires, use the median or mode to fill in according to the overall situation of the questionnaire.
- ***Encoding categorical variables***: For categorical variables, unique thermal coding is used for conversion to facilitate subsequent analysis.

As shown in Fig. 2, a specific example of data cleaning is presented:

After pre-processing, the purified data of 200 valid questionnaires were obtained, which provided a solid foundation for the subsequent demand analysis and system design.

3.2. User requirements and analysis results

Based on the collected and pre-processed data, the research makes an in-depth analysis of user needs. Through statistics and analysis, the following main conclusions are drawn as shown in Fig. 3.

- ***High demand for improving transportation efficiency and information transparency***: It can be seen from the statistics that the vast majority of the surveyed enterprises have a high demand for improving transportation efficiency (70%) and information transparency (75%). This shows that in the current water transport logistics industry, informatization and efficiency are urgent problems that enterprises need to solve, and cloud computing and intelligent management systems should focus on solving these two aspects of demand.
- ***Reduce operating costs and solve resource scheduling difficulties***: Most surveyed enterprises also expressed the desire to reduce operating costs (65%) and solve resource scheduling difficulties (60%). This shows that enterprises do face the pressure of cost and resource scheduling in operation, so the designed system also needs to propose corresponding solutions to these problems.

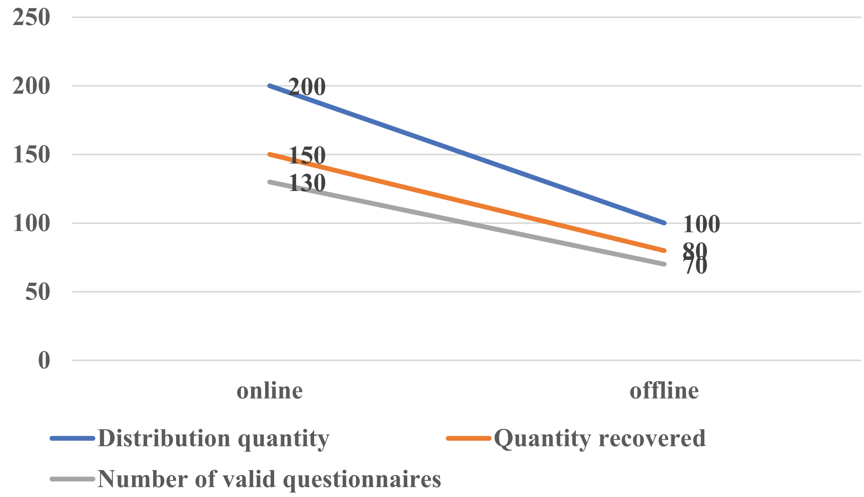

Fig. 1. Data collection.

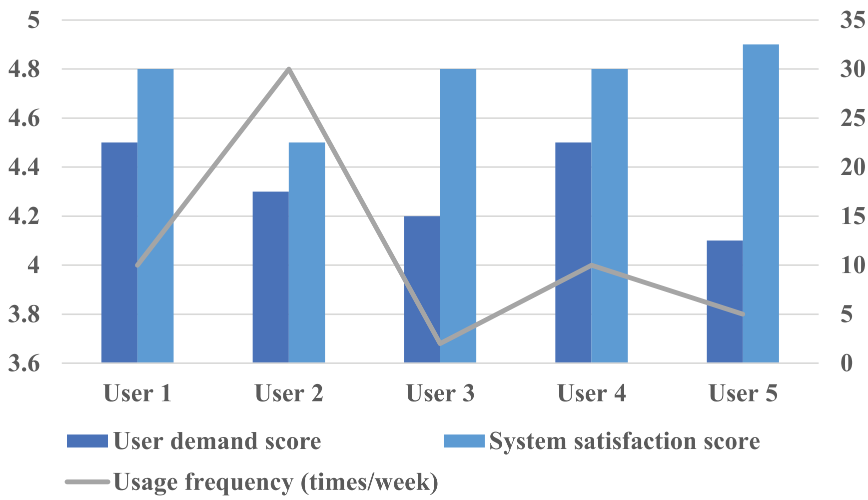

Fig. 2. Data example after data cleaning.

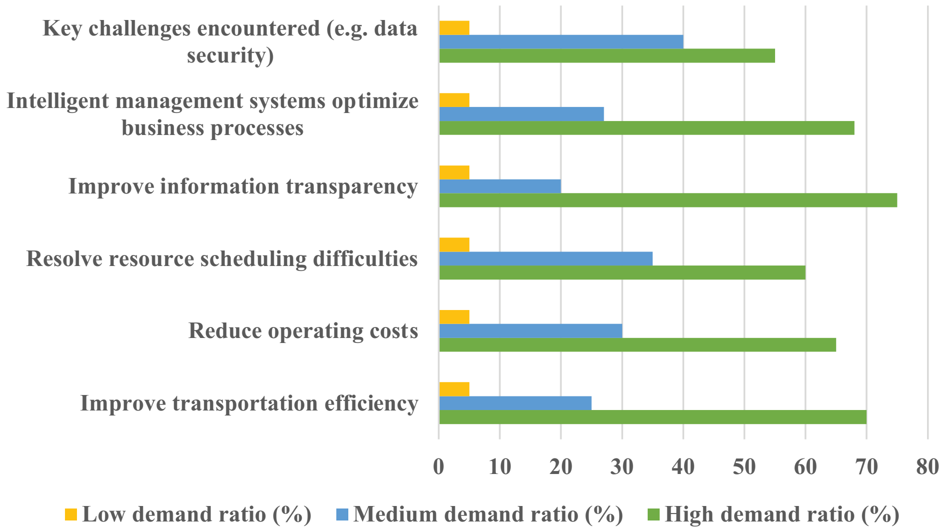

Fig. 3. Analysis results of user requirements.

Table 1
Questionnaire design

Question sequence number	Problem content	Options
Q1	How familiar are you with cloud computing?	1. Very familiar with; 2. Somewhat familiar with 3. Heard of, but not familiar with; 4. Have no idea.
Q2	Has your business used cloud computing services?	1. Yes; 2. No.
Q3	What do you think is the most important problem that an intelligent management system should solve?	1. Low transportation efficiency; 2. High cost; 3. Difficult resource scheduling; 4. Opaque information; 5. Others (please specify).
Q4	What business processes do you want to optimize with an intelligent management system?	1. Cargo scheduling; 2. Ship scheduling 3. Route planning; 4. Fee settlement; 5. Others (please specify).
Q5	What business processes do you want to optimize with an intelligent management system?	1. Improve transportation efficiency; 2. Reduce operating costs; 3. Improve service quality; 4. Improve information transparency; 5. Others (please specify).
Q6	What do you think are the main challenges to introducing cloud computing and intelligent management systems?	1. Cost problem; 2. Technical problem; 3. Employee acceptance; 4. Data security; 5. Others (please specify).
Q7	What is the size of your business?	1. Large; 2. Medium; 3. Small.
Q8	What is your company's main business direction?	1. International; 2. Domestic.

- ***Intelligent management system to optimize business processes***: 68% of enterprises said that there is a high demand for intelligent management system to optimize business processes, which means that the system needs to have certain business optimization capabilities to meet the actual needs of most enterprises.
- ***Main challenges encountered***: 55% of enterprises believe that they will encounter major challenges such as data security, which suggests that the research needs to pay attention to the protection of user data in system design to ensure the safe and stable operation of the system.

Through the above requirement analysis, the foundation has been laid for the subsequent system design and model construction, and the user needs to be met and possible challenges have been clarified.

4. System design and model construction

4.1. System architecture design and division

In order to meet the needs of water transport logistics management and take advantage of cloud computing, a layered system architecture is designed in this study. This architecture ensures the flexibility, scalability and efficiency of the system, while maximizing the utilization of resources and minimizing costs. The specific design is shown in Table 2.

4.1.1. Data layer

The data layer is mainly responsible for data storage, retrieval, backup and recovery of the whole system. Considering the large amount of data involved in logistics management and the need for high concurrency and low latency access, the study chooses cloud database service, which can provide features such as high availability, elastic scaling and disaster recovery.

4.1.2. Service layer

The service layer is the core of the system, which provides various business services and API interfaces for upper-layer applications or external system calls. In order to ensure the high availability of services and isolation of failures, the study adopts a microservice architecture, where each service runs in a separate container, which enables rapid deployment, scaling, and failover.

4.1.3. Logical layer

The logical layer is responsible for handling complex business logic, such as order scheduling, path optimization, and so on. Based on the previous requirements analysis, the research can design corresponding mathematical models to solve these problems, such as using quadratic functions to describe certain business relationships or optimization problems, as shown in Eq. (1):

$$f(x) = ax^2 + bx + c \quad (1)$$

4.1.4. Presentation layer

The presentation layer provides users with an intuitive operating interface. Considering the diversified needs of modern logistics management, front-end applications suitable for various devices and platforms, such as desktop and mobile devices, are researched and designed, so as to provide users with consistent operating experience and efficient workflow.

Through this layered architecture, research ensures the stability, scalability and efficiency of the system, and is able to respond quickly to changes in the market and the needs of users.

4.2. System modeling

Based on user demand analysis and system architecture design, research and system modeling to ensure that the system can meet user needs and achieve efficient logistics management. This study will use mathematical modeling methods to optimize logistics routes, costs and time through algorithms.

4.2.1. Optimization model

Considering the characteristics of water transport logistics and user needs, the research focuses on the following optimization objectives:

C: total cost, including transportation cost, storage cost, etc.;

Table 2
System architecture division

Layer	Function description	Uses and key components
Data layer	Responsible for data storage, backup and recovery	Use cloud Database services such as AWS RDS, Azure SQL Database, etc.
Service layer	Provides a variety of core business services and API interfaces	Leveraging microservices architecture, container technologies such as Docker and Kubernetes
Logical layer	Responsible for business logic processing, such as scheduling, optimization, etc	Use ML and AI models, such as $f(x) = ax_2 + bx + c$
Presentation layer	Provide user interfaces, such as web and mobile terminals	Use modern front-end technologies like React, Vue, Angular, etc

T: total time, including transportation time, waiting time, etc.;
D: Requirement satisfaction accuracy, a measure of how well the system meets the needs of users.

The optimization model can be expressed, as shown in Eq. (2):

$$\min Z = \alpha C + \beta T - \gamma D \tag{2}$$

where α, β, and γ are weight coefficients that indicate the importance of different goals.

4.2.2. Constraint conditions

The operation of the system is subject to a number of constraints, including:

Load capacity constraint: $\sum_{i=1}^{n} x_i \leq C_{\max}$, where x_i represents the cargo volume of the i order, and $C_{\max}$ is the maximum load capacity of the ship;

Time window constraint: For every order i, there is $T_{\text{early}} \leq T_i \leq T_{\text{late}}$, where T_i is the actual arrival time of order i;

User demand constraint: The system must meet the user's demand, that is, $D \geq D_{\min}$, where $D_{\min}$ is the minimum accuracy that the user can accept to meet the demand.

4.2.3. Solution method

For the above optimization model, mixed integer linear programming (MILP) method will be used to solve it. This method can deal with multi-objective optimization problems effectively and find the optimal solution satisfying the constraints.

4.2.4. Parameter setting

Based on the data, some parameter values are set to solve the model. Specific parameters are shown in Table 3.

By adjusting these parameters, the research can explore the optimal solution in different scenarios, and adjust and optimize the system according to the actual situation.

4.3. Cloud computing platform selection and application

Combined with user requirements and system model, this study discusses the selection and application of cloud computing platform suitable for intelligent water transport logistics management system. The choice of cloud computing platform is crucial because it will directly affect the performance, scalability and cost of the system.

In order to select the right cloud computing platform, the study defines the following evaluation metrics:

P: Performance, which measures the processing power and response speed of the cloud platform;
S: Scalability, measuring whether the capacity and functions of the cloud platform can be flexibly expanded;
C: Cost, including the use of the platform, maintenance costs, etc.;
R: Reliability, which measures the stability and availability of the cloud platform.

The goal is to find a balance so that performance, scalability, and reliability are met while minimizing costs. Therefore, the optimization model of this study can be expressed, as shown in Eq. (3):

$$\min Z = C - \delta\left(P + S + R\right) \tag{3}$$

where δ is the weight coefficient, indicating the importance of different indicators.

This study considers the mainstream cloud computing platforms in the market, such as AWS, Azure, and Alibaba cloud. Based on the data, the evaluation indicators of each platform were quantified, as shown in Table 4.

Through comparative analysis, the study found that AWS has excellent performance and reliability, but the cost is slightly higher; Alibaba cloud has an advantage in terms of cost, but it is slightly inferior in terms of performance and reliability. Considering all factors comprehensively, Azure, which is more cost-effective, is selected as the cloud computing platform.

Applying the Azure cloud platform, research can take advantage of its rich services and tools, such as Azure Kubernetes Service (AKS) and Azure DevOps, to achieve efficient operation and continuous optimization of intelligent water transport logistics management system.

Table 3
Parameter settings

Argument	Value	Description
α	0.5	Weight coefficient of cost
β	0.3	Weight coefficient of time
γ	0.2	Weight coefficient of accuracy to meet the requirements
$C_{\max}$	1000	Maximum carrying capacity of the ship
$D_{\min}$	0.95	Minimum user-acceptable accuracy in meeting requirements

Table 4
Cloud computing platform indicators

Cloud computing platform	P (Performance)	S (Scalability)	C (Cost)	R (Reliability)
AWS	0.9	0.85	0.75	0.95
Azure	0.85	0.8	0.7	0.9
Alibaba cloud	0.8	0.82	0.68	0.88

5. User experience evaluation and continuous system optimization

5.1. Acquisition and analysis of user feedback

Based on user demand analysis and system design and model construction, the research further evaluates the user experience. This section focuses on the acquisition and analysis of user feedback, so as to identify the shortcomings of the system and carry out continuous optimization.

This study designed a user feedback questionnaire, which mainly includes system performance, convenience, function satisfaction and overall satisfaction. The questionnaire used a five-point scale, with 1 being "very dissatisfied" and 5 being "very satisfied". The specific situation is shown in Fig. 4.

Through the analysis of user feedback data, the study found that the system received high ratings for performance and overall satisfaction, with an average score of 4.0. This indicates that users are satisfied with the response speed and stability of the system, which is consistent with the system design and model construction.

However, the average score of functional satisfaction is 3.6, which is relatively low. This means that some functions of the system may not fully meet the needs of users and need to be further optimized.

The research will use mathematical models to find out the factors that are most relevant to user satisfaction. Let the relationship between satisfaction Y and score x_i of various factors be linear. The following Eq. (4) is shown:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \varepsilon \quad (4)$$

where β_0 is the constant term, β_i is the weight coefficient of each factor, n is the number of factors, and ε is the error term. The research will use the regression analysis method to calculate the coefficients, find out the most important influencing factors, and provide a basis for the continuous optimization of the system.

5.2. System optimization strategy and implementation

Based on the acquisition and analysis of user feedback, key areas for optimization are identified, especially those factors that affect user satisfaction. On this basis, the corresponding system optimization strategies are studied and formulated, and these strategies are implemented.

From user feedback, the study noted a relatively low functional satisfaction score of 3.6, which is the primary goal of optimization. In order to describe the optimization effect quantitatively, the optimization objective function is set, as shown in Eq. (5):

$$J(\theta) = \frac{1}{2m}\sum_{i=1}^{m}\left(h_\theta\left(x^{(i)}\right) - y^{(i)}\right)^2 \quad (5)$$

where $J(\theta)$ is the cost function, m is the number of users, $h_\theta(x)$ is the actual satisfaction degree of system functions, and y is the expected satisfaction degree of users. The research goal is to find the parameter θ to minimize the cost function $J(\theta)$.

In order to improve the functional satisfaction of the system, the following optimization strategies are adopted:

- ***Enhance system functions***: by adding new functions and optimizing existing functions to meet the needs of users.
- ***Improve system stability***: maintain and upgrade the system to ensure the stable operation of the system.
- ***Optimize the user interface***: Improve the user interface and improve the convenience of users to use the system.

According to the above optimization strategy, the system is comprehensively optimized, and users are invited to evaluate the optimized system. As shown in Fig. 5, the comparison of user satisfaction before and after optimization is presented:

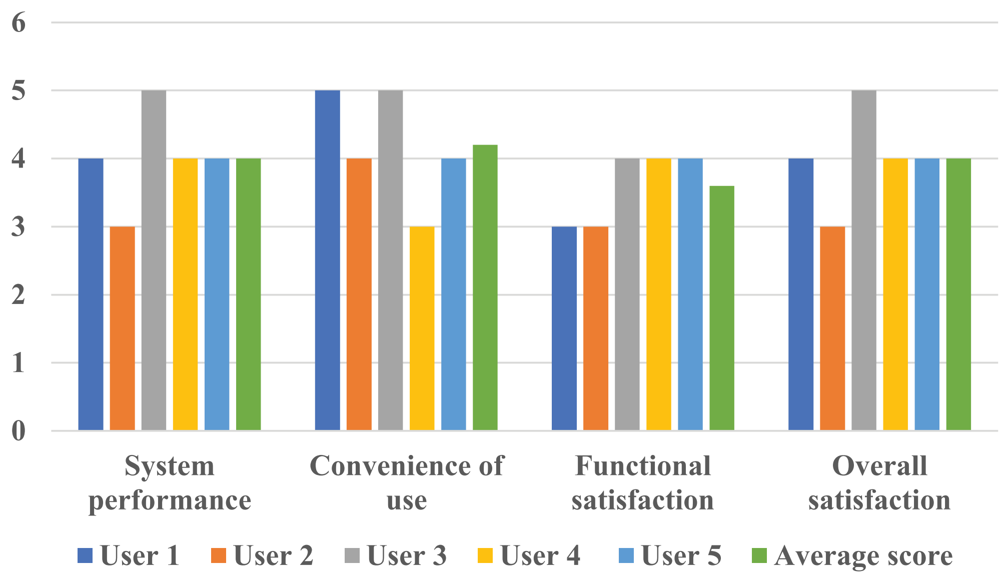

Fig. 4. User feedback data.

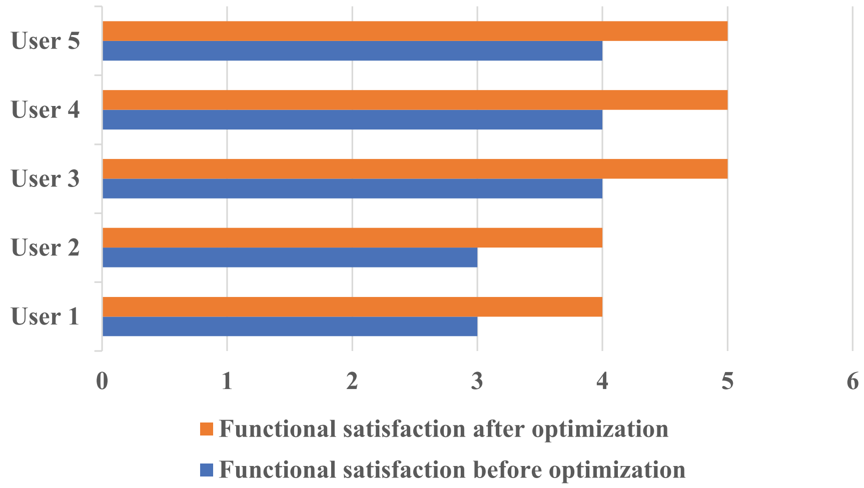

Fig. 5. Comparison of user satisfaction before and after optimization.

After optimization, the functional satisfaction of the system has been significantly improved, with the average score increasing from 3.6 to 4.6. This shows that users are more satisfied with the optimized system function, which proves that the optimization strategy of this study is effective.

In order to ensure that the system can continuously meet the needs of users, the study will implement continuous system monitoring and optimization. By collecting user feedback on a regular basis, the optimization strategy is constantly adjusted and implemented in a timely manner to maintain the high performance of the system and user satisfaction.

6. Conclusion

This research takes cloud computing and intelligent water transport logistics management system as the core, comprehensively discusses the basic theory of cloud computing, intelligent logistics management system framework and the specific application of cloud computing in intelligent water transport logistics management. Firstly, through the analysis of the basic theory of cloud computing and the framework of intelligent logistics management system, this paper reveals the importance and practicability of cloud computing in intelligent logistics management. At the same time, through a comprehensive overview of the water transport logistics industry, this paper also shows the extensive application prospects of cloud computing in this field.

Through the in-depth analysis of user needs, this paper designs and implements a questionnaire to effectively collect the actual needs of users and feedback to the existing system. Based on the actual data, the system architecture is further designed, and the function of the system is optimized by mathematical modeling to meet the needs of users. In the process of system modeling, the most suitable cloud computing platform was selected and applied according to the actual requirements.

The user experience evaluation shows that through the integrated application of cloud computing technology, the system has been significantly improved in terms of functionality, stability and user friendliness. In particular, through the system optimization strategy and implementation of this study, users' satisfaction with the system has been significantly improved. At the same time, the study also developed a continuous optimization plan to ensure that the system can continue to adapt to the changes in user needs and maintain high user satisfaction.

To sum up, this study not only has theoretical guiding significance, but also reveals the important role of cloud computing in modern logistics management by exploring the combination of cloud computing and intelligent water transport logistics management system. Moreover, it has practical application value. Through actual system design, modeling and optimization, it is verified that cloud computing technology can effectively improve the performance of logistics management system and user satisfaction. In the future, with the continuous development of cloud computing technology and the continuous innovation of the logistics industry, it is believed that cloud computing will play a more important role in the field of logistics management.

References

[1] Y. Guo, W.T. Zhang, Q. Qin, K.Q. Chen, Y. Wei, Intelligent manufacturing management system based on data mining in artificial intelligence energy-saving resources, Soft Comput., 27 (2023) 4061–4076.
[2] W. Xu, M. Rong, Research on optimization of expressway logistics path based on the advantages of multimodal transport in the environment of Internet of Things, Wireless Pers. Commun., 126 (2022) 1981–1997.
[3] C.M. Qi, J.J. Fang, L.Y. Sun, Implementation of emergency logistics distribution decision support system based on GIS, Cluster Comput., 22 (2019) 8859–8867.
[4] C. Wang, Y.H. Qian, S. Shaic, The applications of nature-inspired algorithms in logistic domains: a comprehensive and systematic review, Arabian J. Sci. Eng., 46 (2021) 3443–3464.
[5] M. Thürer, Y.H. Pan, T. Qu, H. Luo, C.D. Li, G.Q. Huang, Internet of Things (IoT) driven *kanban* system for reverse logistics: solid waste collection, J. Intell. Manuf., 30 (2019) 2621–2630.
[6] J.C. Xie, Y.R. Sun, X. Huo, Dry port-seaport logistics network construction under the belt and road initiative: a case of Shandong Province in China, J. Syst. Sci. Syst. Eng., 30 (2021) 178–197.

[7] H. Horshidian, M. Akbarpour Shirazi, S.M.T. Fatemi Ghomi, An intelligent truck scheduling and transportation planning optimization model for product portfolio in a cross-dock, J. Intell. Manuf., 30 (2019) 163–184.
[8] A. Aliakbari, A. Rashidi Komijan, R. Tavakkoli-Moghaddam, E. Najafi, A new robust optimization model for relief logistics planning under uncertainty: a real-case study, Soft Comput., 26 (2022) 3883–3901.
[9] K.R. Hasan, W. Zhang, W.M. Shi, Barriers to intermodal freight diversion: a total logistics cost approach, Marit. Econ. Logist., 23 (2021) 569–586.
[10] Q. Guo, Logistics supply chain management based on business ecology theory, Cluster Comput., 22 (2019) 13827–13833.
[11] Z. Hassanzadeh, I. Mahdavi, A. Tajdin, H. Fazlollahtabar, Collaboration analysis for a three-tier sustainable logistics network considering 3PL using BCVR technique, Environ. Dev. Sustainability, 25 (2023) 13451–13470.
[12] Y.Q. Zhang, H. Alshraideh, A. Diabat, A stochastic reverse logistics production routing model with environmental considerations, Ann. Oper. Res., 271 (2018) 1023–1044.
[13] A. Ghasemi, E. Miandoabchi, S. Soroushnia, The attractiveness of seaport-based transport corridors: an integrated approach based on scenario planning and gravity models, Marit. Econ. Logist., 23 (2021) 522–547.
[14] C.Y. Lam, W.H. Ip, An integrated logistics routing and scheduling network model with RFID-GPS data for supply chain management, Wireless Pers. Commun., 105 (2019) 803–817.
[15] J. Chen, W. Zhao, Logistics automation management based on the Internet of Things, Cluster Comput., 22 (2019) 13627–13634.
[16] G.Y. Ke, J.H. Bookbinder, Emergency logistics management for hazardous materials with demand uncertainty and link unavailability, J. Syst. Sci. Syst. Eng., 32 (2023) 175–205.
[17] R.Kr. Singh, A. Gunasekaran, P. Kumar, Third party logistics (3PL) selection for cold chain management: a fuzzy AHP and fuzzy TOPSIS approach, Ann. Oper. Res., 267 (2018) 531–553.
[18] J.D. Alejandro-Chable, T.E. Salais-Fierro, J.A. Saucedo-Martínez, M.G. Cedillo-Campos, A new lean logistics management model for the modern supply chain, Mobile Networks Appl., (2022).
[19] Y.X. Zhou, The overall framework design of automatic logistics system using a hybrid ANN-PSO model, Eng. Comput., 38 (2022) 2515–2531.
[20] S.-H. Woo, M.-S. Kwon, K.F. Yuen, Financial determinants of credit risk in the logistics and shipping industries, Marit. Econo. Logist., 23 (2021) 268–290.