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Research on Ship Manning Data Visualization

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Abstract

In order to improve the efficiency of ship manning management and ensure the operational efficiency, safety, and stability of the shipping industry, this paper designs and implements a ship manning data visualization platform based on knowledge and analysis of ship information and manning management. The platform adopts a front-end and back-end separated software development mode, with the front-end using the Vue progressive framework to build user interfaces and the back-end utilizing the Flask lightweight web framework. Data storage and management are implemented using the MySQL database, combined with PyMySQL and Flask-SQLAlchemy for data read and write operations. The platform intuitively displays and manages data related to ship manning, enabling ship managers, crew members, and other relevant personnel to effectively manage and utilize this data, provide decision-making support, and optimize ship manning management.

Keywords

Ship manning management, Front-end and back-end separation, Flask web, Vue, ECharts, Axios, MySQL.

1. Introduction

China's vast shipping industry has positioned it as a major maritime nation as well as a significant crew provider. The regulations and management of minimum safe manning on ships are crucial for both the safe operation of Chinese ships and the development of the country's crew force. This requires joint research and continuous improvement of related systems by stakeholders such as regulatory authorities, shipping companies, and maritime academies to promote the healthy development of China's shipping industry and crew force. However, with the continuous development of the shipping industry, the management of ship manning information has become increasingly prominent to ensure the safe navigation, berthing, and operation of ships. Consequently, managing and utilizing ship basic information and manning information correctly, allocating crew resources reasonably and efficiently to ensure navigation safety and improve operational efficiency, and ensuring the steady development of the shipping industry have become major issues that urgently need to be addressed in the shipping industry. At the same time, with the continuous development of data visualization technology, people can understand the information and patterns behind the data more intuitively and clearly. The rapid development of technology also provides powerful support for the management and analysis of ship manning information.

The significance of ship manning visualization also lies in promoting the digital transformation and intelligent upgrading of the shipping industry. By combining visualization technology with shipping business, more efficient and intelligent ship management can be achieved, enhancing the competitiveness and sustainable development capabilities of the entire shipping industry. To drive continuous innovation and development in ship manning management and ensure the safe and efficient operation of ships, this paper designs and implements a ship manning data

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visualization platform. The platform utilizes data visualization tools and adopts a front-end and back-end separated development mode to visualize ship manning data, aiming to optimize the statistics and management of ship manning data. The platform first collects and organizes ship manning data, further classifying and processing it. From multiple perspectives such as the number, positions, and departments of ship crew members, it visually displays ship manning information, personnel allocation, and minimum safety standards. In this way, the distribution of ship manning positions and departments, as well as the impact of various factors on ship manning, can be intuitively seen. Various data visualization charts are used to convert complex ship manning data into intuitive graphics, making the management and utilization of ship manning information more convenient and efficient.

2. Platform Design

2.1. Platform Architecture

The ship manning data visualization platform is part of the ship manning data analysis system. The entire system comprises a data acquisition platform, a data analysis platform, and a data visualization platform. The data platform facilitates the collection of business data and Automatic Identification System (AIS) data from vessels into a data warehouse. The vessel crewing system stores business data in a MySQL database, and employs Canal to synchronize data between the business database and the Hive data warehouse. AIS data is collected in real-time via AIS base stations and ingested into the data warehouse through a Kafka message queue. The data analysis platform primarily utilizes the Hive data warehouse to perform functions such as data cleaning, transformation, classification, and statistics for vessel crewing data. Hive is a data warehouse tool built on Hadoop, designed for data storage, extraction, transformation, querying, and analysis of large-scale data stored in Hadoop. The data visualization layer stores statistical results in MySQL, provides ad-hoc queries through Presto, and uses Spring Boot to transform computational results, offering them as services via APIs.

The platform adopts a front-end and back-end separated development architecture and a B/S development framework model. The front-end development framework chooses Vue, a progressive framework, which is very suitable for building complex single-page applications. The front-end is mainly responsible for data display and interaction. The back-end development selects the Flask microservice web framework, which is easy to implement and expand, concise, and flexible. The back-end is primarily responsible for data processing, business logic implementation, and data storage. Flask is used to create RESTful APIs for front-end use. MySQL database is used for data storage and management. The platform is deployed on a lightweight web server, Nginx. The platform is divided into four layers: the interface display layer, business logic layer, data interface access layer, and database layer. The system architecture design diagram is shown in Figure 1.

2.2. Functional Modules

The functional modules consist of five parts: user login module, project overview preview module, ship manning module, data preview module, and visualization module. The functional module diagram is shown in Figure 2.

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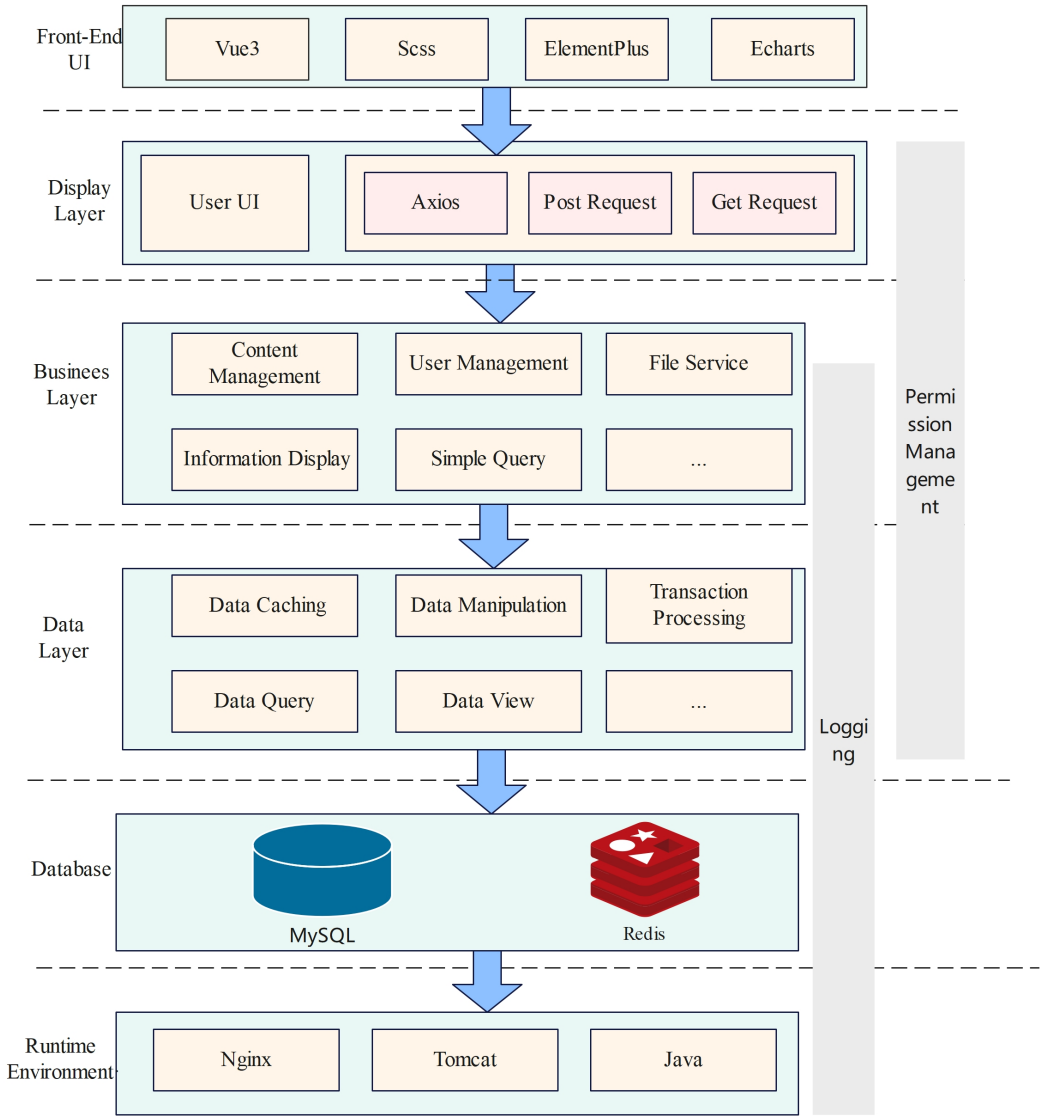

Figure 1. The system architecture design diagram

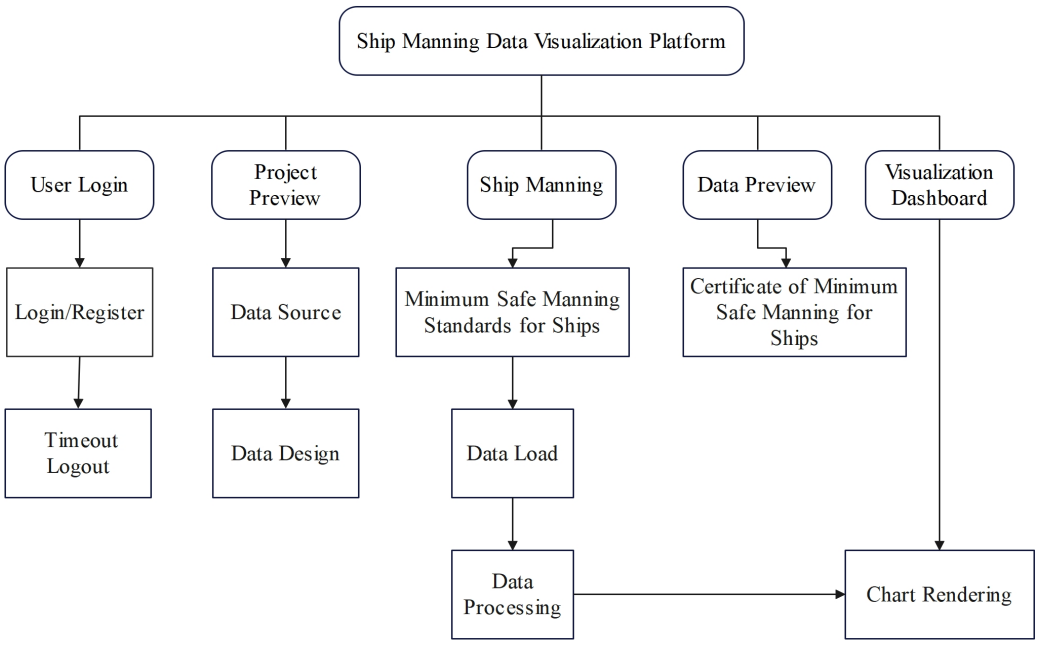

Figure 2. The functional module diagram

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The user login module verifies user login information and status to ensure that only authorized users can access the system. After successful login, users can enter the system's main interface and see the entrances and navigation menus for various functional modules. The project overview module mainly displays basic development information about the ship manning visualization project, providing users with an overall understanding of the system. This module also includes information on the system's data standards and sources. The ship manning module displays the standards and regulations for minimum safe manning on ships. This module lists the minimum manning requirements for various ship types, tonnages, and navigation areas for user reference and comparison. It displays the minimum safe manning standards for ship types, tonnages, or total power. Users can understand the basic requirements and norms for ship manning through this module to ensure the safe operation of ships. The data preview module provides preview and query functions for ship manning data. Users can browse basic information about ships in this module. The system offers multiple query conditions, such as ship name, ship type, and time period, to facilitate quick location and acquisition of the required data information. The visualization module is the core part of the platform, used for visualizing and analyzing ship manning data. This module utilizes data visualization tools and charts to present ship manning data in an intuitive and vivid manner.

2.3. Core Technologies

Flask is a lightweight web application framework designed to provide a lightweight, flexible, and easily extensible framework that enables developers to quickly build web applications. Flask can rely on various flexible extensions to add additional required functionalities to web applications based on specific business needs [1]. The platform uses the flexible, efficient, and lightweight Flask framework for the back-end development of the system, employing PyMySQL and Flask-SQLAlchemy to handle data and define data interfaces as needed.

Vue is a progressive, powerful, and high-performance JavaScript front-end web framework, as well as a flexible and maintainable web development framework [2]. Vue is an MVVM (Model-View-ViewModel) framework that achieves two-way data binding for Vue, improving upon the MVC framework by adding a ViewModel. It focuses solely on the view layer and is highly suitable for building complex single-page frameworks. This platform is based on a Vue3 and Flask front-end and back-end separated and decoupled project. This development mode is more conducive to improving development efficiency and facilitates later updates and maintenance of the project, enhancing the system's scalability and maintainability. The platform uses Vite to build Vue programs. Vite is currently a very popular new-generation front-end project construction tool that reduces the complexity of the development environment, providing faster cold starts and instant module updates in the development environment. The front-end UI interface is mainly built using ElementPlus. The front-end project is packaged and deployed on the Nginx web proxy server, a high-performance, lightweight HTTP reverse proxy server with strong capabilities for handling high concurrency and supporting hot deployment [3].

Axios is a promise-based HTTP library that simplifies the process of sending asynchronous requests to RESTful APIs to obtain data, usable in both browser and Node.js environments [4]. It mainly implements ajax asynchronous communication functionality and is used to initiate requests to the back-end. It is a JavaScript library that can send HTTP requests and is the standard data request library in Vue projects. The system's front-end encapsulates Axios, redefining Axios default parameters and custom interceptors, which is beneficial for unified request processing, improves efficiency, facilitates maintenance, and reduces code coupling.

ECharts is an open-source visualization chart library based on JavaScript, featuring intuitive, vivid, interactive, and customizable characteristics [5]. It provides developers with rich

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visualization types, powerful interactivity, and flexible customization capabilities, suitable for various data display and analysis scenarios.

MySQL, as the most popular and widely used open-source relational database management system, performs basic operations based on Structured Query Language (SQL) [6]. It is easy to learn and use, and has strong cross-platform capabilities. Since the platform's data volume is not large, MySQL can fully meet its performance requirements for such a small project.

3. System Implementation

3.1. Project Preview Module

The project preview module uses the v-md-editor Markdown editor plugin to translate static Markdown files, displaying the README.md file in the root directory of the Vue project. It briefly introduces the project's basic development information, the main open-source development frameworks used, data design sources, and table creation statements. The project preview interface is shown in Figure 3.

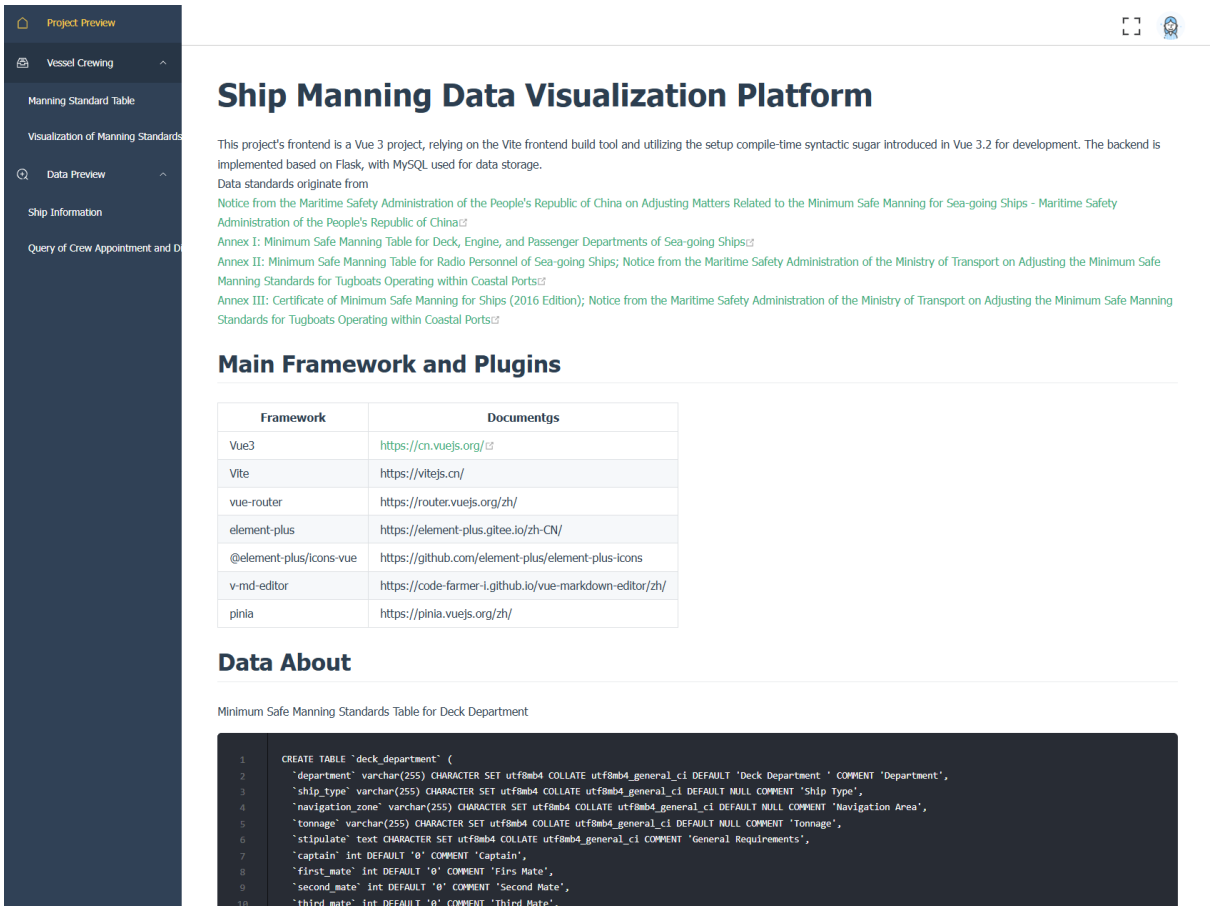

Figure 3. The project overview preview interface

3.2. Ship Crewing Module

The Ship Crewing Module encompasses a Crewing Standards Table Interface and a Crewing Standards Visualization Interface. The crewing standard data originates from Annex 1 of the Notice on Adjusting Matters Related to the Minimum Safe Crewing of Sea-going Ships issued by the Maritime Safety Administration of the People's Republic of China, specifically detailing the minimum safe crewing requirements for deck, engine, and passenger departments of sea-going

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ships. The crewing standards table employs the ElementPlus Collapse component to fold and display the minimum safe crewing standards for different ship types, tonnages, and total engine power ranges across deck, engine, and passenger departments, while also supporting editing and modification functions.

3.3. Data Preview Module

The Data Preview Interface offers keyword-based search and query functionality, covering ship information and crew appointment/resignation information. Pagination controls from ElementPlus facilitate paginated query and data preview of ship information, allowing users to conduct fuzzy searches using keywords to locate desired ship and crew appointment details. A visualization button in the operation column on the right side of the ship information table enables more clear and intuitive visual analysis of crewing data for corresponding ships. The minimum safe crewing standards and minimum safe crewing certificates provide data support for the visualization charts.

Regarding the ship information table export function, users can export and download ship information data from the database in Excel format for offline analysis and processing. This functionality is implemented using the Flask-Excel library, which effortlessly converts data to Excel format and provides it for user download. Flask-Excel, based on the PyeExcel library, simplifies the storage of data as Excel files for user download and the processing of user-uploaded Excel files. It can convert Excel data into two-dimensional arrays, one-dimensional dictionary arrays, and dictionaries with Excel sheet names as keys and two-dimensional arrays as values, and vice versa. the data preview interface is shown in figure 4.

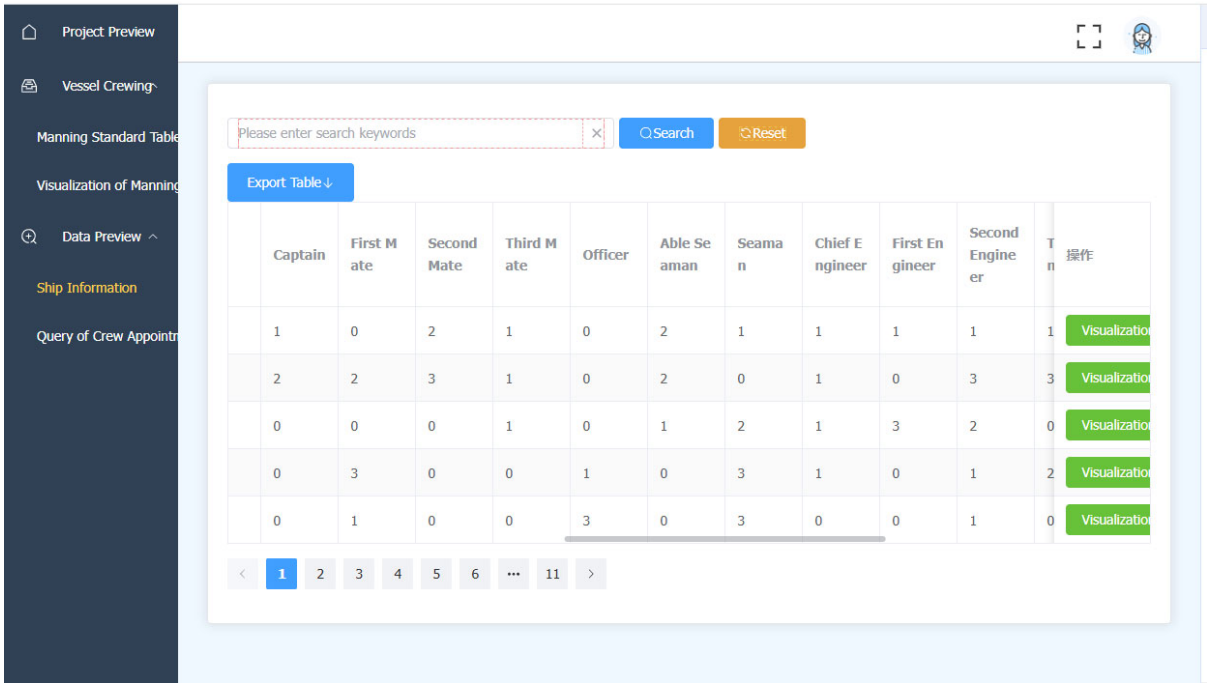

Figure 4. The data preview interface

3.4. Visualization Module

The Visualization Module presents visual analysis results for specific ship information. To enable users to more intuitively understand the basic information and crewing details of corresponding ships, the system utilizes ECharts data charts for the display of ship crewing information. In the Data Preview Interface, users can search for specific ship information using

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keywords, select the desired ship data, and click the visualization button in the operation column on the right side of the table to navigate to the visualization page for a clearer and more intuitive analysis of the selected ship data.

The visualization section showcases basic information of a specific ship, such as the ship identification number, ship name, ship type, tonnage, and total engine power. It also displays the proportion and specific number of crew members in various positions on the ship, as well as the departmental distribution of crew members. By comparing the crewing information of the selected ship's deck and engine departments with the minimum safe crewing standards published by the maritime authority for different tonnages and total engine power ranges, the module visually highlights any discrepancies in crew numbers between the actual ship crewing and the minimum safe crewing standards.

The Visualization Module primarily utilizes the ECharts chart library and Axios. Axios sends asynchronous requests to backend interfaces to retrieve data, which the frontend program then processes into the data format required for ECharts charting. The Pinia state management plugin is used to temporarily store selected ship information in a global session cache, facilitating the retrieval and display of corresponding ship information when navigating from the data preview interface to the visualization analysis page. This process involves sending Axios requests to the backend with parameters such as ship type, tonnage, and total engine power to obtain the required data. The interface is shown in Figure 5.

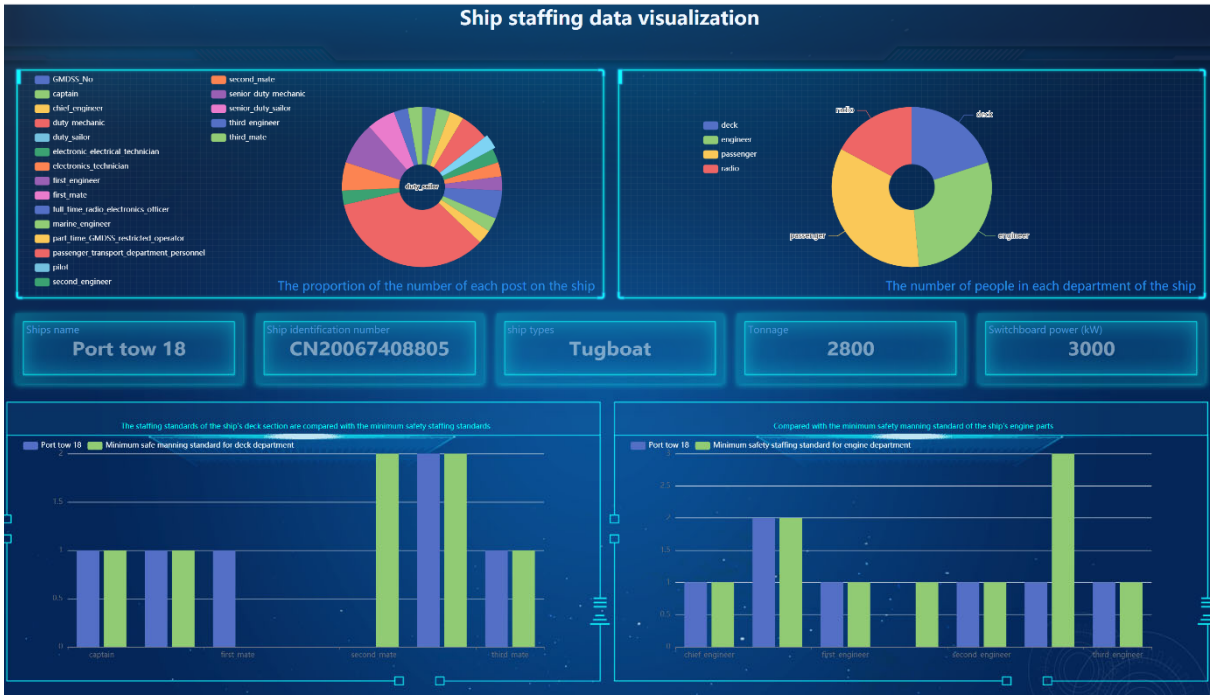

Figure 5. The visualization interface

4. Conclusion

This paper elaborates on the design and implementation of a data visualization system for ship manning. To address issues related to ship manning configuration, it proposes a front-end and back-end separated visualization project implementation plan based on Vue3 and Flask. The front-end is primarily responsible for data display and interaction, while the back-end handles data processing, storage, and business logic implementation. By presenting manning positions and department information through the system and comparing them with corresponding minimum safe manning standards, users can gain an intuitive and clear understanding of ship

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manning information. In summary, ship manning management is of great significance for ship operations, and it is essential to attach great importance to the issue of ship safety manning management to ensure that ships have sufficient and qualified crew resources during navigation.

China is a major maritime and crew power, and the future development prospects of the shipping industry are very promising. Ship manning is a crucial prerequisite for ensuring the safe navigation of ships. The ship manning data visualization system will surely continue to improve and expand in the future, becoming increasingly automated and intelligent.

Acknowledgements

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References

[1] Mufid, Mohammad Robihul, et al. "Design an mvc model using python for flask framework development." 2019 International Electronics Symposium (IES). IEEE, 2019: 214-219.

[2] Liu, Chen, et al. "Practice and Application of Wiki Open Source Document Platform Based on Vue." 2023 3rd International Symposium on Computer Technology and Information Science (ISCTIS). IEEE, 2023: 819-822.

[3] Kithulwatta, W. M. C. J. T., et al. "Performance evaluation of docker-based apache and nginx web server." 2022 3rd International Conference for Emerging Technology (INCET). IEEE, 2022: 1-6.

[4] Szabó, Ágnes-Kriszta, et al. "Atlas: Software System for Monitoring and Reserving Free Parking Spaces." 2020 IEEE 18th International Symposium on Intelligent Systems and Informatics (SISY). IEEE, 2020 : 71-76.

[5] Shen, Leiming. "Application of Lightweight Freshmen Group Portrait Based on ECharts." Journal of Electrical Systems 20.4s (2024): 178-199.

[6] Noviana, Rina. "Pembuatan aplikasi penjualan berbasis web monja store menggunakan php dan mysql." Jurnal Teknik dan Science 1.2 (2022): 112-124.