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Visualization Design and Implementation of Enterprise Expense Data Based on the Whole Value Chain

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ABSTRACT
This study focuses on the visualization design and implementation of enterprise expense data, based on the theory of the whole value chain, aiming to address the issues of data redundancy and analytical difficulties in modern enterprise management information systems. The research constructs a system that integrates and visualizes expense data from various systems. Through intuitive and comprehensive analytical tools, the system supports managers in transcending system boundaries to achieve rapid and accurate decision-making from a global data perspective. Built upon the theory of the whole value chain, this system covers core activities such as raw material procurement, production and processing, and product sales, as well as supporting activities including finance and human resources. Adopting a front-end and back-end separation architecture with technologies such as React.js and Node.js, the system ensures flexibility, maintainability, and scalability. Furthermore, it designs associated data table structures and optimizes indexes to enhance query efficiency. By presenting data through visualization, the system provides managers with intuitive and comprehensive analytical tools to optimize resource allocation and improve enterprise competitiveness.

KEYWORDS
Whole Value Chain; Expense Data; Information System; Data Visualization

1 Introduction

In modern enterprise management, the importance of data becomes increasingly prominent with the expansion of enterprises. The "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the 2035 Long-Term Goals" clearly emphasizes: "We should fully tap the potential value of data elements, strengthen the in-depth integration of digital technology and the real economy, and use data as a powerful engine to promote collaborative innovation and in-depth transformation of the entire industrial chain.[1]" In the past, the traditional method of generating data reports was inefficient and error-prone, requiring managers to spend a lot of time on analysis with limited perspectives. Insufficient data sharing between systems led to data redundancy. This study innovatively constructs an enterprise expense data visualization system from the perspective of the whole value chain, integrating expense data from information management systems across all links, aiming to assist managers in making rapid and accurate decisions. Through a visual interface, managers can grasp the overall expense situation across systems and optimize enterprise management.

2 Connotation of the whole value chain Theory

The concept of the value chain was proposed by the renowned American scholar Michael Porter in 1985. He elaborated: "A series of operational activities involved in an enterprise, such as research and development, design, procurement, production, marketing, service, and delivery, are all aimed at enhancing the enterprise's value. These activities not only perform their respective functions but also interrelate and influence each other, jointly constructing a dynamic process of enterprise value creation.[2]" Furthermore, when all the value chain activities of an enterprise are organically connected, a complex overall structure, the so-called "whole value chain," is formed. Since its inception, the whole value chain theory has been widely applied in enterprise management. With the expansion and extension of its application fields, relevant scholars have conducted in-depth research on the theory[3-5], developing it into an enterprise strategic analysis model to help enterprises understand their position in the value chain and competitive advantages [6]. The theory holds that an enterprise's value-creating activities can be divided into two categories: primary activities and support activities. Primary activities include raw material procurement, production and processing, product sales, and other activities directly related to products. Support activities include internal management, human resources, technological development, and other activities indirectly related to products [7]. The theory emphasizes the interconnection and mutual influence between various links within an enterprise, and highlights the improvement of overall competitiveness by optimizing each link in the value chain.

3 System Design

From the perspective of the whole value chain, the design of an enterprise data visualization system is a complex and critical task. It not only needs to meet the basic requirements of enterprises for data visualization but also consider the characteristics and requirements of the whole value chain management, ensuring that the system can comprehensively and accurately reflect the enterprise's value creation process.

3.1 Demand Analysis

3.1.1 User Demand Analysis

In the demand analysis phase, it is necessary to communicate with relevant departments and personnel of the enterprise to understand their specific needs and expectations for data visualization. Managers from different departments may have different focuses and needs for data visualization. For example, the financial department may pay attention to cost and profit conditions, the production department may focus on production efficiency and quality, and the sales department may care about sales volume and market share. Therefore, it is necessary to analyze the needs of different user groups and determine the system's functions and interface design [8].

3.1.2 Functional Demand Analysis

Functional requirements cover data collection, cleaning, storage, query, analysis, and visualization. The system needs to support multi-source data import, perform preprocessing to ensure data accuracy, consider data scale for secure storage, provide flexible query and rich analysis functions, and adopt diverse visualization methods for easy understanding. Non-functional requirements focus on performance (response speed, throughput, concurrency), stability, usability (simple interface, convenient operation), and security (authentication, access control, data encryption), comprehensively ensuring the system is efficient, stable, user-friendly, and secure. In summary, the demand analysis phase of system design is a crucial step in the system design process. It provides important guidance and reference for the system's design and implementation, ensuring that the system can meet the needs of users and the enterprise's business requirements. Combined with the whole value chain theory, we can more comprehensively analyze and understand the enterprise's business situation, thereby designing a data visualization system that is more in line with actual needs [8].

3.2 Overall System Design

The system adopts a front-end and back-end separation architecture. The front-end presents a user-friendly interface, while the back-end handles data logic and storage. Modular design promotes efficient operation and enhances stability, scalability, and security. Figure 1 shows the whole value chain enterprise expense data visualization system, which meets the needs of expense data management and analysis. The front-end interface displays expense data through visualization tools such as charts, facilitating users to view and analyze. The core of the back-end is the application server, which processes requests and schedules modules, including two major modules: data processing (cleaning, processing, calculation) and data storage (database management to ensure security and efficient access). Additionally, there is a data collection and processing module that collects raw expense data from various systems, ensures its accuracy and completeness, and then transmits it to the data processing module, constructing a complete data processing flow.

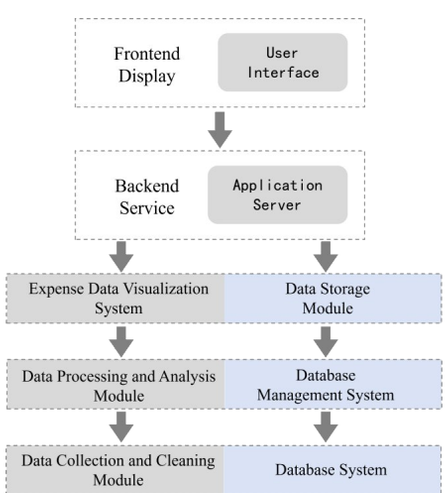


Figure 1 Overall Design of the Enterprise Expense Data Visualization System Based on the whole value chain

4 System Implementation

4.1 System Architecture

4.1.1 Framework Design and Technology Selection

The system adopts a modern three-tier architecture model, including the presentation layer, application layer, and data layer [9]. This architecture divides the system into three independent layers, as shown in Figure 2. Each layer has its own responsibilities and functions, which can improve the system's flexibility, maintainability, and scalability.

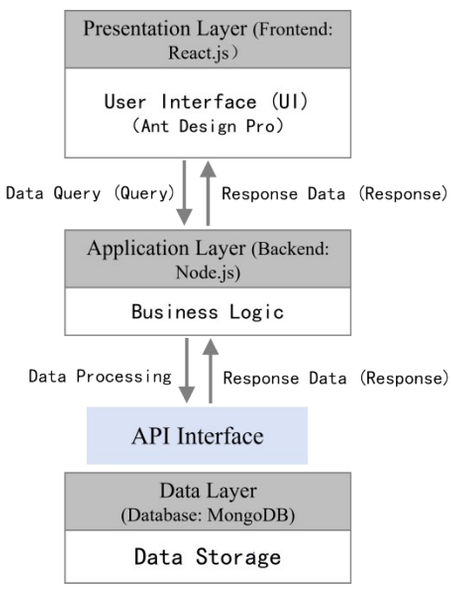


Figure 2 Framework Design of the Enterprise Expense Data Visualization System Based on the whole value chain

Presentation Layer: Located at the top level, it presents the user interface. It uses React.js + Ant Design Pro + GraphQL to build a modern interface and improve user experience [10].

Application Layer: Located in the middle layer, it handles business logic and data transmission. It uses Node. js + Express.js + GraphQL to build an efficient back-end, process requests, and interact with the database.

Data Layer: Located at the bottom level, it stores and manages data. MongoDB, a non-relational database, is adopted to meet the needs of large-scale data storage and processing.

4.1.2 Database Design and Implementation

Database design and implementation are the core parts of the system, directly related to data storage, management, and retrieval efficiency.

4.1.2.1 Database Design

In the database design phase, it is necessary to consider data objects, relationships, and attributes to ensure the comprehensive storage and flexible query of expense data across the whole value chain. Key objects include users, data, enterprise information, departments, and reports, which store user authentication information, expense details, basic enterprise data, department information, and report content respectively. Corresponding data tables are designed for each link of the whole value chain, such as raw material procurement, production and processing, sales and distribution, logistics and transportation, customer information, and financial data tables. The tables are interconnected to achieve information sharing, supporting the full-process data management from raw materials to sales [11].

4.1.2.2 Index Design and Optimization

To improve data retrieval and query efficiency, index design and optimization are performed on the database tables. According to the query frequency and key fields of the data, appropriate indexes are created for each table to accelerate data retrieval. For example, for the data table (Data), indexes are created for the companyId, departmentId, and timestamp fields to support fast queries by enterprise, department, and time range.

4.1.2.3 Database Connection and Operation Implementation

In the actual implementation, the Mongoose library in Node.js is used to connect and operate the MongoDB database. Mongoose provides a simple and easy-to-use API, which can conveniently define data models, establish database connections, and execute various database operations, such as data insertion, update, deletion, and query. Through the above steps, the database structure is designed and implemented, ensuring that the system can efficiently store and manage the enterprise's expense data, and support flexible data query and analysis.

4.2 Implementation of Data Visualization

In terms of data visualization, a variety of charts and visualization tools are adopted, such as line charts, bar charts, and pie charts, to present data in an intuitive way. According to the characteristics of the data and user needs, appropriate chart types are selected, and customized design and optimization are carried out. Through data visualization, users can more clearly understand the distribution and trends of data, thereby making more accurate decisions. Different system interfaces provide customized data visualization displays for managers of different functional departments and users, helping them fully understand the data situation of each link of the enterprise and supporting the formulation and execution of decisions and actions. At the same time, the data flow and connections between various interfaces ensure the efficient transmission of information and the realization of collaborative work. Taking Figure 3 as an example, it is a visual presentation of raw material procurement expense data. Users can view expense data related to raw material procurement. Bar charts are used to compare the procurement amounts of different suppliers, line charts show the changing trends of procurement expenses over time, and pie charts display the procurement proportion of each raw material category. At the same time, in-depth analysis can be carried out on the data presented in the form of charts and tables.

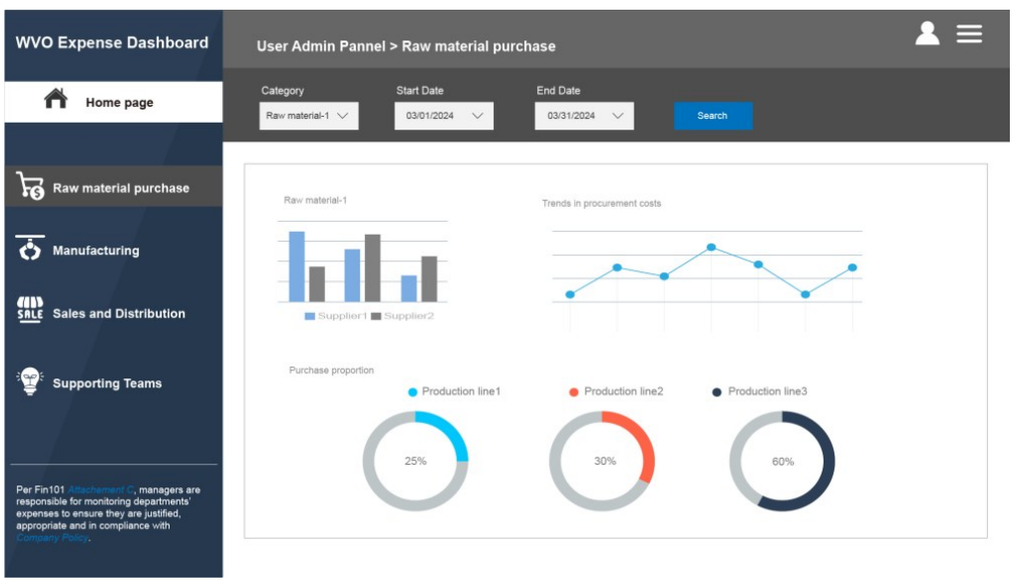


Figure 3 Raw Material Procurement Expense Data Visualization Page

In addition, data flow and connections are realized between various interfaces, ensuring the efficient transmission of information and the realization of collaborative work. For example, the expense data of supporting departments may be associated with raw material procurement and production and processing links, while the data of product sales and distribution may affect the costs of production and processing. Through such data flow and connections, different departments can better cooperate to jointly optimize the enterprise's operational efficiency and cost management, and realize the optimization and improvement of the overall value chain. The realization of this data flow and connection not only promotes collaboration between departments but also provides the enterprise with more comprehensive and accurate data support, thereby better guiding the enterprise's development and decision-making.

5 Conclusion and Outlook

Based on the theoretical framework of the whole value chain, this study explores the design path and implementation strategy of enterprise data visualization in depth, constructing a full-chain data visualization system covering raw material procurement, production and processing, sales and distribution, and supporting departments. It provides strong decision support for management, promotes the optimization of resource allocation and the improvement of management efficiency. However, the research also has certain limitations. For example, the data is mainly derived from the enterprise's internal systems, with insufficient integration of external data; the interface interactivity and user experience still have room for improvement; and the current application scenarios of the system are mainly concentrated on the core links of the whole value chain, and its wide applicability to specific industries remains to be verified. In the future, we will strive to break through the existing limitations, strengthen the diversification of data sources and quality management. At the same time, we will continuously iterate the interface design, improve user interaction experience and personalized customization capabilities, and actively expand the application boundaries of the system to cover more industries and

sub-fields, so as to fully release the potential value of enterprise data visualization.

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