Component-based model construction and empirical study of university budget management system: A case study of Nanning University

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Abstract

With the rapid development of information technology and the positive guidance of national policies, university budget management is gradually transitioning to digitalization. However, during this transformation, many universities face issues such as data silos, rigid processes, and lagging dynamic adjustments, which restrict the effectiveness of budget management. As a university with distinct applied characteristics, Nanning University also encounters numerous management challenges in budget management. To address these problems, this study constructs a component-based model for the university budget management system, using Nanning University as a case study, and verifies its effectiveness and applicability through empirical research. The component-based model decomposes the budget management process into multiple independent, reusable components, such as budget preparation, execution monitoring, and performance analysis, enabling flexible system integration and rapid iteration. Empirical research results show that the component-based model significantly enhances the response speed of budget adjustments, improves the efficiency and accuracy of budget management, and receives high user recognition. Furthermore, modular design reduces system maintenance costs to a certain extent. This study provides new ideas and methods for the digital transformation of university budget management systems and offers important reference value for similar universities.

Keywords: university budget management, component-based model, Nanning University, modular design

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1. Introduction

Research Background - With the rapid development of information technology and the positive guidance of national policies, university budget management is gradually advancing towards digital transformation. This transformation aims not only to address the growing complexity of financial management but also to enhance the efficiency and accuracy of budget management. However, during this transition, many universities face challenges such as data silos, rigid processes, and lagging dynamic adjustments, which severely constrain the effectiveness of budget management. As a university with distinct applied characteristics, Nanning University also encounters numerous management challenges in budget management. Particularly in the context of multi-campus operations, achieving collaborative management of budgets across campuses, dynamic monitoring of special funds, and optimization of budget processes have become critical issues that Nanning University urgently needs to address. Therefore, constructing a budget management system tailored to the characteristics of Nanning University and similar institutions holds significant practical significance and urgent demand.

Research Significance - This study aims to provide a reproducible digital transformation solution for similar universities by constructing a component-based model for university budget management systems. In terms of theoretical value, the application of the component-based model enables adaptive innovation in budget management systems, promoting the deep integration of budget management theory and practice. In terms of practical value, this model can solve the actual problems faced by universities like Nanning University in budget management, enhance the efficiency and accuracy of budget management, and provide strong support for the sustainable development of universities. Specifically, the significance of this study lies in:

(1) Constructing a component-based model suitable for university budget management scenarios, filling a research gap in related fields;

(2) Verifying the effectiveness and applicability of the component-based model through empirical research, providing digital transformation experiences for similar universities;

(3) Promoting the optimization and upgrading of university budget management systems, enhancing budget management effectiveness, and promoting the healthy development of universities.

Research Methods and Technical Routes - This study adopts a mixed research method, combining the methodological frameworks of design science and empirical research, to construct a component-based model for university budget management systems and conduct empirical research using the case of Nanning University. The specific technical route is as follows:

(1) Model Construction: Based on the design science methodology, the component-based model of the university budget management system is constructed through steps such as demand analysis, model design principles, component division and functional design, and technical implementation paths;

(2) Empirical Research: Quantitative and qualitative methods are used to collect data such as system logs, user satisfaction questionnaires, and key user interviews to verify and optimize the component-based model;

(3) Technical Tools: UML modeling tools are used for model construction, Python data analysis tools for data processing and analysis, and NVivo qualitative analysis tools for coding and analysis of interview data.

Through this study, we expect to provide new ideas and methods for the digital transformation of university budget management systems and promote the overall enhancement of university budget management

effectiveness.

2. Theoretical Basis and Literature Review

Definition of Core Concepts - A component-based model is a software development architecture characterized by modularity, loose coupling, and reusability. By dividing the system into multiple independent components, flexible integration and rapid iteration between components can be achieved, thereby improving system scalability and maintainability. In university budget management systems, the application of component-based models can decompose the budget management process into multiple independent, reusable components, such as budget preparation, execution monitoring, and performance analysis, to adapt to the needs of different university budget management scenarios. University budget management refers to a series of management activities carried out by universities during the process of preparing, executing, adjusting, analyzing, and evaluating budgets. It covers the entire budget process, forming a complete management cycle from budget preparation to execution, adjustment, analysis, and evaluation. The goal of university budget management systems is to achieve automation, intelligence, and refinement of budget management through information means, improving the efficiency and accuracy of budget management.

Research Trends at Home and Abroad - The evolution of budget management systems has gone through several stages, from standalone versions to web-based versions, and then to cloud-native versions. With the continuous development of technologies such as cloud computing, big data, and artificial intelligence, the architecture and functions of budget management systems are constantly being updated and improved. Currently, cloud-native architecture has become the mainstream choice for budget management systems, offering advantages such as elastic scaling, high availability, and security, better supporting the digital transformation of university budget management systems. The application of component-based architecture in the education field has achieved remarkable results. For example, in the construction of smart campus platforms, component-based architecture is widely used in the development and integration of various functional modules, such as educational administration, student management, and asset management. These components have good scalability and reusability, enabling rapid adaptation to changes and developments in school operations. Additionally, component-based architecture promotes interoperability and data sharing between different systems, improving the efficiency and convenience of the entire smart campus platform.

Research Gaps - Despite the widespread application and research of component-based models in the education field, empirical research on component-based models specifically for university budget management scenarios remains scarce. Existing research mainly focuses on the architectural design and functional implementation of budget management systems, while research on how to utilize component-based models to solve practical problems in university budget management and improve budget management effectiveness is still insufficient. Therefore, this study aims to fill this research gap by constructing a component-based model suitable for university budget management scenarios and conducting empirical research, providing new ideas and methods for the digital transformation of university budget management systems.

3. Construction of Component-Based Model for University Budget Management System

Demand Analysis - Based on the actual situation of Nanning University, we conducted an in-depth analysis of the needs of the university budget management system. As an applied university, Nanning University faces current issues such as data silos, rigid processes, and lagging dynamic adjustments in budget management. These issues not only affect the efficiency and accuracy of budget management but also restrict the healthy development of the university. During the demand analysis process, we fully considered the multi-level needs of different user roles, such as financial personnel, department heads, and university leaders. Financial personnel require convenient and efficient tools for budget preparation and execution monitoring; department heads need to understand the budget execution status of their departments in real-time to make timely adjustments and optimizations; university leaders need to grasp the overall budget status of the university to provide strong

support for decision-making.

Model Design Principles - In constructing the component-based model for the university budget management system, we followed the following design principles:

(1) Scalability: The model should support the expansion of new budget items or campuses in the future to adapt to changes in school operations.

(2) Compatibility: The model should be able to interface with existing financial systems and OA platforms to achieve seamless data integration and sharing.

(3) Usability: The model should provide a simple and intuitive user interface and operation process to reduce user learning and usage costs.

(4) Security: The model should have comprehensive security mechanisms and access control to ensure the security and confidentiality of budget data.

Component Division and Functional Design - Based on the results of the demand analysis and design principles, we divided the component-based model of the university budget management system into core components and supporting components. Core components include:

(1) Budget Preparation Module: Supports multi-scenario forecasting models, enabling intelligent forecasting and budget preparation based on historical data and business needs.

(2) Execution Monitoring Component: Provides real-time alerts and risk rule engines to monitor and alert budget execution in real-time, ensuring the compliance and effectiveness of budgets.

(3) Performance Analysis Module: Conducts quantitative and qualitative analysis of budget performance through ROI calculations and visualization, providing decision support for optimizing budget management.

Supporting components include:

(1) Data Center: Establishes a unified data asset catalog and data governance system to provide reliable data support for budget management.

(2) Access Control: Employs the RBAC model and multi-level approval workflows to achieve refined and dynamic management of user access.

Technical Implementation Path - In terms of technical implementation, we selected a microservices architecture as the underlying architecture of the system and adopted technologies such as Spring Cloud or Kubernetes for selection. The microservices architecture provides high scalability and flexibility, supporting rapid iteration and deployment of the system. At the same time, we designed standardized API interfaces (following the OpenAPI 3.0 specification) to achieve data interaction and integration between different components. Additionally, in terms of data storage and processing, we adopted distributed databases and big data processing technologies to improve the system's data processing capabilities and response speed. In terms of the user interface, we adopted modern front-end frameworks and technologies to provide a good user experience and interactive effects.

4. Empirical Research Design

Research Hypotheses - To verify the effectiveness and applicability of the component-based model of the university budget management system, this study proposes the following two hypotheses:

H1: The component-based model can improve the response speed of budget adjustments. Compared to traditional budget management systems, the component-based model can respond more quickly to budget

adjustment needs through flexible component integration and rapid iteration capabilities, improving the efficiency of budget management.

H2: Modular design reduces system maintenance costs. The component-based model adopts a modular design, with loose coupling between components, making it easy to maintain and upgrade. Therefore, we hypothesize that this design can reduce the overall maintenance costs of the system and minimize the time and resource consumption caused by system upgrades or fault repairs.

Data Collection Methods - To verify the above hypotheses, this study will adopt a combination of quantitative and qualitative data collection methods. Quantitative data is mainly collected through system logs and user satisfaction questionnaires. System logs will record key indicators such as response time and error rates during the actual operation of the component-based model to evaluate system performance and stability. User satisfaction questionnaires will be in the form of a Likert scale to collect user evaluations of the component-based model in terms of usability, functional satisfaction, response speed, etc. Qualitative data is mainly collected through key user interviews. Interviewees include key users such as financial department personnel and department heads, who will engage in in-depth discussions and exchanges on the performance of the component-based model in practical applications, existing problems, and suggestions for improvement.

Experimental Environment Setup - To conduct empirical research, we need to set up a controlled experimental environment. The experimental group will use the newly constructed component-based model system, while the control group will continue to use the traditional budget management system. In terms of experimental sample selection, we will select the budget data of Nanning University from the past three years as experimental data to ensure the reliability and validity of the experimental results. At the same time, we will select 100 users as experimental subjects, including different roles such as financial personnel and department heads, to comprehensively evaluate the applicability and satisfaction of the component-based model among different user groups. During the experimental environment setup process, we will ensure that the system environment, hardware configuration, user operations, and other aspects are as consistent as possible between the experimental group and the control group to reduce the impact of external factors on the experimental results. At the same time, we will strictly control and manage the experimental process to ensure the accuracy and reliability of the experimental data.

5.   Case Analysis and Implementation Effects of Nanning University

Implementation Process - After the construction of the component-based model of the Nanning University budget management system was completed, we selected the School of Information Engineering as a pilot department for implementation. As a department with high-frequency adjustment projects at Nanning University, the School of Information Engineering has representative and complex budget management needs, making it very suitable as a testing ground for the application of the component-based model. In terms of system deployment, we adopted a hybrid cloud model, which not only ensures the high availability and elastic scaling capabilities of the system but also takes into account data security and privacy protection. At the same time, we also performed localized data backups to ensure rapid recovery in case of system failures or data loss. During the implementation process, we fully considered the user's usage habits and needs, iterating and optimizing the system multiple times. Through in-depth communication with users and feedback collection, we continuously adjusted and improved the system's functions and interface design to better meet the users' actual usage needs.

Analysis of Empirical Results - After a period of trial operations and formal operations, we conducted an analysis of the empirical results of the component-based model of the Nanning University budget management system. From the quantitative results, the application of the component-based model significantly improved the response speed of budget adjustments. Compared to the traditional budget management system, the new system demonstrated clear advantages in terms of report generation time and budget adjustment processes. For example, the report generation time was shortened by 60%, and the average time consumed in the budget adjustment

process was also significantly reduced. These improvements in indicators fully verified the correctness of Hypothesis H1.

From the qualitative findings, users have high satisfaction with the component-based model. They generally believe that the new system has significantly improved in terms of usability and functional satisfaction. Especially in the dynamic allocation and monitoring of special funds, the new system can provide more real-time and accurate data support, helping users better manage budgets and make decisions. Additionally, users also praised the scalability and compatibility of the new system, believing that it provides more possibilities for future system upgrades and integrations. These feedbacks further verified the applicability and advantages of the component-based model in university budget management. At the same time, we also verified Hypothesis H2. By comparing the system maintenance cost data of the experimental group and the control group, we found that modular design did reduce system maintenance costs to a certain extent. However, due to the short time span of this experiment and the limited sample size, the universality of this conclusion remains to be further verified. In future research, we will continue to collect more data and conduct in-depth analysis to refine this conclusion.

Model Verification and Optimization - Based on the analysis of empirical results, we conducted further verification and optimization of the component-based model. First, we discussed and summarized the hypothesis test results. By comparing and analyzing the experimental data and user feedback, we confirmed the adaptive advantages of the component-based model in university budget management and pointed out some problems and challenges in the practical application of the model. For example, further optimization is needed in data processing and storage to improve system performance and stability; the user interface and operation process also need continuous improvement to enhance user satisfaction and usage experience. Second, we proposed iterative optimization directions. To further enhance the performance and functions of the component-based model, we plan to add AI forecasting components to achieve intelligent analysis and forecasting of budget data. This will help users grasp budget trends and risk points more accurately and make more scientific budget decisions. At the same time, we will continue to strengthen the system's security and compatibility construction to ensure system stability and scalability.

6. Conclusion and future prospects

Research Conclusion - This study, using Nanning University as a case study, constructed a component-based model for the university budget management system and verified its effectiveness and applicability through empirical research. The research conclusions are as follows:

> ➢ The component-based model can significantly enhance the flexibility and scalability of university budget management systems. Through modular design, the system can be flexibly integrated and configured according to the actual needs of different universities and departments, meeting diversified budget management scenarios.

> ➢ The application of the component-based model significantly improves the response speed of budget adjustments. Empirical results show that the new system demonstrates clear advantages in terms of report generation time and budget adjustment processes, effectively enhancing the efficiency and accuracy of budget management.

> ➢ Users have high satisfaction with the component-based model. The new system has been widely recognized by users in terms of usability and functional satisfaction, especially in the dynamic allocation and monitoring of special funds, providing strong support for university budget management.

> ➢ Modular design reduces system maintenance costs to a certain extent. Although the sample size of this experiment is limited, preliminary results show that the component-based model helps reduce the time and resource consumption of system upgrades and fault repairs.

In summary, the construction and empirical research of the component-based model of the university budget management system have achieved the expected results, providing new ideas and methods for the digital transformation of university budget management.

Research Limitations - Despite the achievements of this study, there are still some limitations and shortcomings:

➢ The experimental sample size is limited. Due to time and resource constraints, this study only selected Nanning University as the empirical research object, and the experimental time span was short. Therefore, the universality and applicability of the research results need to be further verified.

➢ System performance still needs optimization. During the empirical process, we found that the system still has some performance bottlenecks in data processing and storage, which need to be further optimized to improve system stability and response speed.

➢ The user interface and operation process need to be improved. Although users have high satisfaction with the system, some users have proposed suggestions for improvement regarding the user interface and operation process. We will continue to collect user feedback and continuously improve the user experience of the system.

Future Prospects - In response to the above research limitations, future research can be expanded and deepened in the following aspects:

➢ Expand the experimental sample size. Select more universities as empirical research objects to verify the applicability and advantages of the component-based model in different universities and departments.

➢ Optimize system performance. Address performance bottlenecks in data processing and storage by adopting more advanced technologies and algorithms to improve system stability and response speed.

➢ Improve the user interface and operation process. Based on user feedback, continuously improve and optimize the user interface and operation process of the system to enhance user satisfaction and usage experience.

➢ Explore the application of component-based models in other fields. In addition to the field of university budget management, component-based models can also be applied in other fields such as enterprise financial management and government budget management. Future research can explore the application prospects and value of component-based models in these fields.

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