Research Article

SOA-based Information Integration Platform for Educational Management Decision Support System

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The resource management platform based on the resource library has different structures, which brings a lot of inconvenience to the sharing of educational resources. However, the scale of the school is constantly expanding, the number of campuses and departments within the school increases, and the number of teachers and students increases. These new circumstances need the development of an open, secure, and effective school administration system that can operate online at any time and from any location. The “plan norm model” of educational management decision-making goals controls the decision-making dynamic structure. Whether the decision-making object is an “economic man” or a “social man,” its dynamic structure is built on a top-down control sequence, with the only variation being the control mechanisms used. In colleges and universities, educational administration management is an essential aspect of educational management. It is a work with strong timeliness, heavy workload, and high accuracy requirements, affecting the overall situation of teaching. This paper proposes an information integration platform based on SOA, which integrates various enterprise application systems into a unified platform by using a loose coupling structure, realizes information sharing among application systems, and meets the needs of cross-departmental enterprise business. As a new architecture idea, service-oriented architecture can package existing assets and reuse existing assets. It can also minimize the impact of demand changes because its implementation is loosely coupled. When users need to add or modify a function, they only need to make a few modifications in the presentation layer or business process layer.

1. Introduction

With the increasing size of schools and the increasing number of students and teachers, the work of school administration has become more and more confusing [1]. It is mainly manifested in the lack of smooth administration, lack of information, lack of data sharing, lack of easy access to data, duplication of work, low work efficiency, and parents and students not being informed of their school situation in a timely manner [2]. Generally speaking, educational management decision-making goals should be consistent with the overall goals of educational organizations, and this consistency can be used as a specific criterion to measure the performance of actual decision-making [3]. With the introduction of computers at all levels of educational management in China and their application to some extent, they have played a positive role in improving the office level of educational management [4]. Nowadays, more and more schools have established their own educational resource libraries and used them as the basis for their own teaching applications [5]. However, some results have been achieved and valuable experiences have been accumulated in building educational resource libraries, and some standards have been developed about educational resources [6].

However, owing to the various technologies and standards utilized in the development of educational resource banks, each database’s data structure and organization differs, and retrieval platforms built on this foundation vary even more in terms of retrieval techniques and interfaces [2]. Results: the problem of “information island” developed from a lack of essential linkage among educational resource banks. Manual management was utilized in the early days when the number of pupils in school was relatively modest. The school used stand-alone administration and small LAN
management as the number of pupils increased [8]. Many instructors, on the other hand, are studying current educational philosophies. Modern instructional media used to aid teaching are growing more diverse, and their roles are getting increasingly refined [9]. New instructional media are continually being produced, which surely improves the environment and tools available to address this issue [10]. In general, the typical EAI scheme combines information-oriented and business process-oriented components. Its drawbacks include being overly closely tied with the original system design, being rigid and difficult to implement, and being difficult to adjust to quickly changing business demands [11]. For the developers of resource banks, due to the rapid spread of educational informatization, the demand for resource sharing and information exchange has also increased sharply, and to realize resource sharing and information exchange among different educational resource banks requires a complete set of sharing and exchange norms [12]. At present, due to the lack of such a norm, the sharing of educational resources has begun to be affected to a certain extent [13].

In order to ensure the efficiency and scientificity of educational administration management and reduce the workload of educational administration staff, today, with the rapid development of science and technology and information, all disciplines are constantly moving forward to high precision and excellence. As the top priority of school work, educational administration work inevitably needs an effective management and control method. In the daily management of colleges and universities, “educational administration management” is undoubtedly the core work and the top priority. The scientization and standardization of its management mode and the informatization and automation construction of management means will have a far-reaching impact on the overall development of the university [14]. In order to overcome the problems existing in the traditional EAI process, a new software architecture, Service-oriented Architecture (SOA), has emerged in recent years. It can not only quickly adapt to the changes of enterprise business requirements but also integrate the existing applications of enterprises. It is an effective solution to enterprise level information integration. In order to realize the sharing of resources among educational resource databases, we need a unified resource construction standard and a unified resource management platform.

2. Related Work

Literature [15] holds that “Education plan is a kind of knowledge system, which includes the activities of system analysis, homework research and technology, and the main purpose of the plan is to achieve the goal.” Literature [16] analyzes the characteristics of Chinese educational resources, then puts forward a hierarchical model based on a grid platform suitable for Chinese educational resources management, and puts forward a comprehensive security solution for educational resources management according to the characteristics of the educational resources grid. Literature [17] focuses on how to make use of the existing systems and data in newly built enterprise application systems and proposes to solve the problem of data sharing and interaction between old and new enterprise systems, different application systems, or different data sources. Literature [18] holds that the education plan “must be aimed at the whole education system, and it should contact all aspects of the education system to coordinate the education policies.” Literature [19] reviews the current typical network education resource management modes, namely, document management system, special and subject websites, resource management database, resource center, and distributed resource database system, and points out their basic characteristics and limitations. On this basis, this paper puts forward two development trends of the future educational resource management model, namely, the expanded educational resource database system and the user-centered resource service system. Document [20] proposes that it is used as the standard application program interface for accessing data between database systems, as the general underlying application programming interface to support basic functions, to provide a unified user interface at the level of different database function modules, and to provide sealing mode with technology to construct the application of heterogeneous databases. According to the literature [21], the metadata inside the enterprise is stable, the data model made of metadata is essentially stable, and the metadata processing technique is flexible as long as the firm’s business strategy and content stay intact. Reference [22] proposed a method of database integration of application systems using a federated database integration framework, which, when combined with a virtual example, detailed the integration of heterogeneous databases, the data access process, and the federated database integration framework’s design concept. Literature [23] creates heterogeneous resource sharing systems by providing service technology based on a comparison of the inadequacies of current heterogeneous resource sharing systems. References [24] integrate grid computing to the area of educational resource management, utilize grid computing to establish a system platform, achieve effective sharing and unified administration of educational resources, remove the island problem, and improve resource scheduling.

3. SOA-Based Enterprise-Wide Information Integration Platform

3.1. Integrated Platform Infrastructure. SOA (Service-Oriented Architecture) is a service-oriented architecture [25]. It refers to different functional units of an application as services, which are connected by well-defined interfaces and contracts between these services [26]. For SOA-based information integration, first and foremost, enterprise business function module rationalisation and modularization, as well as information access, should be carried out to achieve reusability of business function modules, which is the foundation for generating new services and processes through service composition arrangements [27]. Students use course selection and arrangement to select courses, inquire about them, and generate the curriculum schedule for the new semester based on the course plan, course selection results, and teachers’ situation, as well as manage information and links like teaching material plan, bibliography, inventory, purchase, order, warehousing, sales, and
teachers’ book collection. According to the data of exam place, exam time, invigilator, etc., students’ graduation is automatically processed, and the graduation information, certificate granting, and alumni information are also managed. The basic structure of the whole educational administration system is shown in Figure 1.

Under its guidance, the business is transformed into a set of interlinkable and reusable services. It defines such an infrastructure that allows different applications to exchange data with each other and participate in business processes in a format, regardless of the programming language they use [28]. No matter where the user is, as long as they can access the Internet, they can view the information within the authority through the browser. Starting with the notion, these interpretations of educational plans are either focused on national educational policy, or on educational administrative efficiency, or on highlighting the planning process and methods, or on the rationality of planning decision-making. It represents educational planning as a process for achieving educational objectives, which includes analyzing the existing state of education, forecasting future development, and developing implementation plans and other processes and stages [29]. To put it another way, all types of data are consolidated and kept in a single database. The operation mode of data is carried out on the customer’s microcomputer through the client-server mode or through the browser server mode, that is, the principle of centralized storage and step-by-step processing of data. It actually assumes that senior management knows best what goals should be set because only they have all the information of the organization and take a panoramic view of the organization. Obviously, this is a “top-down” process of decision-making objectives. The plan specification model is shown in Figure 2.

From the perspective of the application prospect of decision support system, it will become the component of information system to provide decision service in the future. Accordingly, its core business logic (decision module) also needs to adopt integrated description, analysis, use, and management technology to realize the on-demand use of information system assisted decision-making. Accordingly, its core business logic (decision module) also needs to adopt integrated description, analysis, use, and management technology to realize the on-demand use of information system assisted decision-making. Enterprise application systems and other information systems are the function providers of enterprise business module functions and information access and the specific implementation of enterprise business module. The user interface is defined in a nonobtrusive manner. It should be independent of the service’s physical platform, operating system, and programming language. In terms of decision support system implementation technology, as the demand for auxiliary decision-making function and performance grows, as does the complexity of the problems to be decided, more and more models are involved, and model representation and management technology become more and more complex as the number of models, types, interweaving relationships, and nonstandard data become more prevalent. These services can be combined to complete specific business tasks, allowing the company to quickly adapt to changing objective conditions and needs and promote collaboration and coordination between IT capabilities and business goals, which has become a key factor influencing the development and application of decision support systems.

According to the school’s current hardware and software environment, we are in the process of designing and investigating this system. It is chosen as the development platform and the development language on the basis of selecting the Microsoft operating system and database software, taking into account the requirements of the equipment and the actual hardware conditions and environment, as well as the requirements of the customer and future upgrades. SOA service management, enterprise service bus integration, business process management, and other tasks are provided by the SOA integration platform on this foundation. The business application system and other systems of the enterprise, together with the SOA integration platform, are the entity layer of the SOA information integration platform framework, which completes the business function modules and business process goals of the service architecture layer and realizes the rapid establishment and optimization of business processes.

3.2. Enterprise-Level Integration Platform Core Functions. The information integration platform based on SOA is divided into five functional modules: service bus, BPM, service directory, CIM, and platform management. This enables the services built in various such systems to interact in a unified and common way. The emergence of SOA has introduced new concepts to traditional architecture so that the architecture is no longer an independent form but a way to freely combine and facilitate the sharing of information. To solve the module division of the software system, the hierarchical organization of the module, and the database design, also known as the overall structure design of the system, the function of the system is decomposed into many basic functional modules, the relationship between them is determined, and their functions and processing flow are specified. From a macro perspective, social, economic, and educational issues influence educational decision-making goals. As a result, the majority of educational decision-making goals are multiobjective difficult issues. This necessitates that the new management system’s database’s general structure, coding scheme, and design concept comply with the relevant national requirements. Here, the description and data description of the decision-making problem are called Model, and the concrete process realization of the model solving method, that is, the running software module, is called Solvare. In the model assembly scheme of complex decision-making problems, the model body and the solver are the basic components. And the model body and its assembly relationship describe the original problem and processing flow. The solver realizes the core operation logic, and its composition structure is shown in Figure 3.

The service abstraction layer is the abstract expression of business modules, processes, and other information access services of the enterprise. It is a standard service defined by
service encapsulation standards (Web services, JMS, or other service standards). The model body puts forward a solution request to the solver, and the solver obtains data from the model body. In this architecture, all functions are implemented by independent services. The solver is independent of the specific problem. The model body can call different solvers to meet different computing needs. It can also call multiple solvers to solve complex problems. They may be integrated into one application, distributed on the Internet, or built on heterogeneous platforms. The functional modules of the educational resource management platform are mainly divided into seven major functional modules: user management, courseware management, courseware retrieval, courseware statistics, feedback information, system help, and platform introduction. Each major functional module contains different numbers of small functional modules. The detailed description of each functional module is shown in Figure 4.

Dividing the decision model into two parts, the model body and the solver, is a key link to ensure the agility of system development. Its functions are multifaceted, such as the separation of problem processes and core logic and the requirement for developer knowledge. Talents with a broad understanding of both subject knowledge and programming are required. SOA believes that the system will be service centric rather than application centered. From the standpoint of service providers and users, the technique hierarchizes the items, components, and business processes involved in the functional aspects. The service monitoring system gets data from the service provider or feedback from the service customer and dynamically assesses and modifies the service’s reputation based on the feedback data. Simultaneously, it dynamically monitors and reflects the service’s state. For instance, if the number of services in the service container hits a specific threshold during the time period, the service will be unavailable for that time period, and so on. Figure 5 shows the many protocols and standards that are utilized to implement Web services.

The system should be described in a unified data format so as to standardize educational affairs such as teaching plans and student status management. Information such as student number coding, class coding, professional coding, and course coding should be formulated in a way that conforms to the norm. Second, it is relatively easy to change existing processes and introduce new ones because changes are limited to process control, and changing one process does not affect other processes. Finally, redundancy can be reduced because the core logic only needs to be implemented once. Under the guidance of the SOA framework, enterprise business services and various information access functions can use standard technologies based on Web services and XML to realize the isolation between service layer expression and specific technology implementation. The technical implementation can be based on historical existing systems or J2EE or Net, so as to ensure the reusability of business function modules, the rapid arrangement and optimization of business processes (because it does not need or rarely involves application system transformation), and the interoperability of business modules.

4. Module Function Description and Implementation Technology Analysis

4.1. Algorithm Development and Registration. The solver, which is the concrete process embodiment of the above-mentioned model solving approach, is referred to as the algorithm. The SOA corporate information integration is centered on the service layer. All services that fulfill the tasks of business functions, data interchange, and business process arrangement and give a global perspective of services, administration, and monitoring are objects of the integration layer. An application, a software module, or any service that requires service is referred to as a service consumer. Test the real data saved in various collections and storage nodes inside the collections by uploading 100k, 200k, and 300k data via the browser.

It encapsulates the specific operation logic for the model solving server to call. It initiates queries on services in the registry, binds services through transport, and performs service functions. Each storage set is regarded as a large storage node, which reconstructs a large ring, and each large storage node is assigned a corresponding weight value, which satisfies the following formula:

$$\omega_j = \frac{1}{n_j} \sum_{i=1}^{n_j} w_{ij},$$  \hspace{1cm} (1)

The user executes the service according to the interface contract. The meta model inherits the platform-independent
model from the model-driven framework to model the business process. Module is the basic unit of the system, which is characterized by combination, decomposition, and replacement. Any processing function in the system can be regarded as a module. According to this average weight, assign virtual sets to each node set, the number of which is as follows:

\[ N_i = \left\lfloor \frac{\omega_i k \log n}{\omega_k} \right\rfloor. \]  

(2)

The good scalability of the system will protect the existing resources and data when the system needs to be upgraded in the future and make the system easy to expand and upgrade, which can not only meet the current business needs but also leave room for future expansion. In order to verify whether the data layout algorithm can meet the adaptability requirements, storage devices are added or removed to make the aggregate storage capacity change. The experimental results are shown in Figures 6 and 7.

The service contract is a WSDL-defined information definition that outlines the solver’s role, function, restrictions, and use. Customers may access the solver’s functionality via the interface, which is physically implemented in the solver and solution server administration application. A standardized algorithm implementation framework is being developed in order to better reuse existing modules and organize and execute algorithms. The service implementation implements the service contract and provides the appropriate operation logic and data. Operational logic is a service-encapsulated algorithm module. Provide business logic implementation as well as modular business function services. The viability of the local data deduplication method based on the features of instructional data is confirmed by a comparison of the quantity of data stored before and after data deduplication. Figure 8 shows a comparison of the quantity of data held in each class before and after data deduplication.

The framework includes the interface definition of solver classes, hierarchical structure, and interaction between classes, etc. Among them, the base class Entity defines multiple solving units in a solver and realizes the hierarchical relationship and interaction process among them. Regard the current weight value as the first weight value, followed by the second weight value, renumber the remaining weight values in turn, and then repeat the second step until all the weight values have been traversed. Calculate the average weight of each merged set:

\[ \omega_i = \frac{\sum_{j=1}^{n_i} \omega_j}{n_i}. \]  

(3)
To provide a uniform interface of services, business module function services adhere to the SOA integration platform’s service encapsulation criteria. It is the SOA integration platform’s service invocation object and process composition object and a network accessible entity that takes and performs consumer requests. The first three data samples are separated into the clustering center in the initial state. After further steps are made to enhance the k-means algorithm, it has been shown that the specified initial three sample data may be substituted by samples representing the three levels as the beginning clustering center, reducing the amount of data and the number of executions to the bare minimum. Figure 9 shows sample data from three levels.

The core layer of the whole architecture, which mainly defines the services that need to be exposed. The internal cohesion of modules is stronger, and the connection between modules is less. That is, modules have strong independence. The organizational structure follows the hierarchical system of the pyramid, and its information transmission path is also “top-down,” which requires users to input data in a natural and intuitive way as far as possible. And the information transmitted by computers to people must be accurate so as not to cause misunderstanding or confusion, and it is not necessary to prompt users’ information as far as possible so as not to make users feel puzzled. When adding a device, its storage capacity, calculate the relative weight of the device:

\[
W = v_i \left( \sum_{i=0}^{n} v_i + v \right)
\]  

(4)

The service provider can use WSDL to describe the interface and calling mechanism of the Web service and
publish and register the Web service to the SOA registry. It publishes its own service and interface contract to the service registry so that service consumers can discover and access the service. The interface IRegister is used for the registration of the solver in the solver server, IInput and IOutput are used for data input and output control, IConnect is used for runtime control, and the classes Description, Autho, and Domain are used for the general description of the solving unit.

4.2. Model Creation and Management. The actual decision problem can usually be decomposed into several different subproblems. Accordingly, the model body describing the problem can also be assembled by multiple submodel bodies to form the description of complex decision problems. After the request data enters the platform through the service access framework, the service bus will carry out three steps of access control, message conversion, and service routing, and then call the service adapter to transfer the request data to the corresponding service. The model body that calls only one solver is called the basic model body, and the model body assembled by the basic model body is called the composite model body. If there are mixed type variables in the database, we can measure the dissimilarity between objects \( i \) and \( j \) with the following formula:

\[
d(i, j) = \frac{\sum_{f=1}^{p} \delta_{df}(f) d_{df}^{(f)}}{\sum_{f=1}^{p} \delta_{ij}(f)}
\]

Web services registered by the SOA registry may be searched by name, category, identifier, or supporting standard. Users may get location information from WSDL files after they have been located (WSDL files contain information about how to contact Web services and the format of requesting service information, including XML Schema used). If the compound model body's meaning and input and output parameters are standardized, it may be used as an example of a model body for addressing a certain kind of issue and kept in the model library for future reference or direct reuse in other decision-making situations. The sample data all contain four types of attributes: management attitude, management ability, management method, and management effect. Data mining and clustering are carried out on these aspects, and the final mining results are divided into management attitude and management ability, as well as management methods and management effects, as shown in Figures 10 and 11.

Arbitrarily select \( k \) objects as the \( K \) barycenters or centroids set in advance. Then calculate the distance between the remaining objects and the set \( K \) barycenters or centroids, calculate the centroid or centroid of each new cluster again, and repeat the above steps until the criterion function converges; that is, the objective function is minimized. The commonly used criterion function is the square error criterion function:

\[
E = \sum_{i=1}^{k} \sum_{p \in c_i} |p - m_i|^2.
\]
for obtaining services. Web services are ubiquitous because more vendors implement Web service standards, and structured XML documents are utilized as the mechanism of information exchange across Web services allow heterogeneous data information to communicate. The STNG in the grid-based method and the COBWEB algorithm based on the model-based method are compared, and the comparison results are shown in Figure 12.

Modern educational decision-making requires planning the future on the basis of accurate, timely, and fully providing information as much as possible. The effectiveness of educational decision-making increasingly depends on the perfection of its information system. For business modelers, they do not need to care about the function and significance of the solver but assemble the appropriate model bodies in the model base according to the problem to be decided and their own professional knowledge to form a model assembly scheme to solve the problem to be decided. In order to achieve obvious test results, try to widen the capacity gap, assign different weights to these 150 devices, and sort them in ascending order, including

$$\omega_i = \frac{v_i}{\sum_{j=1}^{200} v_j}$$  \hspace{1cm} (7)$$

$$N = \sum_{i=1}^{5} \frac{\Delta_i}{\Delta_1}. \hspace{1cm} (8)$$

The firewall of the educational administration information system is set up by using routing technology and a combination of database identity authentication, operating system authority system, and campus network security mechanism, and the data backup work is done well to ensure the accurate and rapid recovery of the system in case of system failure and the safe and reliable operation of the entire management system. In the model registration server, the model manager may also edit and remove the model as required. Monitoring, statistics, operation authority management, log management, platform management interface, service catalog management, service authority control management, service routing management, data model library management, and platform parameter configuration should all be provided by the platform management module via a unified management interface. Calculate each set’s average weight, and then allocate 2 virtual sets to the lowest weight value, then virtual sets to the other four sets, for a total of 8 virtual sets:
A service provider is used to describe the services it provides and publish this description to the registry or other service registries. The model assembly scheme of decision-making is a semantic medium for communication with other modules. In the process of requesting services, users inside and outside the school can access the system uniformly by logging in to the school portal Website without knowing the inside story, just knowing the services provided, and the system discovers and integrates the existing web services through the service registration center. Then directly call the required service. How the model body represents the decision-making problem, how to map the data parameter relationship, how to describe the basic model body and its assembly relationship, and how to analyze the consistency and completeness of the assembly scheme description ability are the key technologies of this platform.

5. Conclusions

The automation of educational administration in colleges and universities is the trend of the times, which is imperative. With the deepening of educational reform in colleges and universities, the management in colleges and universities is becoming more flexible, and the requirements for educational administration system are becoming higher and higher. This system uses SOA architecture and Web services to realize the master data integration of the university information system, makes full use of the hardware and software resources of the existing information system, and saves the development investment. According to the principle of paying equal attention to practicality, scientificity, and operability, the purpose is to free the educational administration personnel from complicated manual labor and improve the quality of performance management. According to the actual demand of a future-oriented integrated information system, a design scheme of an integrated decision-making platform based on service-oriented architecture is proposed. With the rapid development of computer technology, information technology, and network technology, it will be possible to meet these requirements. Applying SOA technology to the enterprise-level information integration platform can protect the original information resources of the enterprise, encapsulate the functions in the original information system into services, and then recombine the services to meet new business requirements. The architecture of the entire platform is realized based on the design of Web services, the modules are loosely coupled, and the modules are reusable, which solves the platform heterogeneity and the language difference between the various layers of the software and makes the various layers more convenient. The realization of seamless integration reduces the development complexity and shortens the development cycle. Because the Web service technology uses the XML-based SOAP protocol to express data and call requests and uses HTTP to transmit the data in XML format, the data and requests can directly pass through the firewall, which greatly facilitates the deployment and use of the system. It is believed that with the development of SOA basic support platform products, the SO-based information integration platform proposed in this paper will be more widely used in enterprise informationization.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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