Research and Construction of Data Sharing and Exchange Platform of Smart Campus

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Abstract: In order to solve the problems of poor data interaction, low data utilization rate and weak data security among various systems in the process of smart campus construction, avoid "information island" and improve data value, this paper carries out in-depth research from the aspects of data sharing and exchange mode, standard specification, data sharing and exchange process. On this basis, this paper puts forward the construction scheme of data sharing and exchange platform, realizes the data sharing among various business systems, and builds a unified data sharing and exchange center.

1. Introduction

With the rapid development of Internet of Things, cloud computing, big data, artificial intelligence and other technologies, China has issued relevant laws and regulations to clarify the development direction of education informatization[1][2], the Outline of national medium and long term education reform and development plan (2010-2020) points out that China should accelerate the process of education informatization, speed up the construction of education information infrastructure, and integrate education informatization into the overall strategy of national informatization development[1]. In this context, colleges and universities are vigorously promoting the construction of smart campus. Business departments build independent business systems according to business and management needs, and the demand for data interaction between systems increases. The current problems in data sharing and exchange are mainly reflected in the following aspects:

1.1. Poor data interactivity

The data interaction between systems is difficult due to the different construction parties, different operating environments, different system structures and data standards, and different data storage technologies. Due to the lack of a unified data sharing and exchange platform, manual export and import are mostly used for data interaction between systems. Automatic flow is not realized, and data synchronization is not timely, which ultimately leads to the generation of "information islands" [3].

1.2. Low data usage

Due to poor data interaction and delayed data synchronization among various systems, teachers and students need to collect and fill in data repeatedly, and data is scattered in various systems, resulting in extremely low data utilization rate. There is no data flow between systems, no overall analysis, and no decision support for the manager, which greatly reduces the value of data.

1.3. Weak Data security

In view of the independence and closure of each system, the dispersion of data, difficult to manage, lack of feasible data management systems and technical means, resulting in data in the process of transfer security cannot be guaranteed, easy to cause data damage and leakage [3].

2. Research on data sharing and exchange in smart campus

Data sharing is the behavior that multiple information systems within an organization need to share and use data from other systems due to business interaction.

Its main purpose is to break barriers between business departments and eliminate information islands. Data exchange refers to the process of establishing a data communication interconnection path for any two information systems among multiple information systems [4]. Data sharing and exchange refers to the flow of data. It is a process in which the data stored in the source system is transferred to the destination system according to certain rules. The realization of data sharing and exchange between systems can improve the data supply capacity, improve the operation efficiency of the organization, and reduce the operation cost of the organization.

2.1. Data sharing and exchange mode

The main modes of data sharing and exchange are divided into point-to-point mode, network structure mode and star structure mode [5], as shown in Figure 1. The point-to-point shared exchange mode is the point-to-point exchange between systems, which is suitable for the single information system within an organization.

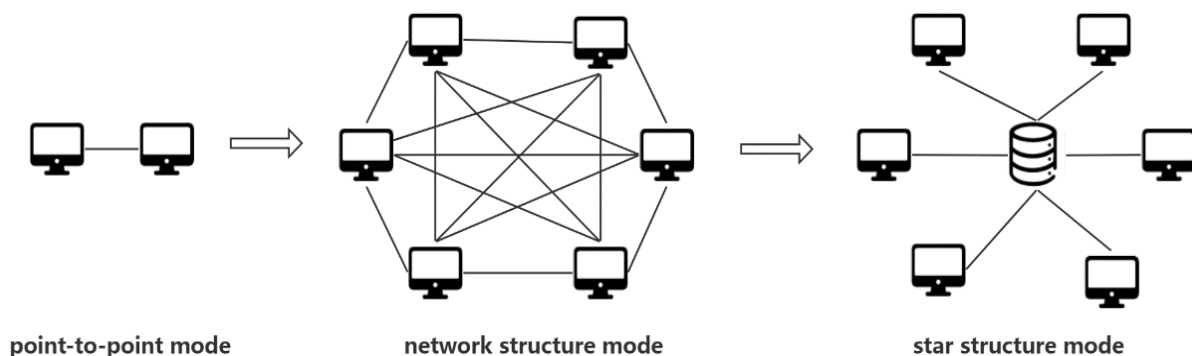point-to-point mode   network structure mode   star structure mode

Figure 1: Data sharing and exchange mode

When the number of internal information systems in an organization increases and multiple systems need to share data, a network structure sharing mode is formed. This mode is still implemented in a point-to-point manner technically, and each system needs to adapt to the sharing needs of different systems. With the increase of systems and business volume, each system is burdened with heavy data sharing pressure, which cannot meet the complex data interaction scenarios in the construction of smart campus.

The establishment of data sharing and exchange center is the biggest characteristic of star structure which is different from other modes. All data sharing and exchange between systems are realized through this central node. In this mode, all systems only need to adapt to the data sharing exchange center, which serves as an intermediate bridge to reduce the coupling between all systems and meet the data interaction requirements in the construction of smart campus.

2.2. Data standard specification

Data standard specification is the basis of data sharing and exchange. Data standard specification system should be formulated before implementing data sharing and exchange. According to the "Education management information management information of colleges and universities" standard issued by the ministry of education of China, combined with the information industry standard, the data standard specification systems in line with the actual situation of the school are formulated, and all information systems are built in accordance with the standard [4].Gradually establish and improve the system norms of data management, so that there are rules to follow, evidence to follow, orderly construction, so as to ensure the security of data at the management level.

2.3. Data sharing and exchange process

Data sharing and exchange includes the whole life-cycle process of data production, collection, cleaning, storage, sharing and consumption [6]. How to share data well, improve sharing efficiency, and reduce sharing failures and interruptions is involved in every step of the whole life-cycle process.
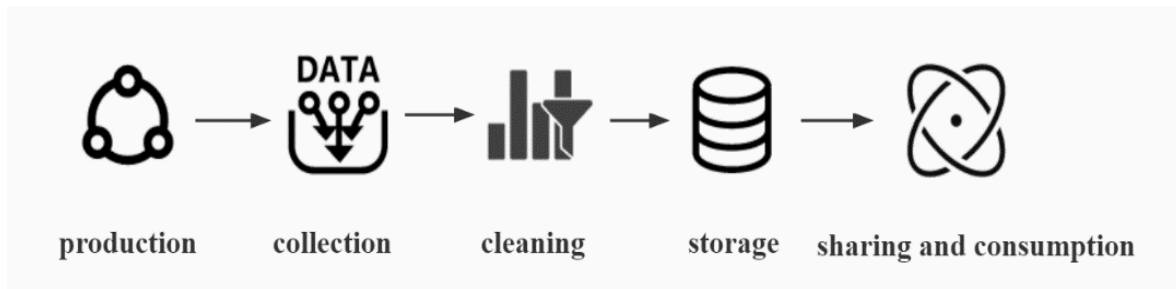

Figure 2: Whole life-cycle process

Data production: data production is the data generated during the construction of each system. In the process of data sharing and exchange, we pay special attention to the production of basic data. As the foundation of most systems construction, basic data needs to be used by most systems, so ensuring the authority, accuracy and real-time of basic data becomes the top priority in the construction of data sharing and exchange center.

Data collection: data collection is to collect the data of each system to the data sharing and exchange center. The data acquisition techniques commonly used are: ODI tool, data interface, data synchronization tool based on database transaction log. The ODI tool is generally used for timing data synchronization, which is suitable for synchronization with low requirements on real-time performance and large data volume. Data interface collection is generally flexible, and can be developed according to needs. However, this is only applicable to the situation where the data volume is not required. Once the data volume is large, the data synchronization will often be long, and once the network is interrupted, the collection will be interrupted, resulting in poor stability [7]. There are many data synchronization tools based on database transaction logs in the market, which can basically realize real-time data synchronization. However, due to the need to monitor database

transaction logs, it is usually necessary to open relevant database permissions and modify database configurations, which is complicated to configure.

Data cleaning: data cleaning is to clean and transform the collected system data in accordance with a unified standard. The main task is to deal with the data that does not meet the requirements, is incomplete, inconsistent and abnormal, and to improve the data by using SQL scripts or manual checks for the wrong data and the data with incorrect format [7].

Data storage: transfer of collected and cleaned data. A central database can be established for data storage. Common relational databases include Oracle, SQL Server, MySQL and so on. Oracle is one of the most widely used relational databases, with good portability, compatibility, connectivity and high productivity. SQL Server has an easy and friendly interface, but it only runs on Windows and is highly dependent on the operating system. MySQL is the most popular open source database system and is a fast, multi-threaded, multi-user and robust database system.

Data sharing: the data sharing and exchange center shares data to each business system. Data can be shared in the following ways: (1) read data directly from the data sharing and exchange center. The data sharing and exchange center assigns read-only permissions to system users to read data directly. In this way, each business system relies on the data sharing and exchange center. With the increasing amount of data and users, the pressure of the data sharing and exchange center increases. (2) Encapsulate API interface to synchronize data. The data sharing and exchange center synchronizes data in real time for the data encapsulation API interface with high demand for use and real-time performance. This mode greatly depends on the stability of the interface. (3) Use data synchronization tools or business systems to develop their own programs to synchronize data regularly. This mode is applicable to scenarios where the data changes slowly and the data volume is large.

Every step in the whole life-cycle process of data sharing and exchange needs to select an appropriate way to share and exchange data according to the business attributes and data characteristics of each business system. Through this process, a data sharing and exchange platform is established to form a unified data sharing and exchange center in the whole school, so as to realize data sharing and exchange, eliminate "information islands", improve data utilization rate, enhance data security, provide basis for organizational decision-making, and maximize the value of data.

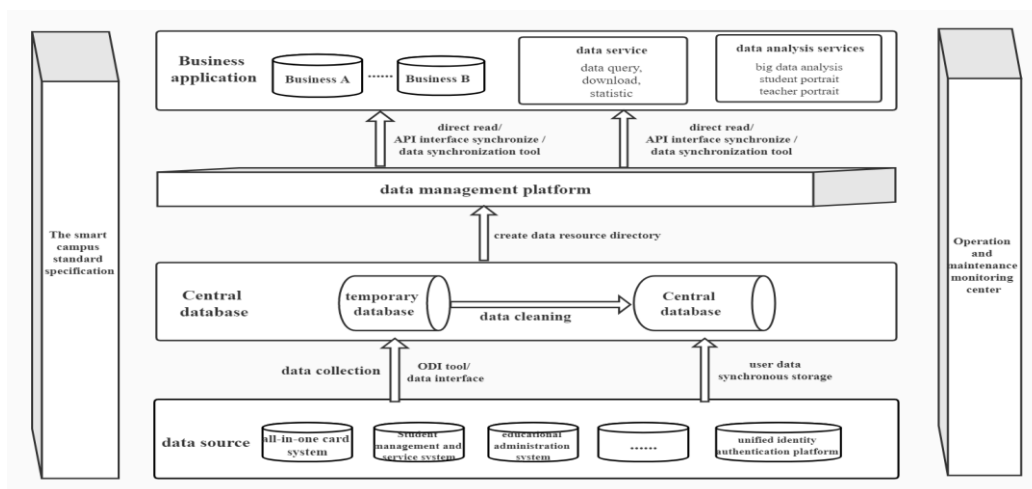## 3. Realize the construction of data sharing and exchange platform

Figure 3: Platform architecture design drawing

This paper takes the construction of data sharing and exchange platform in our school as an example to explore the whole process of data sharing and exchange platform construction under the background of smart campus.

The platform architecture design is shown in Figure 3 below:

In the construction of data sharing and exchange platform, the smart campus standard specification is the foundation, each business system is the source (data producer), the central database is the core, the data management platform is the key support platform, and business applications and data services are consumer, operation and maintenance monitoring center provides guarantee.

3.1. Standard specification precede

As the basic guarantee of data sharing and exchange platform, the smart campus information standard specification is built in advance. Combining with the state, the ministry of education, industry standards and the standard specification system of informatization construction in our school, we have formulated the "Informatization management regulations of Shenzhen Polytechnic " and " Information system building and integrated management of Shenzhen Polytechnic", so that the campus informatization construction can be implemented, so that the system construction has rules to follow and basis to follow, and the standardization and specification of the system construction can be guaranteed from the system, so as to ensure the orderly operation of information work. "Data management specification of Shenzhen Polytechnic" has formulated data standards applicable to school informatization construction and data life-cycle management process, providing institutional basis for the operation of data sharing and exchange at each stage, so as to maximize the realization of information resource sharing.

3.2. Construction of central database

Central database is the core of data sharing and exchange platform. We used the mainstream relational database as the basic database platform. We created the temporary database and the central database. The temporary database is used to temporarily store the data collected from various business systems. After data cleaning and integration, the data is finally stored in the central database.

3.3. Construction of data management platform

The data management platform that suits the reality of the school is the key to success of the data sharing and exchange platform. The data in data sharing and exchange is displayed on the data management platform in the form of data resource directory. Each business system can submit an application according to system needs. Only the approved data resources can be shared with the corresponding system, and the data permissions are well controlled. The data produced by each business system can also create a new data resource directory as needed, which can be used by other systems after implementation.
Data application and use process:

The applicant selects the data resource catalogue and submits the application for use. After being reviewed by relevant personnel and approved by technical personnel, the system automatically opens the user account and notifies the applicant by SMS to view the configuration information. The developer can obtain the corresponding data for development according to the configuration information. Figure 4 shows the entire data usage application process and trigger events for key nodes.

Procedure for adding a data directory:

```
         ╭──────────╮
         │  start   │
         ╰──────────╯
              │
              ▼
    ┌──────────────────┐
    │      apply       │
    └──────────────────┘
              │
              ▼
    ┌──────────────────┐
    │   reviewed by    │
    │ department leader│
    └──────────────────┘
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    ┌──────────────────┐
    │ reviewed by data owner │
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    └──────────────────┘
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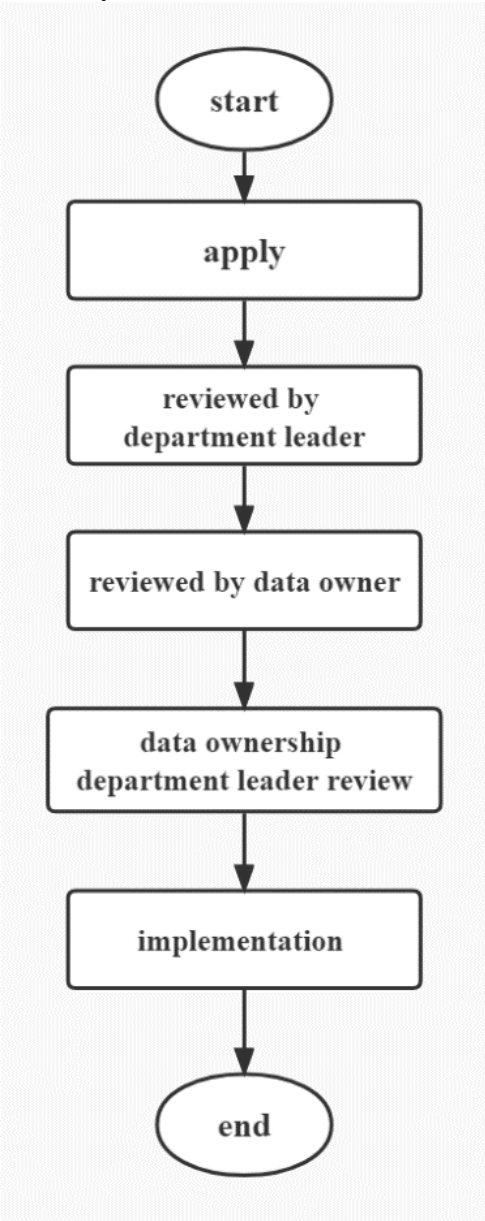
Figure 4: Data application and use process

For the data collected, cleaned and stored, establish the corresponding resource directory, fill in the related attribute fields of data resources, submit them for review, and generate the resource directory after the review by relevant personnel and the configuration by technical personnel.
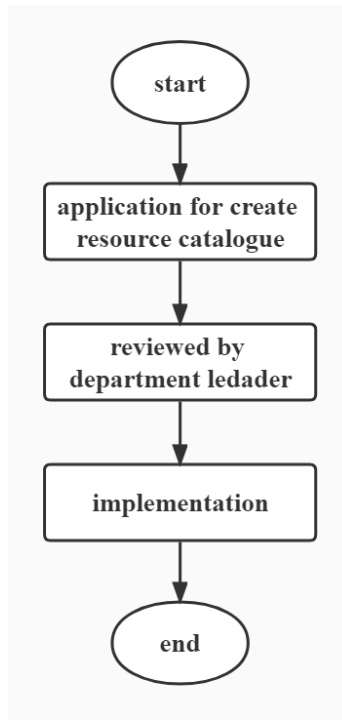
Figure 5: Establish the corresponding resource directory

3.4. Construction of data sharing and exchange process

Because there are many business systems in our school, data sources are different, the construction cycle of each system is not synchronized, and heterogeneous databases are used, there are some difficulties in data collection. We use ODI tool and data interface to collect data. For data with small changes, low real-time requirements, and the database access authority data, we use ODI tool for timing synchronization, such as student status information in the educational administration system, student card information in the all-in-one card system. Data interface is adopted to collect data for data with fast updating and changing, high real-time requirements or inaccessible database, such as one-card consumption record, school gate entry and exit record and vehicle entry and exit record.

The collected data that does not meet the data standards will be stored in the temporary database first and then stored in the central database after data cleaning. In addition to the normal ETL tools, manual way of data cleaning, we also use "forced" method to clean data. Make a personal big data display interface for personal data, teachers and students can view the data, if they find that the data is inaccurate, they can submit problem feedback on interface, the data administrator will receive feedback remind problem, so as to check the accuracy of the data in time, supervise and urge the accuracy of the data source, and "force" the correction of the data.

The data stored in the central database is finally classified according to business attributes and presented in the form of resource catalog on the data management platform. Each business system can view the required data catalog on the data management platform, submit the application, and obtain data synchronously after the verification is completed. The forms of data applications are also diversified. In addition to the requirements of business applications, also provide query, download, data statistics and other functions. At the same time, the application of big data analysis technology for teachers and students to do personal portrait, academic warning, track query and so on.

Before a data sharing and exchange, we must determine which data is the basic data. In the

construction of smart campus, teachers and students' user data is the basis of the construction of each system. In order to avoid repeated information filling and user registration by teachers and students, we have built a unified identity authentication platform. Users can access multiple integrated systems by providing only one certificate, without multiple login and verification. The unified identity authentication platform synchronizes user data to the central database, and then synchronizes user data from the central database to each system. In addition, each system integrates unified identity authentication to realize the sharing and exchange of basic data between systems, greatly improving user experience.

3.5. Operation and maintenance monitoring center

In order to guarantee the stable operation of the data sharing and exchange platform, we integrate business systems, center database, data management platform and the API interface into the operation and maintenance monitoring center, monitor the operation situation of the system, database, interface, send alarms to notify the responsible person in case of problems, and realize active operation and maintenance.

3.6. Data sharing and exchange results

At present, the platform has completed the data integration of 60 systems, among which 35 systems share data to the data sharing exchange center, 45 systems apply to use data from the data sharing exchange center, and 20 systems both share and apply to use data. The data management platform has built 107 information resource catalogs, with a total of 200,320,001 pieces of data, and 259 applications. All business systems share and use data through data sharing and exchange platform has formed a pattern, and the consciousness of data sharing and exchange of all business departments has been significantly improved. The data sharing and exchange platform effectively solves the problem of data transfer between systems, avoids the generation of "information islands", improves data utilization rate and data security, and lays a solid foundation for the construction of smart campus.

4. Conclusion

Data sharing and exchange platform is the core foundation of the construction of smart campus, which is related to the success or failure of the whole construction of smart campus. After in-depth research and analysis of data sharing and exchange technology, this paper puts forward the construction idea of data sharing and exchange platform in our university. From the standard specification to the establishment of the central database, building a data management platform suitable for the actual situation of our school, getting through the whole life-cycle process of data sharing and exchange, established a data sharing and exchange center with the characteristics of Shenzhen Polytechnic. Although we have initially built a data sharing and exchange platform, there are still some problems in the process of providing data sharing services. For example, data categories are not rich enough, data quality is yet to be improved, data synchronization tools are not intelligent enough, and there are problems of data interruption and delay. The construction of data sharing and exchange platform is not achieved overnight, but a long-term and continuous process. With the deepening of the construction of smart campus, a large number of business data will continue to be imported into the data sharing and exchange center, we will continue to explore and study the data sharing and exchange technology, provide laying solid foundation and guarantee for the school information construction, to provide teachers and students with a higher quality of information experience.

References

[1] Min Zhou, Jun Ye, et al. An Applied Research on Integration of Fragmented Data of Higher Institutions Based on Big Data [J]. Journal of Hechi University, 2019(2): 84-91.

[2] Jianbin Qiu. Research and construction of data management and exchange platform for smart campus [J]. Computer Age 2019(4): 107-110.

[3] Chun Yu, Fang Yuan, et al. Application research on data sharing and exchanging in colleges and universities [J]. Experimental Technology and Management, 2012(11): 109-112.

[4] Wenhui Mao, Yaqin Liu, et al. Some practical research on data sharing in universities [J]. The Chinese Journal of ICT in Education, 2021(1): 39-42.

[5] Min Zhou, Jun Ye, et al. A Brief Analysis on the Realization and Application Prospect of University Data Sharing platform [J]. Computer Knowledge and Technology 2018(33): 1-3.

[6] Baomei Liu, Meiling Chen, et al. Research on University Data Center under Background of Smart Campus [J]. Journal of Longyan University 2020(2): 29-32.

[7] Qianchen Yang. Application research of Heterogeneous data sharing and exchange in colleges and universities [J]. Education Modernization 2017 (46): 353-354.

[8] Zhenxing Lei. Design and Implementation of Digital Campus Public Data Management Platform [D]. Xi'an University of Science and Technology 2015 06.

[9] Xinyao Chen. Research and Application of Intelligent Campus Data Sharing and Exchange [D]. Zhejiang A&F University 2020 07.

[10] Kasrin, Nasr Benaddas, et al. Data-sharing markets for integrating IoT data processing functionalities [J]. CCF Transactions on Pervasive Computing and Interaction, 2021, 3(1): 76-93.