Application Design and Implementation for Smart Kindergarten

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Abstract. The advent of the "Internet +" era has made the construction of smart kindergartens necessary. However, the reality is the information construction of kindergartens is relatively lagging behind. There are some problems such as low information literacy of kindergarten educators, lack of initiative to accept information technology, lack of interconnection and interoperability of existing application systems, which lead to difficulties in using information technology. It is suitable to adopt a hierarchical architecture. From bottom to top, the layers are: Smart perception layer, Network communication layer, Data storage and access layer, Smart application layer and User interaction Layer. All layers can be expanded in the future and provide service interfaces to the upper layer. Applications for smart kindergartens can be divided into Teaching, Internal management, Parents-kindergarten cooperation, and Social promotion. The Smart kindergarten application deployment architecture should use a hybrid architecture of public and private clouds, and interoperates with third-party platforms. The construction of smart kindergartens is a long-term process and should be implemented in phases.

1. Introduction

At present, the Internet is profoundly influencing and even changing the way of human thinking, production, life and learning. Informatization is rapidly infiltrating into the field of education. Young teachers and parents are eager for various internet applications, and they are also hope to improve the level of information service in kindergarten management, Parents-kindergarten cooperation and teaching [1-2]. Therefore, the construction of smart kindergartens is the trend of the times.

Many kindergartens are actively engaged in informatization construction, invest a lot of money, and construct their own application software systems, which cover most of the daily work of kindergartens. With these systems, it seems that the kindergarten informatization construction has reached a very high level. However, due to the inadequate understanding of the value of software interconnection and interoperability, many incompatible systems have had problems of mutual influence and containment. So the construction of smart kindergartens is by no means a simple superposition of various application systems, and application systems must be interconnected and interoperable.

In order to interconnect application systems, network technology must be used. In general, a WIFI network can be built to cover the entire campus, and a communication link provided by some communication company can be rented for Internet connection. This saves a lot of wiring costs and makes it easy for employees to access the Internet anywhere in the campus. Only when achieving network interconnection and system interoperability, the overall benefits can be realized.
construction of the new system, kindergarten managers should brainstorm ideas, especially pay attention to the opinions and suggestions from front-line users and propose constructive high-quality requirements. When considering requirements, it is necessary to put the system interoperability at the core position, not only to consider the data exchange between the new system and various existing systems, but also to provide data interfaces in advance, which can be used to interface with other various systems in the future.

2. Smart kindergarten architecture

From the perspective of common software architecture patterns, smart kindergartens are suitable to adopt a hierarchical architecture [3-4]. In a hierarchical architecture, each layer provides services directly to its upper layers, and service calls between layers are performed through public interfaces. In this way, as long as interfaces remain unchanged, the contents of each layer can be changed without causing changes of the upper layer. Smart kindergarten architecture is illustrated in Figure 1.

![Figure 1. Smart kindergarten architecture](image)

Smart perception layer is the data acquisition layer of the smart kindergarten. It collects real time data of the kindergarten environment, personnel, equipment and items, such as temperature and humidity in activity rooms, locations of children and body temperature, by using network camera, radio frequency technology, mobile terminal and various sensors. Smart perception layer is the basic data source for analyzing and adjusting environmental parameters, personnel or important item locating, monitoring and management equipment, and children health monitoring services. The collected data enters the data storage and access layer through the network communication layer.

Network communication layer undertakes the seamless communication task of the smart kindergarten. Through the wired and wireless communication equipment, the kindergarten network is fully covered and there is no communication blind zone in the campus. The network communication layer is the basis for the interconnection among the smart kindergarten physical environment, equipment, personnel and various smart applications, mainly through the construction of a network covering the entire campus. Generally speaking, the kindergarten campus has a small scope and few buildings. It can build a high-speed wired backbone network in the kindergarten, connect the main buildings, and have a high-bandwidth communication link with the Internet. In other areas, wireless WIFI is built to access the backbone network in the kindergarten, which not only saves the cost of wiring, but also achieves the whole network coverage.

The smart perception layer collects a large amount of data in real time. Various smart applications generate a large amount of data, and also need to access various existing data. The data storage and access layer is at the heart of the entire architecture and is responsible for data storage and access services. Kindergarten data is divided into two categories: structured data and unstructured data. Structured data includes information such as basic information for employees, children, teaching toys and equipment. These data belong to the basic data and should be stored in the core database to facilitate sharing among smart applications. All kinds of data collected by smart perception layer and part of structured data generated by some application have the characteristics of fast updating and small scope
of use. These data should be stored in an extended database. Unstructured data mainly includes various teaching resources such as documents, pictures, audio and video, etc., such data is stored in a resource library or archive system for easy searching and access.

Smart application layer covers all kinds of kindergarten applications, including teaching, internal management, parents-kindergarten cooperation, and social promotion. The smart application layer is the main construction content of smart kindergartens. The intelligence degree of kindergartens is reflected by various smart applications. User interaction layer includes mobile APP, WeChat and portal website. Mobile APP and WeChat support all kinds of smart applications anytime and anywhere. Portal website supports single sign-on, one-stop use of a variety of smart applications.

The left side of Figure 1 is the general standard and protocol, and the right side is the network security technology. These two parts are through the above five layers. That is, all layers need to follow the common standards and protocols, and all kinds of network security technologies must be adopted in every layer. In the process of building smart kindergartens, it is necessary to pay attention to the use of software and hardware devices that comply with these common standards and implement various communication protocols and network security technologies. When developing smart applications, we need to use secure programming techniques, and conduct security testing to ensure safety of various applications. It is also necessary to follow various industry standards to facilitate interoperability among smart applications.

3. Application classification and deployment architecture

3.1 Application classification

According to the different domain of smart kindergarten application, kindergarten applications can be divided into four categories: Teaching, Internal management, Parents-kindergarten cooperation, and Social promotion.

Teaching applications mainly refer to various applications that use multimedia and network technologies in kindergarten teaching activities. Multimedia technology, which integrates sound and image, is vivid, expressive and interactive. It is a kind of teaching method that children like. Multimedia technology can be embodied not only in traditional video recordings, but also in more interactive learning software. Network technology is mainly used to realize the access of interactive software and the sharing of teaching resources in daily teaching activities.

Internal management applications mainly refer to video surveillance system, office automation system, attendance management system, asset management system, financial management system, children dietary nutrition and health care management system, etc.. This kind of system is mainly used in kindergartens, which facilitates collecting, making statistics of various data, reduces the workload of management, improves the accuracy and efficiency of daily work, and promotes the modern management of kindergartens.

Parents-kindergarten cooperation applications mainly refer to parents-kindergarten communication, child growth archives and other systems. This kind of system is mainly used to strengthen parents-kindergarten communication, so that parents can learn children's performance at home or in the kindergarten all day. Cooperative education should be carried out in a coordinated way. Social promotion applications mainly refer to kindergarten websites, WeChat and forums. This kind of system provides kindergartens with ways to show their elegant demeanor, popularize scientific parenting knowledge and close ties between parents and the kindergarten. It plays a role of social propaganda, enlarges the prestige of kindergartens and improves their reputation.

3.2 Application deployment architecture

Smart Kindergarten has a wide variety of applications, which can be deployed on cloud computing platforms, so that cloud computing resources can be flexibly added as deployment applications increase [5]. Smart kindergarten can build private clouds in the campus and rent public clouds on the Internet. Some applications can only be deployed in kindergartens, such as smart devices and applications in the
smart perception layer, video surveillance systems, check-in and check-out systems, visitor registration systems, and catering systems. Some applications can be deployed in kindergartens, such as financial management system, archives management system and curriculum resource library, because of high confidentiality requirements, or high access bandwidth and large amount of visits during office hours. The above mentioned applications are all suitable for deployment in private cloud of kindergartens. Some applications are suitable for deployment in the public cloud because they need to be accessible anytime and anywhere, such as collaborative OA system, portal websites and child growth archives system. With the popularization of WeChat, some of them need to be deployed on the platform of WeChat, such as the application in the form of WeChat applet and the mobile OA platform of WeChat. The application deployment architecture of the smart kindergarten is shown in Figure 2.

![Figure 2. Application deployment architecture of the smart Kindergarten](image)

The public cloud and the private cloud and WeChat platform in the above figure are connected via the Internet. The applications on the same platform are interconnected and interoperable. The applications on the WeChat platform and the private cloud platform are interconnected through applications on the public cloud, realizing application and technology fusion and innovation.

4. Implementation of main applications

4.1 Online child growth portfolio

Online child growth portfolio [6] consists of four parts: a front cover, a catalog, inner pages and a back cover. In particular, the inner pages are designed with 16-20 columns according to the age characteristics of the toddler class, junior class, middle class and senior class. Besides, the same column has different names in the portfolio of different classes, and the content and operation requirements are adjusted accordingly. The design makes the entire portfolio both systematic and complete, and highlights the different requirements and characteristics of different age groups.

The content design of the portfolio can be summarized into 8 modules: Basic information, Kindergarten activities, Family activities, Children's works, Children's words, Memorial columns, Growth reports and Reviews, which combined with graphics and text, interspersed with audio and video. More specifically, the "Basic information" includes children, families, kindergartens and classes information. The "Kindergarten activities" includes the typical parts of the one-day activities, function rooms and regional activities, large-scale activities and theme activities. The "Family activities" includes the daily activities, none-routine activities, outdoor activities and other different types of activities which deserve to be recorded in the family. The "Children's works" includes various representative pictures, videos and sound recordings created by children in the kindergartens, families and communities, which include paintings, handmade works, construction works, self-compilers songs, dances, stories, games and so on. The "children's words" are interesting and memorable speeches and deeds that reflect children's thinking and cognitive characteristics. They can be written records or recorded audios or video clips by adults. The "Memorial columns" includes the birthday activities, graduation activities, friends souvenirs and so on. The "Growth reports" is a 11-page fuzzy rating evaluation form designed according to targets of the Guidelines, and combined with educational
recommendations from the Guidelines. The "Growth reports" is also equipped with about 69,000-word of online assessment guidance, and is proposed for teachers and parents for each specific goal so as to make daily observations and evaluations of both teachers and parents in the kindergartens and homes to become more operational. The "Reviews" not only includes the overall evaluation and message of parents, teachers, friends and relatives writing or recording on the birthday of the child or at the end of the school year, but also includes the anecdotal records of teachers and parents in the form of learning stories and educational stories. Figure 3 shows the catalog page of the senior class in the online child growth portfolio.

Figure 3. The catalog page of the senior class

4.2 Collaborative OA system
The collaborative OA system can greatly improve the office effectiveness of the kindergarten and provides convenience for retaining electronic materials and files. The application system has comprehensive functions, including message center, online application and approval, personnel management, teaching management, online teaching research, asset management, enrollment recruitment, online survey, rules and regulations, message wall, etc.. There are 15 functional modules and more than 60 functions. The module list is shown in Figure 4.

Figure 4. The module list of OA

Kindergartens can issue notices to employees and parents. Teachers can send messages to each other in the message center or send a notice to the parents of the class. Teachers and parents can read and reply on mobile phones. The director and administrator can check the reading and reply of employees and parents. Teachers in charge of classes can formulate and publish weekly plans, kindergarten doctors can publish weekly recipes, warehouse administrators can manage teaching toys online, employees can share documentation resources, and managers can carry out various approvals according to their
authority. The collaborative OA system and the WeChat platform interoperate to support mobile office. Figure 5 is a screenshot of the use of the collaborative OA system on WeChat.

![Figure 5](image1.png)

**Figure 5.** Screenshots of OA on WeChat

### 4.3 Check-in and check-out system for children

Check-in and check-out system uses barcode or face recognition for quick and easy. When sending children to kindergartens, they only need to show barcodes or their faces. The system scans them and sends the information for checking. By the time of school, parents scan their codes directly on the system, and then the corresponding electronic board in the class prompts the teacher. The class teacher sends the child to the security office according to the prompt information and hands the child over to his parents. When the child pick-up person changes, parents only need to log into the system, delete the information of the pick-up person who no longer picks up the child, add new information of the pick-up person, and the system generates the barcode corresponding to the new pick-up person automatically. The system topology is shown in Figure 6.

![Figure 6](image2.png)

**Figure 6.** Check-in & check-out system topology

Bar codes don't contain any information of children. Compared with traditional cards, there is no problem of information leakage. The bar code generated by the system is unique to each pick-up person for each child. Traditional cards can't do this. The information of multiple cards of the same child is often the same. There are also personal information of the child on the card. Once lost, it is easy to be misused by bad guys.
At the same time of pick-up, the system takes pictures of the pick-up person and sends it to the child's parents WeChat for checking. All children's attendance data, including temperature data, can be directly counted and exported to the OA system. Even in the absence of a network, the system can also send and receive attendance, and when the network is restored, the data will be synchronized to the cloud-based OA system.

4.4 Kindergarten website
We developed a content management system, which can set the domain name for each kindergarten separately. The kindergarten does not need to build its own site, which avoids the cumbersome declaration procedures that the kindergarten has to apply for independently. The website generated by the system has a variety of templates to choose, with features such as message, online survey, online enrollment and recruitment.

After kindergarten administrators log in, they can set or modify the kindergarten website columns and boards, and publish various information. The information set up or published will be displayed on the kindergarten website in real time. Each kindergarten can set up different columns and sections according to actual requirements of the kindergarten, which avoids the problem of uniformity and universality of kindergarten websites and realizes personalized requirements of every kindergarten.

4.5 Kindergarten archives management system
The number of kindergarten archives is huge, the workload of filing and collation is large, manual inquiry and classification is time-consuming and laborious, and the work efficiency is low. Moreover, the original physical archives are subject to the impact of the preservation environment, long-term use may cause damage to the original archives and bring great difficulties to management of archives. Archives management system is a set of system which is directly deployed in kindergartens to provide electronic and information management for the whole kindergarten archives. Employees can upload and manage archives directly and quickly on the Intranet, and authorize, browse them. Archives management system brings standardization to the archives management of kindergartens, which not only improves the security of documents, but also greatly improves the reusability of archives, and reduces the risk and workload of archives management in kindergartens. The archives management system function list is shown in Figure 7.

![Archives management system function list](image)

Figure 7. Archives management system function list

Although the archives management system is deployed in the kindergarten internal network or private cloud, it also interconnects with the collaborative OA system. Daily office documents, materials, videos and images in the OA system can be directly archived into the archives management system, which is simple and fast, without repeating labor.
5. Conclusion
Despite the low level of informatization in kindergartens, practice has proved that the construction of smart kindergartens is feasible and valuable. The government should invest more money in the kindergarten informatization, improve the information literacy of preschool educators, build a number of smart kindergartens with demonstration, lead the development of the industry and speed up the modernization process of preschool education.

The wide range of smart kindergartens and the diversity of technologies have determined that the construction of smart kindergartens is a long-term process that cannot be accomplished overnight. Employees and parents also need time to adapt, and improve information literacy gradually. Smart kindergartens can be constructed in three stages: the first stage focuses on intelligent management, the integration of various smart applications, the deepening of kindergarten-parents cooperation, and the improvement of office efficiency; the second stage focuses on the construction of smart environment, the comprehensive construction of smart perception layer, and the creation of a comfortable and safe kindergarten environment; and the third stage focuses on the construction of intelligent curriculums, integrating new technologies and innovating curriculum construction.

Acknowledgements
The paper's work is supported by Guangzhou Education Science 13th Five-Year plan Key project 1201720422("Internet +” kindergarten informatization construction research).

References
[1] Levine L., Waite B., Bowman L., Kachinsky K. Mobile media use by infants and toddlers. Comput. Hum. Behav.,94 (2019), pp. 92-99.
[2] Papadakis St., Kalogiannakis M. Mobile educational applications for children. what educators and parents need to know. Internet J. Mobile Learn. Organization, 11 (3) (2017), pp. 256-277
[3] R. Heinrich, M. Strittmatter and R. H. Reussner, "A Layered Reference Architecture for Metamodels to Tailor Quality Modeling and Analysis," in IEEE Transactions on Software Engineering. doi: 10.1109/TSE.2019.2903797
[4] J. Lindman, J. Horkoff, I. Hammouda and E. Knauss, "Emerging Perspectives of API Strategy " in IEEE Software. doi: 10.1109/MS.2018.2875964
[5] F. Fowley, C. Pahl, P. Jamshidi, D. Fang and X. Liu, "A Classification and Comparison Framework for Cloud Service Brokerage Architectures," in IEEE Transactions on Cloud Computing, vol. 6, no. 2, pp. 358-371, 1 April-June 2018. doi: 10.1109/TCC.2016.2537333
[6] Jingrong Liu and Miao Liu, "Construction and Application of an Online Child Portfolio Assessment System", in IOP Conf. Series: Journal of Physics: Conf. Series 1284 (2019) 012034 IOP Publishing doi:10.1088/1742-6596/1284/1/012034.