# Management Strategy Selection of Information System Construction for Chinese Universities[1]

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**Keywords:** Chinese universities, informatization, information system construction, management strategy, selection

**Abstract:** With the promulgation of *the Educational Informatization 2.0 Action Plan*, universities in China have generally proposed the goal of information construction which is characterized by "the smart campus". The key to the success of information construction lies in the selection of management strategy. We first discuss the content of university information construction, the current situation of university information construction and management, the concept of IT outsourcing, and the development and research status of IT outsourcing for university. Subsequently, we analyze the management strategy selection of information system construction from strategic, economic, and technical perspective. Finally, we classify the Chinese universities and analyze the characteristics of every type of universities. Based on the full-text analysis, we propose that the non-core information system of Chinese universities' information construction should adopt external management; "Double First-rate" universities' core information system should adopt internal management, and it is best that strategic suppliers are used to provide services; For higher vocational colleges and universities, external management should be applied to both non-core and core information system. As for the higher vocational colleges and universities with poor IT infrastructure and poor IT professionals, a strategic contractor can be selected to provide IT services. For general colleges and universities, the core information system management strategy should be determined according to specific conditions. We also present that the construction of cloud services and data centers is the trend of university information construction and the administrators of university informatization should pay special attention to the planning of information construction and the standardization construction of data and interfaces.

## 1. Introduction

On April 13, 2018, the Ministry of Education of People's Republic of China published t*he Educational Informatization 2.0 Action Plan*. This action plan puts forward the basic goal, which requires the realization of covering all schools with the construction of digital campus and the improvement of the informatization application level as well as the information literacy of the teachers and students, by implementing the *Educational Informatization 2.0 Action Plan*.

Currently, in response to the call of the Ministry of Education, the department of education of all provinces (Education Committee) and universities are preparing for their new round of information construction. The whole process of intellectual economy is constructed from the digitalization to the informatization, then to the knowledge. We hold that there must be an intelligent (or wisdom) process after the process of knowledge. From the perspective of Chinese top universities with higher levels of information technology, they have gone through two eras of campus network and digital campus, and are moving from digital campus to smart campus. Although Chinese universities have achieved remarkable results in information construction in recent years, compared with countries with

[1] This paper is the research results of "Digital Fujian" Higher Education Big Data Institute.

advanced levels of information construction, there are still some gaps. There are problems such as emphasis on construction and light planning and lack of top-level design[2].

At present, China is in the initial stage of the construction of the smart campus. The investigation found that only the internal IT (Information Technology) departments of a few universities, such as Tsinghua University, Peking University and Sun Yat-sen University, have certain technical research and development ability, and most universities are only equipped with basic IT maintenance and management personnel. Information construction outsourcing has become the preferred strategy for Chinese universities, and the key to the success of information construction management lies in the selection of management strategy. One of the most important issues for the decision makers of information construction is the management strategy of information system construction. What are the contents of information construction for universities? Is it self-developed or outsourced? What is the content of outsourcing? What kind of IT supplier or contractor are selected? We discuss these problems and analyze the management strategies of information system construction for universities based on different influencing factors.

## 2. Overview of management strategy of information system construction

Before discussion, we first introduce the content of information construction for university, management strategy of information system construction, the concept of IT outsourcing, and the development and research status of IT outsourcing for university.

### 2.1 The content of university information construction

Currently, university information construction is showing an intelligent and diversified development trend and a variety of advanced technologies and applications cross-infiltrate into all aspects of campus, such as teaching, scientific research, learning, management, and life. The university information construction with smart campus as the main feature is data concentration (big data, artificial intelligence)-centered, building a better and updated software and hardware system in the campus. The goal is to achieve comprehensive integration of teaching management, resource management, scientific research management, student management and logistics and service management, providing personalized services and decision support to participants in the information system.

The main content of university informatization includes two parts: infrastructure (hardware) and various information systems (software). It also includes the operation, maintenance and upgrade of software and hardware systems. The infrastructure includes hardware facilities such as network systems, servers, storage equipment, and computer rooms. Various types of information systems also can be divided into two parts: core systems and non-core systems (logistics support systems).

The core system includes a teacher system with a personnel management system as the core and a student system with the student work system as the core. The teacher information system includes scientific research (social science) system, personnel system, employment system, application system, academic affairs system, postgraduate management system, and online office hall, etc.; student information systems include admissions system, orientation system, apartment system, employment system, academic affairs system, postgraduate management system, psychological counseling system, student management system (including student information management, scholarship management and work-study management, etc.), second-classroom system, poor student identification system, performance prediction system, behavior warning system, counselling staff work platform, counselor management system and online office hall, etc.. The academic affairs system and the postgraduate management system are shared by the teacher system and the student system. The online office halls of teachers and students can also be merged into the online office hall of teachers and students. The non-core systems, that is, the logistics support systems, include library management systems, asset

[2] Yingjuan Wu. Discussion on the Problems of Informationization Construction in Chinese Universities. Journal of Northeast Normal University (Philosophy and Social Sciences). (2018) No.4, p. 195-200.

management systems, financial systems, logistics management service systems, security management systems and network course resources, database resources and their management systems, etc.. Data of various information systems must be aggregated into the core database to form a unified data center to provide data support for data mining and data analysis of big data and artificial intelligence.

### 2.2 The current situation of university information construction and its management

In the 1990s, the concept of education informatization emerged due to the construction of the information superhighway. At the same time, China began to establish a development path for China's education informatization. Nowadays, China has stepped into the era of educational informatization 2.0, and digital campus construction is booming. The content of construction has expanded from infrastructure to various information systems and databases. In recent years, the rapid development of big data, artificial intelligence and other technologies has put the construction of smart campuses characterized by intelligence and individualization into a high. The majority of universities have actively responded to the requirements of educational informatization 2.0, and have started researching solutions. Chinese universities' informatization development has reached unprecedented depth and breadth, and the future development prospects are expected.

However, under this booming situation, there are many problems in the information construction of universities, which are concentrated in the following aspects.

(1) Information construction lacks of planning and demonstration. In some universities, the overall planning of information construction has not yet been scientifically designed; or it remains on paper and has not been implemented; or there are problems with department settings, institutional arrangements, functional integration and management services; or advanced Technology has not been valued and applied. Data in the 243 colleges surveyed show that 47% of campus network outlets use private IPV4 addresses; IPV6 deployment is less than half, and needs development. In some universities, the network centers or informatization offices have been overwhelmingly involved in building information systems for various departments. Due to the lack of communication with specific departments, the information systems cannot meet the needs of the departments; or due to the lack of unified data standard and interface standard, the system cannot guarantee the data consistency, cannot build the data center, and the situation of data island is serious.

(2) Insufficient funding, focusing on hardware construction and light operation and maintenance. According to the survey data of the " Report on the Present Situation and Development Trends of the Information Construction of Universities in the Internet plus era", among the 213 universities, in terms of budget, 35.7% of them have annual budgets, and those without fixed budgets 64.3%; in terms of funding input, the situation of light operating and maintenance, and heavy construction is obvious. The overall construction funding distribution is similar to an olive-shaped feature, and the overall operating and maintenance funds are low and linearly decreasing.

(3) The lack of informatization talents in universities, especially informatization management talents, leads to the lack of planning and data standards for information construction, the lack of information construction supervision and auditing, and the informatization construction progress and quality cannot be guaranteed. existing research shows that There is a structural imbalance in the distribution of personnel in the information management department, with 54% of colleges and universities with personnel size within 10,37.1% of 11-30,7.0% of 31-50 and 1.9% of 51-80.

Because universities are characterized by information intensiveness, the level of information management directly affects the development of their core activities. IT system outsourcing has many advantages. For example, outsourcing allows universities to focus on the development of core business (teaching, research, etc.), especially the practice of outsourcing non-core IT services to professional service providers can avoid the huge team of university technicians, save costs such as human resources, technology updates, and development investment, and bring new technologies and services. Therefore, universities in China have adopted external management to get the desired information system.

In view of the problems in the process of information construction, and the actual use of

outsourcing construction action, in a sense, the strategy selection of IT outsourcing has become the key to the success of information construction. So how can we make the most of the advantages of IT outsourcing? How should the university make the decision to make the information management more effective and successful?

### 2.3 The information system construction management strategy

The information system construction management could be classified into internal and external management shown in Fig. 1.

There are three forms if university choose to manage its information system construction internally: internal system, purchasing resources and relying on the strategic suppliers. In the form of In-house, universities rely entirely on teachers and students with professional knowledge to develop information systems. For example, the early version of Xiamen University's educational administration system was developed by teachers and students who are from the Department of Computer Science, and then upgraded by the Department of Software Engineering's teachers and students. In the form of purchasing resources, universities temporarily purchase resources from suppliers, such as programmers and experts. For example, the earliest version of the welcome system of Xiamen University was developed by the School of Software's teachers and students. At that time, due to the urgent development tasks and time constraints, Xiamen University introduced software architects and programmers from Xiamen telecom company and mobile company as its supplement of development resources. Under the form of relying on the strategic suppliers, universities will establish a relatively stable strategic cooperative relationship with suppliers in order to obtain more flexible and reliable IT support. This type of strategic partnership is similar to the relationship between Xiamen University and the Architectural Design and Research Institute of Xiamen University (hereinafter referred to as the Design Institute). The Design Institute is a member company and a wholly-owned subsidiary of the Xiamen University Assets Company. The Design Institute can accept the design task from society, but its primary task is to accept the design task of Xiamen University's infrastructural construction.

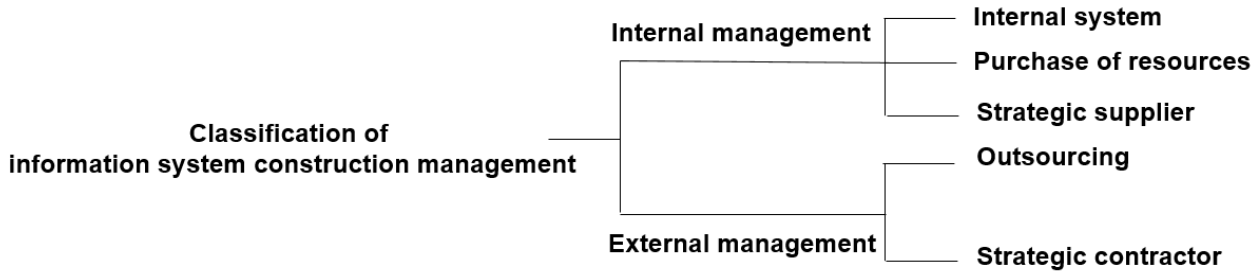


Fig. 1 Classification of information system construction management

There are two forms if university choose to manage its IT (information system) construction externally: outsourcing and Relying on strategic contractors. The former is based on the contract method; the latter is based on the strategic cooperation relationship with the contractor that adds some incentive measures outside the contract to ensure performance and reduce risk. The essence of external management is IT outsourcing.

### 2.4 The concept of IT outsourcing, development and research status of IT outsourcing for universities

There are different definitions of IT outsourcing according to different priorities, but they are almost derived from the following two classical definitions: one is Loh and Venkatrman (1992) [3] in Journal of Management Information Systems: IT outsourcing refers to the way in which outsourcing service providers provide physical or human resources to undertake part or all of the IT facilities'

[3] Loh, L. ,Venkatraman, N. Determinants of Information Technology Outsourcing:A Cross-Sectional Analysis, Journal of Management Information Systems. Vol. 9(1992) No. 01, p.7-24.

services. Since the term "Outsourcing "is intended to obtain the required resources from the outside, emphasizing the way rather than the process, it is outsourcing as long as it is the services that the enterprise obtains from the outside, whether or not they were originally provided by the enterprise itself. The second is the definition of IT outsourcing by City and Hirschhheim (1993) [4] in Sloan Management Review: the outsourcing is understood as purchasing products and services originally provided within the enterprise from outside. This definition states that only IT functions originally provided by the enterprise and then provided by external service providers are considered IT outsourcing. In the process of university informatization construction, there are both IT functions that were originally provided by universities and then handed over to external service providers, and IT functions that were developed and provided by service providers from the beginning. The IT outsourcing in this paper refers to the organization employing an external organization (professional software development company, system integration company and other IT service providers, contractors) to contract the development of new systems, non-core information systems (such as logistics support system), non-core back-office business (such as call center and hardware maintenance), information system maintenance to a professional company, a management strategy for the latter to provide more standard IT services for the former. The IT outsourcing for universities is sometimes accompanied by the IT assets and technical personnel of universities to be managed by IT suppliers.

The research on IT outsourcing mostly aims at IT outsourcing for enterprise. Haihua Hu (2016) [5] through the domestic and foreign database literature research and analysis that the research on IT outsourcing is mainly reflected in: model research, decision research, evaluation mechanism research, performance research, risk research, knowledge transfer research and combined industry research in seven aspects. Research of IT outsourcing for university is relatively few, foreign countries' research started earlier than domestic research, domestic research pay attention until 2006. The famous EDUCAUSE in the United States is an organization specializing in the application of IT in higher education. In 2002, the organization conducted a survey on the IT outsourcing situation in 286 universities of different levels and types in the United States and Canada, including: the scope of IT outsourcing, the motivation, the reasons for not choosing IT outsourcing, the decision-making power of outsourcing and the problems and risks encountered in the process[6]. Chinese researcher Liangping Zhang (2006) [7]first discussed the implementation of IT outsourcing in universities, and put forward the operation mode and matters needing attention of IT outsourcing in universities. More research involves IT outsourcing technology scheme, advantages, facing risks and some risk aversion measures, and there are not many researches on the decision mechanism in IT outsourcing caused by the problems existing in university informatization. Only Xiuquan He (2012) [8] discussed the IT outsourcing measures of universities based on the SWOT analysis method. She analyzed from the perspectives of finance, technology, and strategy, but it did not carry out strategy selection analysis for the information systems of different types of universities.

## 3. The analysis of management strategy of information system construction

De Liu and Guoqing Chen (1999) classified the selection strategies of IT sources and analyzed the three key factors influencing the selection strategy: finance, technology, and strategy[9]. We draw on this method, and analyze the management strategy of information system construction from the

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perspective of strategy, economy and technology. Considering current general methods in purchasing and maintaining hardware equipment are adopting external management, that is, outsourcing or the responsibility of strategic contractors, we only discuss the construction management strategies of various information systems.

### 3.1 Analyzing from a strategic perspective

Universities must consider the impact of the relevant information system will have on the university's IT strategy and even its development strategy when making information system construction management decisions. The impact of information systems or IT activities on university's strategies can be viewed in two ways. First of all, the IT activities of university can distinguish the development level of educational informatization of university, and even directly reflect the academic level and management level of this university and it is an important factor that reflects the level of a university. "The Integrated teaching and educational administration system of graduate and postgraduate students' system" directly reflects the idea and practice of talent training in Xiamen University and the completion of the system will greatly improve the level of talent training in Xiamen University and directly enhance the reputation of Xiamen University. Besides, the services and value creation provided by different information systems to universities are different, for example, the completion of the "Teacher and Student Online Office Hall" will greatly improve the efficiency of teachers and students dealing with issues, and really allow teachers and students to run less and work better.

The strategic position of information system can be divided into different type and general type. Some information systems can reflect the differences between universities, which are called difference type. For example, the "Xiamen University Second-Classroom System" and "Poor Student Identification System" can both reflect the advanced ideas of Xiamen University student management and talent training, and the differences between Xiamen University and other universities; General type refers to those information systems that provide necessary functions but are common to all universities, such as "financial system", "library management" and "academic affairs system" currently used by Xiamen University.

The application value of information systems can be divided into critical type and useful type. Some information systems play a key role in the core business of school are called critical type, such as the "The Integrated teaching and educational administration system of graduate and postgraduate students' system" being developed by Xiamen University; And useful type refers to those useful but not critical systems such as logistics support systems.

Analyzing from a strategic perspective, the management strategy selection of information system construction is shown in Fig. 2.

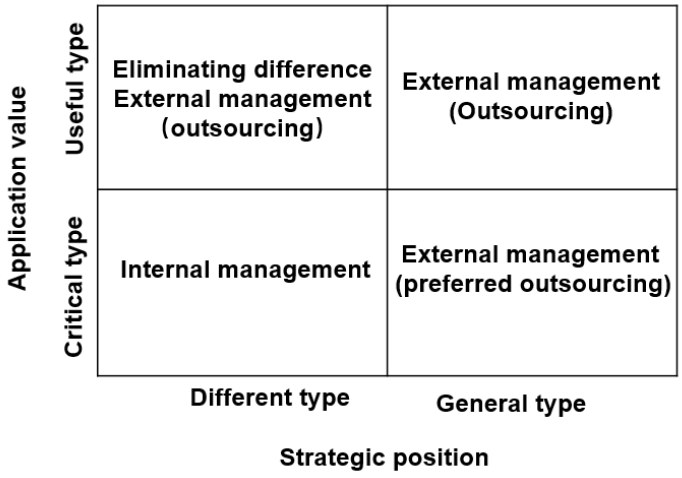


Fig. 2 selection from a strategic perspective

If the information system is not only important or has key application value to the core business of

the university (teaching and scientific research, talent training, etc.), but also can show the characteristics of the university and reflect the level of the university or have a strategic role that reflects the difference. Then, the university should adopt internal management to manage information system and related IT activities so as to maintain the competitiveness and advantage of universities. If universities have technical capabilities, then such systems must be developed by themselves. Of course, the university can also strengthen their capabilities through hire the external experts, but only if these experts are in charge under the management of the university to ensure timely response. The most common choice is letting strategic suppliers provide services. In short, this type of university's core system should adopt internal management strategy, especially choose strategic supplier services.

If the application value of information systems is important, but not the characteristics that distinguish them from other universities, then they are theoretically suitable for outsourcing. However, due to their significant impact, contractors should be selected carefully to ensure that contractors can provide high-level IT services and competitive prices. For example, "financial systems" in non-core systems should adopt this strategy.

If the information system is useful, but not much different from other universities and not the characteristics that distinguish different universities, then this type of system is most suitable for outsourcing, such as "library management systems" in non-core systems.

If the information system is different among different universities, but its application value is not so important to the university, it means that this difference has not brought much benefit to the university, so standardized measures should be taken to eliminate this difference, then to reduce the cost of outsourcing application information. For example, "logistics management service system".

### 3.2 Analyzing from an economic perspective

Considering the university funds and its IT management level is helpful for us to know whether there is cost advantage of relying on IT suppliers (As shown in Fig. 3).

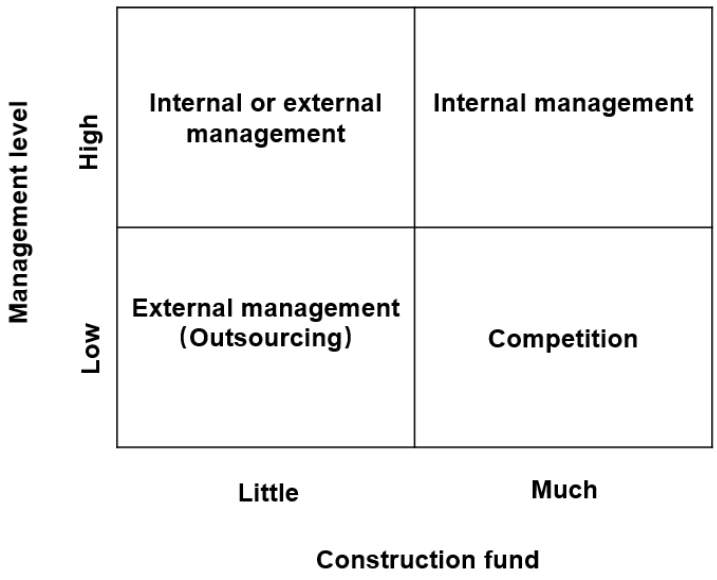


Fig. 3 Selection from an economic perspective

If it is a "Double First-rate" university, it will generally have sufficient funds and have relatively more efficient IT management, thus, it is impossible for suppliers to further reduce costs because they are pursuing profits. Therefore, such information systems are not suitable for outsourcing .

If the university has sufficient funds but the IT management is not perfect, then the best strategy is to let the university compete with those suppliers. If universities improve IT management and reduce costs during the competition, then there is no need for outsourcing.

If the university does not have sufficient funds but its management is efficient, it is not easy to judge whether to outsource. In this case, a detailed economic evaluation should be taken to determine whether the external management or internal management should be adopted, based on the evaluation

results.

If the university do not have sufficient funds for information system development and do not have effective IT management level, then outsourcing may be the best decision.

In general, the amount of funds provided by the university is positively related to its IT management level and its university level.

### 3.3 Analyzing from a technical perspective

The university's technical and business maturity level are important factors in determining the source of information systems. The technical maturity level of teachers and students in the university determines whether the university have the ability to develop information systems on their own. The business's maturity level of teachers and students in the university determines whether its business processes are scientific advanced and whether it can accurately propose the users' needs of the information systems it needs. Selecting the source of the information systems from a technical perspective as shown in Fig. 4.

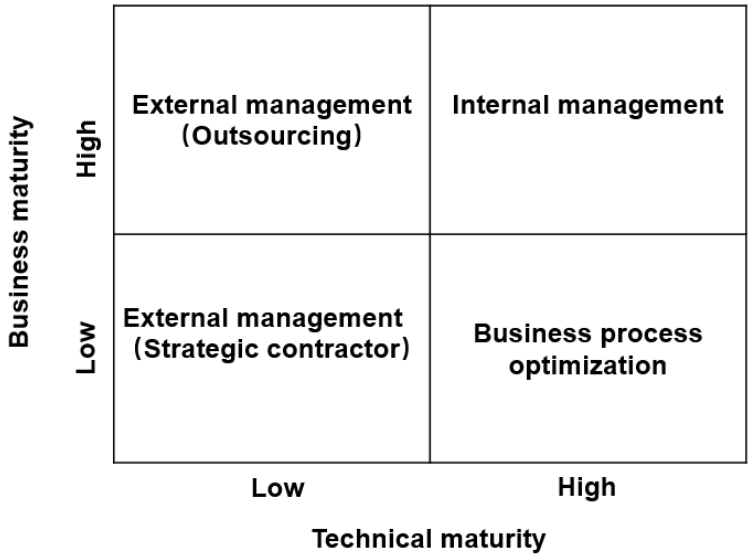


Fig. 4 Selection from a technical perspective

If teachers and students of the university have high-level IT technology capabilities and high business maturity level, then the information systems of such universities should choose internal management.

If the relevant professional teachers and students of the university have high-level IT technology capabilities but low business maturity level, then the information systems construction of such universities should be postponed. First, external resources should be introduced to optimize business processes before building relevant information systems. And then, internal management strategies can be considered. Of course, it also could consider that first to obtain high-quality and advanced related information systems through external management, and then force the optimization of related business processes.

If the university have low technical maturity level but high business maturity level, external management can be considered. At the same time, external IT experts should be hired to control the development progress and be responsible for auditing whether the functions and performance of the information system meet the requirements.

If both the technical maturity and business maturity of the university are low, the university have to choose strategic contractors to take full responsibility for information construction. However, in order to reduce risk, it is best to consult external IT experts.

In general, the technical maturity level and business maturity level of the university generally positively related to the comprehensive strength and level of the university.

## 4. Management strategy selection of information system construction

To clarify the management strategy selection of information system construction for university, we must first classify Chinese universities and analyze the characteristics of various types of universities.

### 4.1 The types of Chinese universities

Chinese universities can be divided into several types: "Double First-rate" construction universities, general colleges and universities, and higher vocational colleges and universities.

There is a total of 42 “Double First-rate” construction universities, such as Peking University, Tsinghua University, Fudan University, and Xiamen University. These universities have distinctive characteristics, strong economic strength, high technology and business maturity level and pay important attention to information construction and the level of information construction is generally relatively high.

General colleges and universities, that is, undergraduate universities which except "Double First-rate" construction universities, such as China University of Geosciences (Beijing), Fujian Normal University, Jiangxi University of Finance and Economics, Xiamen University of Technology, etc. Such colleges and universities accounted for the largest proportion in China. Among them, the level of talent training and scientific research, the level of information construction and management capabilities, the funds for information construction, and the technical and business’s maturity level vary widely.

Higher vocational colleges and universities, that is, higher vocational colleges and higher specialized schools, are general colleges and universities at the specialized level. In fact, the talent training and management mode of this kind of colleges and universities are very similar, not sufficient informatization funds, low technical and business’s maturity level and low information construction and management level.

### 4.2 Management strategies of information system construction for different types of universities

Based on the classification of Chinese universities and the classification of universities’ information systems, compared with the analysis of management strategy of information system construction for universities, we can answer the questions about the management strategies of information system construction for Chinese different types of universities, as shown in Table 1.

Table 1 Management strategy selection of information system construction for Chinese universities

| Information system construction / Perspective of strategy selection / Type of university | | Strategic perspective | Economic perspective | Technical perspective |
|---|---|---|---|---|
| “Double First-rate” construction universities | Core system | Internal management or preferred outsourcing | Internal management | Internal management |
| | Non-core system | External management | External management | External management |
| General colleges and universities | Core system | Internal management or preferred outsourcing | Internal or external management | Internal or external management |
| | Non-core system | External management | External management | External management |
| Higher vocational colleges and universities | Core system | External management | External management | External management (Strategic Contractor) |
| | Non-core system | | | |

From the above three perspectives as a whole, the core systems of "Double First-rate" construction

universities tend to internal management. There are three modes of internal management: the first is internal system, which is developed by internal professional personnel or teachers and students of related majors. If the developers or resources are lacking, the second method can be used, that is, purchasing resources. The shortage of development resources can be supplemented by the purchase of personnel namely hiring external professional technicians. However, with internal teachers and students and purchasing external resources to develop the project, there will come a question that who will maintain the system after the project team is disbanded after the project ends or the graduation of students. If the project development is completed by a full-time engineer hired by the university, the workload of the full-time engineer is not enough after the project has been completed, it will cause a waste of resources and funds. So, how to solve this problem? Bringing in strategic suppliers is a good choice. Finding a high-quality information system supplier with a special relationship with (or establish a special relationship with) the university, and ask the supplier to give priority to serving universities so as to provide the fastest response service.

For non-core systems, internal management are suitable for "Double First-rate" construction universities from an economic and technical perspective consideration, however, from the strategic perspective, external management should be adopted. The strategic perspective is higher than the economic and technical perspectives, in addition, considering the situation that most universities' non-core systems are very similar, the level of productization of information systems is relatively high, the cost of external management can be greatly reduced and the system reliability is high. Therefore, it is recommended to use external management. In the same way, non-core systems of general colleges and universities also should adopt external management. Therefore, non-core systems of all universities should select external management.

For higher vocational colleges and universities, even for the core systems, there is little difference between functional and performance request. Furthermore, the lack of school funds, low level of IT technical and management, IT infrastructure construction and business maturity, it is recommended that external management can be applied to its core system. In order to improve work efficiency and capital efficiency, and IT activity level, external management should not simply adopt outsourcing. Especially, suitable strategic contractor should be selected.

For general colleges and universities, whether internal management or external management are adopted to the core system, should be determined according to the specific situation of the school's strategic arrangements, information funding arrangements, and the school's IT technology strength and business maturity.

## 5. Conclusion

According to the above analysis, the non-core information system of Chinese universities' information construction should adopt external management; "Double First-rate" universities' core information system should adopt internal management, and it is best that strategic supplier are used to provide services; For Higher vocational colleges and universities, external management should be applied to both non-core and core information system. As for the higher vocational colleges and universities with poor IT infrastructure and poor IT professionals, a strategic contractor can be selected to provide IT services. For general colleges and universities, the core information system management strategy should be determined according to specific conditions.

Currently, IT technology develops and with the rise of the Internet of Things, cloud computing, big data and artificial intelligence, more and more information services are on the cloud platform, participants enjoy out-of-the-box cloud services and university information construction is developing toward cloud services. In addition to improving efficiency and standardized processes, the important goals of informatization are providing personalized services for participants and providing decision support for managers. Therefore, the construction of data centers is particularly important. With a data center with sufficient data, knowledgeable and intelligent information system could be possible. The administrators of university informatization should pay special attention to the planning of information construction and the standardization construction of data and interfaces.

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