Application Research on the informationization Architecture of Diversified State-owned Enterprise Groups Based on TOGAF

Liu Bo[1], Chen Hongjun[1,2*]

1. China University of Mining and Technology (Beijing), Beijing 100083, China;

2. Chengtong Holding Group Co. Ltd of China, Beijing 100070, China

Abstract

Enterprise architecture theory provides an effective way to avoid problems related to information construction in diversified state-owned enterprise groups. According to the characteristics of diversified state-owned enterprise groups in China at the present, this paper puts forward a general application framework which is suitable for informationization of diversified state-owned enterprise groups in China based on the enterprise architecture model---TOGAF, and has discussed the establishing steps and key points of implementation for the enterprise architecture of diversified state-owned enterprises group from the following three aspects: clarity of objectives, architecture design and architecture implementation.

Keywords: Enterprise informationization; enterprise architecture; Diversified enterprises group; informationization planning;

1 Introduction

Due to historical factors or practical development needs, during the development process of state-owned enterprises in China, diversification strategies are adopted more widely so as to accelerate the scale expansion, avoid market risks and enhance abilities in market competition. Although there are many controversies, diversified enterprise group has become the mainstream of the governance model in state-owned enterprises of China [1]. In recent years, in response to requirements of "integrating informationization and industrialization", and requirements of improving production efficiency, accelerating the business development and enhancing scientific decision-making level, Chinese state-owned enterprises have increased their investment in informationization one after another, the overall level of informationization has improved obviously. But with the increasing quantity of information systems, a series of problems occur frequently, for example, the informationization of diversified enterprise groups always disconnects with strategic needs and business development, and blind or repeated construction exists in this process, the phenomenon of "information isolated islands" is prominent, and investment efficiency in informationization declines. Some enterprises try to use the integrated tools in information systems or reconstructing to solve these problems, this inevitably requires large capital investment, and it is difficult to solve these problems fundamentally. Enterprise architecture (EA) theory provides an effective way to solve those relevant problems; the domestic and foreign scholars have conducted a lot of researches about it. For instance: The Center of Information Systems Research (CISR) of MIT proposes that enterprise architecture can effectively promote the integration of enterprise strategies, business and information technology [2]. Gatener points out that enterprise architecture is the key to promoting enterprise digital strategies [3]. Song Jundian et al have conducted researches on the practical application of the enterprise architecture theory in rail transit enterprises based on the Open Group Architecture Framework (TOGAF) model [4]; Wang Qiaowen et al combine the existing mainstream enterprise architecture framework models and propose the enterprise architecture framework model corresponding with the actual domestic grid industry [5]. In general, after years of development, the present framework of foreign enterprise architecture (EA) has become quite mature both in theory and in practice [6], but relevant application researches in China is still in the initial stage, it still stays in the stage of theory researching and preaching, there is rare typical cases, and how to apply it into our enterprises needs more practices [7]. In view of characteristics in the informationization of the present diversified state-owned enterprises in China, this paper has studied the application of enterprise architecture theory based on TOGAF model in diversified state-owned enterprises and discussed its key application steps and implemental points based on the practice in the informationization of a large state-owned enterprise.

2 The concept of enterprise architecture

The concept of enterprise architecture was firstly proposed by John Zachman, an information expert of IBM, in 1987, so Zachman architecture is the origin of enterprise architecture. Enterprise Architecture in English

(EA) refers specifically to the general framework of the informationization of enterprises, while the Chinese connotation of "enterprise architecture" is far beyond the category of informationization, and this paper adopts the conventional connotation of enterprise architecture abroad. Enterprise architecture theory mainly studies how to map business functions and requirements to IT system and provides a balanced method which is suitable for enterprise strategies and business demands for the selection, design, development and deployment of all IT systems in enterprises [8]. Enterprise architecture theory is a summary of theories and methods in informationization development, and its main background is: on one hand, information technology is a basic condition and important means for enterprises to obtain competitive advantages, and has become a key factor in the effective management of enterprises or other social organizations, on the other hand, the enterprise informationization system and IT infrastructure have been becoming more complex gradually, it is difficult conduct effective management only by experience. After the development of nearly thirty years, enterprise architecture theory has been becoming mature day by day, and a few recognized mainstream frameworks have been formed in this industry, in addition to the Zachman architecture, there are other ones, such as, Federal Enterprise Architecture Framework (FEAF), Department of Defense Architecture Framework (DODAF), The Open Group Architecture framework (TOGAF) and so on.Generally, the Zachman architecture is too theoretical with complex methods and poor practicability, FEAF is suitable for the E-government, DODAF is suitable for the military system, and TOGAF is the general framework, which is developed and continuously introduced by some of the world's leading IT customers and manufactures, it has become a leader in enterprise architectures [9].

TOGAF is an enterprise architecture framework model developed and maintained by the Open Group of European Community IT Association, including six great components, such as architecture content framework, architecture development method (ADM,), the reference model and architecture competency framework etc.[10] where in, architecture content framework and architecture development method are the core of TOGAF, and architecture development and content framework includes relevant contents in business architecture, data architecture of information system, application architecture of information system and technical architecture, ADM is the methodology for a series of architecture implementing process covering architecture design, scheme selection, architecture controlling and changing. TOGAF model is an effective tool to assist enterprises in the planning, operation and maintenance of informationization architecture; we need to conduct targeted researches according to the actual situation of enterprises in the practical application, pinpoint relevant features in the enterprise informationization, so as to enhance the effectiveness of enterprise informationization

architecture design.

3 Characteristics of the informationization in diversified state-owned enterprise groups

Clarifying characteristics in the enterprise informationization is the basis of informationization architecture design. In recent years, the state-owned enterprise groups in China have made a great progress in the aspect of information construction, due great differences in the external environments between state-owned enterprises in China and developed countries, and historical factors of domestic state-owned enterprises; the informationization in diversified state-owned enterprise groups generally has the following characteristics:

(1) It has been just a short time since the establishment of diversified state-owned enterprise groups in China; there are many management levels and a strong demand on the informationization in control ability improvement. Unlike western enterprise groups which are formed gradually through capital links in the market economy, diversified state-owned enterprise groups in China are usually reorganized with administrative means of government agencies in the recent decade, and it has just been a short time since the establishment, it is common that "subsidiary companies come into being before their parent companies", and the prominent characteristics include large enterprise scale, multiple management levels and poor management and control ability, the phenomenon "managing without controlling and gathering with uniting" is very common, and also there is a strong demand on the informationization in control ability improvement.

(2) Development among different industries is imbalanced and there are great differences in the demand on informationization and investment ability. A diversified enterprise group is usually formed from one or two major businesses and then enters into several industries; the development of different industries is imbalanced in different stages, resulting in that great differences exist in informationization levels of different industries, in addition, the investment ability in the informationization is always related to the economic benefit of the enterprise, enterprises with high benefit have a stronger will in investing in the informationization, and those with poor benefit have a weaker investment ability in the informationization.

(3) Informationizaiton standardization degree and the utilization value of data assets are low, and there is no data sharing. Because the diversified enterprise group involves many industries, there are great differences in standards of data in different industries, data standardization degree on the group level is low in most cases, which causes that the statistical analysis of data is relatively extensive, it is difficult to dig the data value and the support to decision-making cannot meet the needs in business management.

(4) The construction of application system is dispersed; it is extremely difficult to conduct effective integration

and cannot meet the development needs. The overall level of group management informationization is relatively weak, there are many versions of information systems for financial management in different industries and human resources, it is difficult to integrate them effectively, and also they cannot communicate up and down, because of all of these, it cannot meet requirements of the collaboration across industries in the group and the improvement of management; the existing business information systems of different industries can basically meet requirements of the present business operation, but it cannot meet requirements of business promotion and it also does not take the effective integration with information management system, therefore, the phenomenon of "information isolated islands" is obvious.

(5) The investment in the infrastructure is disperse and lack of technical standards, and it is difficult to conduct safety operation and maintenance. Different groups and industries construct information infrastructure in their own different ways, it lacks technical standards support for relevant equipment procurement, causing

difficulties in later system integration and maintenance, and also it cannot adopt to requirements in the rapid development of groups.

4 The application of enterprise architecture in diversified state-owned enterprise groups

4.1 THE APPLICATION FRAMEWORK OF ENTERPRISE ARCHITECTURE IN DIVERSIFIED STATE-OWNED ENTERPRISE GROUPS

Enterprise architecture is an effective tool for diversified state-owned enterprise groups to conduct top designs of information and avoid the systematicity and scientificity of relevant issues in the process of informationization. Combining TOGAF theory and corresponding architecture development methods, the application framework of enterprise architecture in diversified state-owned enterprise groups includes contents in the following three stages: clarity of objectives, architecture design and architecture implementation, which is shown in Figure 1.
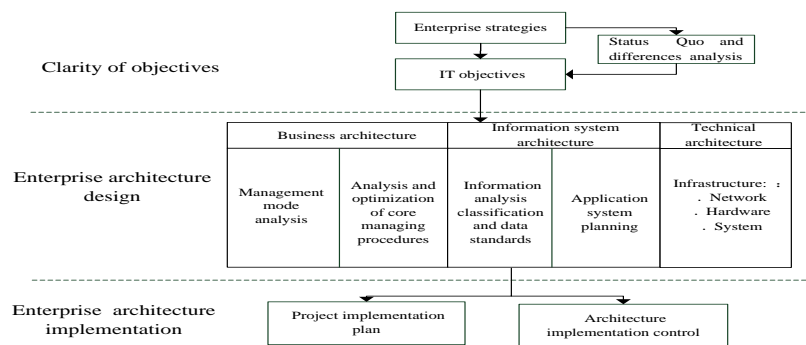
FIGURE 1The application framework of enterprise architecture in diversified state-owned enterprise groups

4.2 MAIN CONTENTS IN THE STAGE OF CLARITY OF OBJECTIVES

Enterprise strategy is an important basis for the goal of clarifying information architecture design, the enterprise strategy of diversified enterprise groups generally contain multiple levels: the overall strategy, function strategies and business strategies in industrial modules, it is the key to identify critical points in the realization of the enterprise strategic target and its requirements on informationization, on this basis, we analyze the status quo and differences of enterprise informationization comprehensively according to informationization benchmark in the industry, and then clarify IT goals of enterprises.

4.3 MAIN CONTENTS IN THE STAGE OF ENTERPRISE ARCHITECTURE DESIGN

4.3.1 Business architecture design

Business architecture can promote information system architecture, the more thoroughly we understand enterprise business and situations, the more pertinent our information system architecture design will be, and then the higher the integrating degree is. Business architecture design must

take the enterprise strategy as the guidance, we shall systemize and design the critical parts centering on the control and business mode and process architecture. For diversified state-owned enterprise groups, the existing prominent problem is that their management and control ability is weak. from the group level, the key of business architecture design is the design of control mode and the carding and optimizing of corresponding core management process, fix the operating process with software program and enhance the automation in the operating process of enterprises [11]. Generally, there are three types of management and control modes used widely in practice: the financial management and control, strategic management and control and operational management and control. Taking the strategic management and control mode adopted by most diversified enterprise groups as the example, the orientation of group headquarters is to promote subordinate companies to create value revolving around group strategies, and provide shared service in proper business fields, their management and control activities can be divided into strategy construction, strategy implementation, strategy control and strategy evaluation, which is shown in Figure 2, on this basis, the critical core
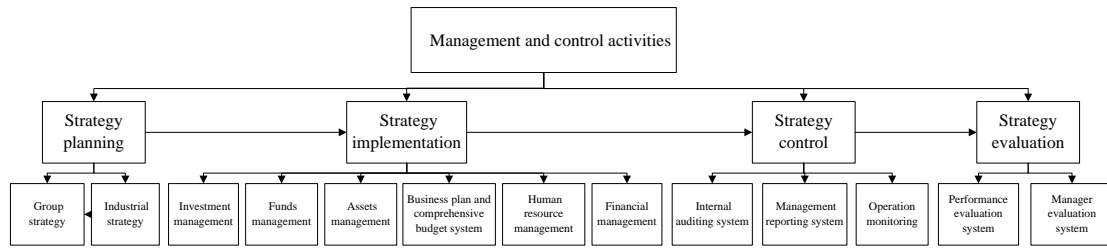
management is systemized and optimized specifically.

FIGURE 2 Key management and control activities of strategy-controlled enterprise groups

4.3.2 Information system architecture design

(1)Information architecture. Its main purpose is defining the logical structure and physical structure in the organizational level data, which can make related data flow among application systems without limitations. General steps of information architecture design include information demand analysis -- information classification -- developing data standards and corresponding processes. Because it involves a number of industries, and there are great differences among different members of enterprises in different stages, the key of data architecture design of diversified enterprise groups is combing and optimizing results revolving around the core controlling activities and business processes of them, analyzing data information demand and flow direction in the key links of business processes and formulating unified data standards for enterprises according to their information themes. Information architecture design on the group level should highlight master data management, establish the corresponding major data management system, concentratedly clean and enrich the core data which need to be shared (master data) in application systems and distribute the unified, intact, accurate and authoritative master data in the way of service, so as to consolidate the basis of data integration for application systems.

(2)Application architecture. Many problems widespreadly exist in diversified state-owned enterprise groups, such as unbalanced industrial development, great differences in the demand of informationization and weak

control capability, therefore, the application architecture should take "strengthening management and control, collaborative optimization, and scientific decision-making" as its design focus. Combined with the early management mode and business analysis results during business processes, the relevant requirements are decomposed into a series of interconnected informationization application systems, the application architecture can be divided into presentation layer, decision-making layer, management layer and service layer from the top to the bottom. Among them, the presentation layer is mainly responsible for the integration and presentation of internal information; decision-making layer includes a decision-making support system (BI) and data warehouse, and is responsible for the comprehensive analysis of internal and external data of enterprises; management layer should focus on the centralized deployment of shared management information systems of groups and sub-groups (financial management, human resources and physical assets), realize the intensive management to core resources of groups, such as "human, capital and materials", and strengthen the management and control ability of groups, it can not only quickly improve the overall informationization level of groups, but also lays a good basis for the future financial management, capital centralized and other shared services of groups; the industrial sector involved should fully consider the management and control of the information systems integration and tries to cover with the same ERP system to meet requirements in the internal integration management, as shown in Table 1.

TABLE.1   Application architecture diagram of diversified state-owned enterprise groups

Presentation layer	Enterprise information portals (internal and external portals)							
Decision-making layer	Decision-making support system (BI)/data warehouse							
Management layer	Archives systems	foreign affairs systems	……	……	Information controlling platform			Coordination work platform
Business layer	Industrial sector 1	ERP	SCM	……	Financial management	HR management	Funds central management	OA Video conference, enterprise mailbox
	Industrial sector 2	ERP	MES	……				
	Industrial sector 3	ERP	PDM					

4.3.3 Technical architecture design

Technical architecture mainly meets requirements in the network, basic software and hardware of application

architecture from the perspective of the overall enterprise planning, and puts forward the corresponding technical norms, standards etc.. The main contents include: the basic platform (hardware, network, software), technology

platform and integration platform (ESB, MDM etc.), to meet operation needs of various business application information systems of application platforms. The basic platform includes hardware, network, database and other basic software, technology platform mainly provides various services, such as workflow, storage, network management, integration platform includes the enterprise service bus (ESB), master data management (MDM) and other integrated management tools. Because there are many diversified enterprise group industries, the

infrastructure investment is easy to be dispersed, it is better to adopt hardware cluster, virtualization (such as Vmware) and other technologies with cloud computing in relevant information infrastructure, and we should conduct centralized construction and avoid decentralized construction, to reduce investment in hardware, network and other aspects and meet requirements in rapid deployment and changing with demands, details can be seen in Figure 3.
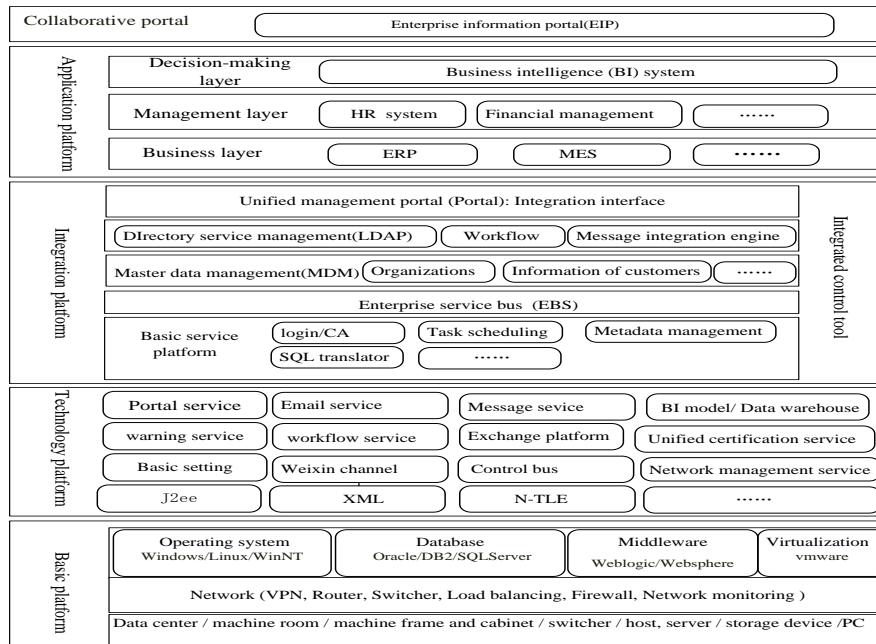

FIGURE 3 Technical architecture logical diagram of diversified state-owned enterprise groups

4.4 MAIN CONTENTS IN THE ARCHITECTURE IMPLEMENTATION STAGE OF DIVERSIFIED STATE-OWNED ENTERPRISE GROUPS

4.4.1 The formulation of project implementation plans

Enterprise architecture provides a integrate and consistent view for enterprise group in the use of informationization tools and connects business with IT system effectively.

The enterprise architecture implementation of diversified state-owned enterprise groups must divide application projects and determine the order of project implementation.

(1) Information application projects of diversified state-owned enterprise groups generally can be divided into 3 categories: shared, key and common informationization project, details can be seen in Table 2.

TABLE.2   The classification table of IT projects of diversified state-owned enterprise groups

Project classification	Examples	Implementation range	Incidence	Major duty allocation
Shared IT project	Shared IT system for the financial management and HR of the group	Sub enterprise of the group	Having significant impact on the whole group	The group headquarter is responsible for the project approval, planning, construction, operation and maintenance
Key IT project	ERP system	The second level industrial group	Having significant impact on main business of the whole group	The second level industrial group undertakes key links of implementation, the project approval and acceptance, The group headquarter should intervenes
Common IT project	DCS、PDM	Single demand subjects(department/unit)	Local affairs of single demand subjects	Following unified information standards, the demand subject take the lead to implement.

(2) The sequential division of project implementation. In order to conduct the sequential division of informationization project implementation, three aspects: the dependencies among different projects, its importance to the enterprise and implementation risk evaluation should be considered. the dependencies among different projects refer to the interdependence of the internal information system, for example the decision support system needs to access data from the management and business information system, the portal system (Portal) can be implemented only based on other information systems; the importance to the enterprise refers to the importance of the project to the enterprise management, improvement of economic efficiency and other aspects; implementation risk evaluation means the present technology maturity of planned implementation information systems, the standardization of corresponding management and the matching degree between resources required and existing resources of the enterprise, it is necessary to conduct a comprehensive evaluation on these 3 aspects in the specific implementation.

4.4.2 The management and control of the enterprise architecture implementation

Diversified state-owned enterprise groups manage and control enterprise architecture effectively in the way of "hierarchical planning, unified examination" The headquarter of the group conducts the overall design of enterprise architecture design, and is responsible for organizing the compliance examination of the architecture, the second-level group design and renew its own enterprise architecture design according to the overall architecture requirements of the group and their own actual situations, to ensure the integrity of the enterprise architecture planning; the third-level and lower groups do not design enterprise architecture any more. The second-level group submits the project to the group headquarter for approval according to project types, the headquarter of the group is responsible for the unified examination of project implementation. It is shown in Figure 4.
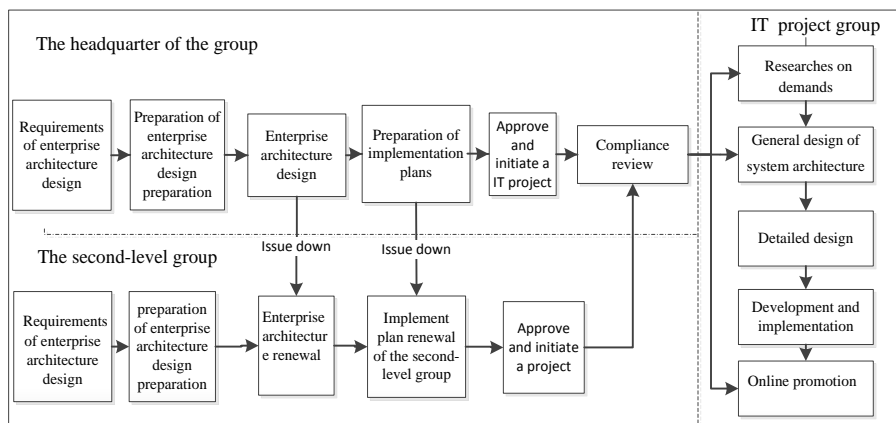

FIGURE 4 The flow diagram of enterprise architecture implementation management and control of diversified state-owned enterprise groups

5 Conclusions

In the informationizaiton society, the ability of using information assets has become one of the key elements for the development of enterprises. Due to historical backgrounds, Chinese diversified state-owned enterprise groups involve many factors in several industries, the informationization advancement is relatively complex, enterprise architecture is a effective method for top design of informationization, it can avoid blind construction of informationization projects in the greatest extent, and establish an organic link between corporate strategies,

business and informationization, which can ensure the later effective integration of information application systems, relevant information can be mined and used effectively, thus, enterprises which are promoting informationization can be changed into information-based enterprises. In order to promote the effective implementation of enterprise architecture, diversified enterprise groups should make out corresponding informationization implementation plans, and effectively control the enterprise architecture implementation, so as to lay a solid foundation for advancing the informationization of groups continuously.

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Authors

< Liu Bo >, <1970.10>,< Xiangtan County, Hunan Province, P.R. China>

Current position, grades: professor of School of Mechanics and Civil Engineering, China University of Mining & Technology (Beijing) (CUMTB).
University studies: received his B.Sc. in mining engineering from Hunan Technology University. He received his M.Sc. and PHD in geotechnical engineering from CUMTB.
Scientific interest: His research interest fields include civil engineering and construction engineering management.
Publications: more than 90 papers published in various journals.
Experience: He presides over 4 projects funded by National Science Foundation of China, and other more than 20 projects funded by the National Ministry of Education, and Beijing government, etc.

< Chen Hongjun >, <1974.03>,< Yancheng City, Jiangsu Province, P.R. China >

Current position, grades: the project manager of Chengtong Holding Group Co., Ltd of China, China.
University studies: received his master degree in business administration from University of International Business and Economics Beijing in China.
Scientific interest: His research interest fields include engineering management informationization and enterprise informationization。
Publications: more than 20 papers published in various journals.
Experience: He has management experience of 10 years, has completed three scientific research projects.