Research on Synergy Effect of Enterprise Architecture Integration in Power Grid Industry from the Perspective of Value Stream

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Abstract. Influenced by the independent relationship between different organizational structures of enterprises, it is difficult to further improve the economic benefits from the perspective of value stream in the process of operation. Therefore, this paper puts forward a study on the synergistic effect of enterprise structure integration in power grid industry from the perspective of value stream. Fully considering the correlation between different components of power grid industry enterprises, a multi-level power grid industry enterprise architecture model is constructed by using multi-Agent technology. The problem of building an integrated collaborative mechanism of enterprise architecture in power grid industry is transformed into an optimization problem of enterprise architecture model in power grid industry. From the perspectives of business architecture, data architecture, application architecture and technical architecture, the mechanism of business interaction and data flow among enterprises in power grid industry is established to realize the integrated collaboration of enterprise architecture in power grid industry. In the test results, the economic benefits of the value stream of the tested power enterprises have been significantly improved.

Keywords: Value stream perspective; Power grid industry; Enterprise architecture integration; Synergistic effect; multi-agent technology; Business structure; Data architecture; Application architecture; Technical architecture;

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1 Introduction

To maximize the value of an enterprise and effectively improve its operating efficiency, it is extremely necessary to build an integrated collaborative mechanism from the perspective of enterprise structure [1-3]. In the related research with this as the core, the integrated collaborative research based on the composite system synergy model has been widely concerned. This method is based on evaluating the synergy of enterprise goal integration [4-5] and constructs a specific evaluation index system [6-7]. Through the establishment of an integrated composite system collaborative model, the purpose of improving the economic benefits of enterprises is achieved. In addition, the research on industrial synergy based on input and output is also one of the more common technical means. It designs the specific total input and distribution based on fully considering the necessity of input [8-9], which has maximized the production and greatly promoted the bidding efficiency of enterprises [10-11].

On this basis, starting from the core of enterprise management, this paper puts forward the research on the synergy effect of enterprise architecture integration in power grid industry from the perspective of value stream, and analyzes and verifies the operation effect of designing enterprise architecture integration synergy mechanism through comparative testing.

2 Power grid industry enterprise architecture integration collaborative mechanism design

2.1 Power grid industry enterprise architecture model building

For enterprises in power grid industry, various concepts appearing in its architecture are the basis and key to reflect the state of enterprises' information-related objects. To achieve the construction of enterprise's architecture integration and coordination mechanism [12-13], this paper constructs the enterprise architecture model of power grid industry based on meta-model. In the process of building the specific model, this paper not only uniformly defines various concepts emerging in the enterprise architecture of the power industry, but also sorts out the related objects reflecting enterprise informatization, including the most basic power grid business processes, system applications, application functions, data entities, nodes, etc. [14-15]. On this basis, this paper fully considers the correlation between the above-mentioned object elements, and defines them in detail. In this way, it provides a reliable basis for the construction of the follow-up integrated collaborative mechanism, and creates more convenient conditions for mutual reference and verification between different objects.

It is a complex process to construct the meta-model of enterprise architecture in power grid industry, which is influenced by its own composition and the relationship between different components. In the concrete construction process, this paper considers different factors in all directions and constructs a mesh-like enterprise architecture meta-model, which has multi-level attribute characteristics and satisfies the multi-perspective structure. The modeling technology adopts multi-agent technology, which can ensure that the meta model of the power grid industry enterprise architecture is more consistent with objective facts. Besides, when describing the active objects of enterprise architecture, this paper uses multiple Agents as the basic elements of the architecture. According to the way shown above, in the enterprise architecture model of the whole power grid industry constructed in this paper, it can be understood that it is composed of multiple Agents, and the operation is achieved by establishing the cooperative relationship between each Agent (architecture element). Since there are some differences in the scope of specific fields corresponding to different components of power grid enterprises, on the basis of setting the correlation relationship for each Agent, this paper also designs its specific attributes and external services. Among them, the domain scope definition result of Agent schema elements can be expressed as

$$D = \{d_1, d_2, ..., d_i\} \tag{1}$$

Among them, D represents the domain scope of Agent architecture elements, that is, the business domain of the corresponding power grid industry enterprises, including marketing services, production and operation, etc. However, it should be noted that in the specific business process, due to the influence of enterprise strategy, the corresponding business domain scope will also be adjusted adaptively and the adjustment at this time is carried out in a hierarchical form. And there are

$$d_i \supset d_j \to d_j = BizFunc(d_i) \tag{2}$$

Among them, d_j represents the adjusted business position, and d_i represents the original business function within the field.

In this way, the hierarchical relationship between different Agent architecture elements is established. In this way, the enterprise architecture model of power grid industry is built.

The meta-model of enterprise architecture designed in this paper provides reliable support for the communication and use of the same concept and dictionary by the relevant personnel of electric power enterprise architecture, and the corresponding architecture information can also be saved in a structured form.

2.2 Power grid industry enterprise architecture integration collaborative mechanism construction

Combined with the enterprise architecture model of power grid industry constructed in Part 1.1, when there are factors that affect the architecture meta-model, collaborative optimization of the architecture meta-model is needed. The specific ways are mainly divided into adding, modifying, removing, replacing, and changing the relationship. On this basis, the problem of building an integrated collaborative mechanism of enterprise architecture in power grid industry can be transformed into an optimization problem of enterprise architecture model in power grid industry. Among them, the optimization object can be expressed as

$$AFAUR = \{D, tf, dt, rel\} \tag{3}$$

Among them, $AFAUR$ represents the optimized object of the enterprise architecture model of the power grid industry, tf indicates factors that can influence the architecture meta-model, dt indicates how the schema meta-model can be changed, rel indicates that the relationship between schema meta-models can be changed.

Combined with the above analysis results, the construction mode of enterprise architecture integration collaborative mechanism in power grid industry is shown in Table 1.

Table 1. Construction of Integrated Collaborative Mechanism of Enterprise Architecture in Power Grid Industry

Architecture	Build a strategy	Mode of execution
Business architecture meta-model	Referring to the power grid enterprise value chain system, the top-down method is adopted to design the business domain according to the boundary of the business domain, and the business domain is further subdivided based on the organizational structure of the power grid company. Based on this, the principle of single responsibility is adopted to form business functions.	Activities and steps are the result of further decomposition of the business process. In the process of processing business information, business functions are composed of corresponding posts and positions. Business function is the source of business system role transformation. Through the function of the business system, the automation of the business process is finally realized.
Data architecture meta-model	Referring to the IEC standard, based on the common information model (CIM), the data entity classification is formed considering the data relevance and the business scope of the enterprise. According to the database design method, business objects are analyzed from the conceptual level, and the conceptual data model is designed and further refined to form the logical data model.	The data storage mode and performance requirements are adopted to form a physical data model and the access unit of data integration structurally.
Application architecture meta-model	Based on the business domain, the application architecture is described from the logical level and the physical level.	Logically, each business domain is supported by an application, consists of a set of related functions, and operated by a corresponding role; Physically, a component function is an instantiation of an application function.
Technical architecture meta-model	According to the information status and technology accumulation of power grid companies, the information technology is classified to form multiple technology areas to support the information construction.	According to the technical relevance, the required technical capabilities are further decomposed in the technical domain, and the technical capabilities are supported by the software and platform components. When components and databases are instantiated, they form cells that can be deployed to different nodes and rely on hardware resources to do so.

According to the above-mentioned methods, the business interaction and data flow mechanism of power grid enterprises are established from four aspects: business architecture, data architecture, application architecture and technical architecture, so that the data distributed in each business system can flow between different databases.

3 Application testing

3.1 Test preparation

In the process of testing, this paper carried out the test based on a provincial power grid company. The basic situation of the enterprise is analyzed, as shown in Table 2.

Table 2. Statistical table of basic situation of enterprises in power industry

Number	Parameter	Configure
1	Administration section	22
2	Management office	93
3	Compass of competency	13 cities, 51 counties (city, district) power supply companies and 17 affiliated units
4	Number of business households	40.4 million households
5	Service population	About 80 million
6	Number of substations of 35 kV and above	3066
7	Main transformer capacity	475 million kVA
8	Electric transmission line	91,100 km

In the specific enterprise decision-making process, the guidance of different components in the enterprise framework is shown in Figure 1.

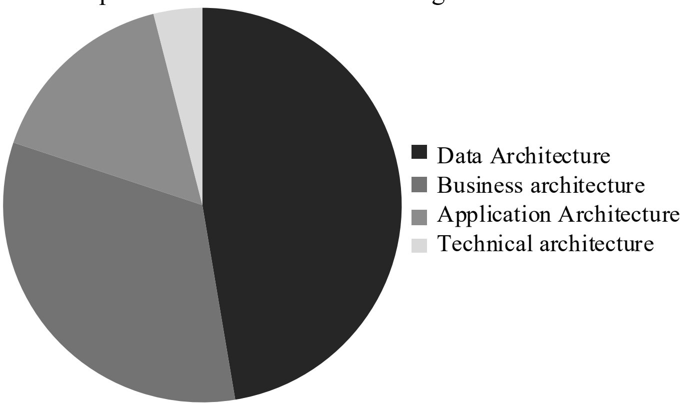

Fig. 1. Guiding statistical chart of decision-making of different components in enterprise framework

As shown in Figure 1, in the specific enterprise decision-making process, data architecture and business architecture in the enterprise framework account for a relatively large proportion, followed by application architecture, and technology architecture accounts for a relatively small proportion.

The importance of data architecture is reflected in the need for accurate and timely data to support decision making. By establishing a sound data architecture, you can efficiently collect, store, manage and analyze data to provide enterprises with data-based insights and decision support.

A large business structure means that the enterprise focuses on maintaining and growing the core business, and the decision-making process is closely centered around the business goals and needs. When making decisions, business architecture provides a clear understanding of business processes, value chains, and organizational structures, ensuring that decisions are aligned with business strategy.

The moderate proportion of application architecture indicates that enterprises are focusing more on how to use advanced application systems to support business and data requirements in the decision-making process. A good application architecture helps improve process efficiency, information sharing and collaboration, making it easier for decision makers to access and process relevant information.

The relatively small proportion of technology architecture is mainly because technology is simply a tool to support the business and data, playing an auxiliary role in the decision making process. The existence of technical architecture is to ensure the stability, scalability and security of application systems and data platforms, providing a good technical foundation for enterprises.

On this basis, in the specific testing process, in order to more intuitively analyze the application value of the integrated collaborative mechanism of enterprise architecture designed in this paper, the integrated collaborative mechanism based on the synergy model of composite system and the industrial collaborative mechanism based on input and output are set as the control group.

3.2 Test results and analysis

Based on the given test environment and oriented by value stream, the specific results of cost input in the operation process of electric power enterprises are analyzed, as shown in Figure 2.

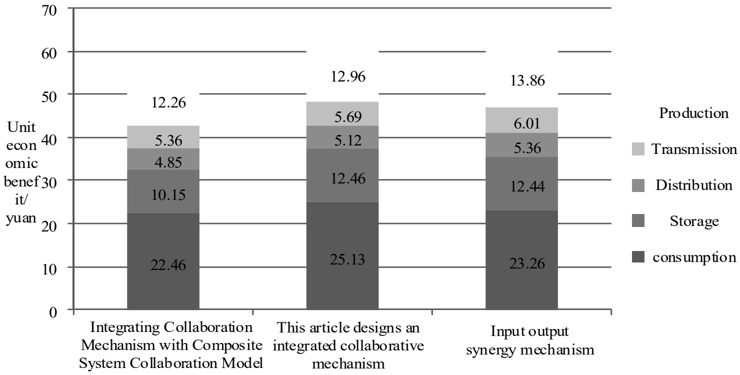

Fig. 2. Comparison of application effects of different integrated collaborative mechanisms

Combined with the test results shown in Figure 2, the synergy effect of enterprise architecture integration in power grid industry from the perspective of value stream designed in this paper is the most significant for improving economic benefits and has a good practical application value.

4 Conclusion

This paper puts forward the research on the integrated synergy effect of enterprise architecture in power grid industry from the perspective of value stream. Based on the construction of enterprise architecture model in power grid industry, the construction of integrated synergy mechanism is transformed into the optimization of basic composition and relationship in enterprise architecture model in power grid industry, and the integrated synergy mechanism of enterprise architecture in power grid industry is realized from four aspects: business architecture, data architecture, application architecture and technical architecture, which greatly improves the economic benefits of enterprise value stream under the same operating state. With the help of the design and research of this paper, it is expected to provide valuable reference for the actual enterprise architecture design and optimization of power grid industry.

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