



Exploring Innovative Models for Digital Transformation Management Mechanisms in Power Grids Under Enterprise Architecture Frameworks

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SUMMARY: *Digital transformation is a key hallmark of enterprises' high-quality development, where finance plays a leading role. As the core of financial management, the treasury system is of great significance for driving enterprises' digital transformation, realizing financial intellectualization and empowering high-quality development. Based on the enterprise architecture framework, this paper constructs a digital transformation management framework for power grid enterprises that is built around the treasury system. Research findings show that over 70% of respondents recognize the positive effect of digital transformation of power grid enterprises on improving revenue, and the comprehensive score of power grid enterprise architecture governance reaches 1.095 points. Therefore, innovating the digital transformation management mechanism of power grids by relying on the enterprise architecture framework can enhance the core competitiveness of enterprises and lay a solid foundation for improving new productive forces.*

KEYWORDS: *Digital transformation, Treasury system, Power grid enterprises, Enterprise architecture*

1 Introduction

An enterprise architecture framework is the core of enterprise architecture management, which provides a conceptual architecture between various levels within an organization, including organizational structure, business processes, information systems, data, and technology architecture, in order to facilitate coordination and unification between different departments within an enterprise [1-3]. It can help business managers and technologists to think about and run the enterprise from both macro and micro perspectives to achieve corporate goals and strategies [4, 5]. The realization and application of enterprise architecture framework can optimize the management and operation of the enterprise, improve the efficiency and flexibility of the enterprise, reduce the cost of change, and create good business competitiveness for the enterprise, and it is also an important theoretical support for the digital transformation of the enterprise [6-8].

With the rapid development of digital technology, digital transformation has been transformed from a strategic choice of enterprises to a necessity for survival, and has become a key engine to drive the sustainable development of enterprises and reshape their core competitiveness [9, 10]. In this wave of transformation, digital technology deeply penetrates into all aspects of enterprise operation and management, triggering disruptive changes in organizational structure, production mode, employment mode, etc., and promoting a comprehensive innovation of the production body, management style, production process, and

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production relations, so that the organizational structure presents significant centralized and disintermediated characteristics, and promotes the upgrading of enterprise efficiency [11-14]. As an important infrastructure related to national economy and people's livelihood, power grid enterprises are facing unprecedented opportunities and challenges. On the one hand, the continuous emergence of advanced technologies such as smart grid, big data, cloud computing, and Internet of Things (IoT) has brought revolutionary changes to the operation and management of grid enterprises, user services, and energy utilization; on the other hand, with the gradual liberalization of the electricity market and the large-scale access to new energy sources, grid enterprises need a more flexible, efficient, and intelligent operation mode to cope with the complexity and uncertainty of the market [15-18]. In this context, digital transformation management practices have become an important path for the transformation and upgrading of power grid enterprises.

However, the current digital transformation management of power grid enterprises faces three major problems. After years of development, the grid enterprise has built a large number of information systems in each specialty, due to the lack of global thinking and top-level design at the beginning of the construction, resulting in the information systems are independent of each other, the data standard is not uniform, data sharing is difficult, which is not conducive to a comprehensive and timely grasp of the business operations, timely warning, disposal of the problem of dissimilarity [19-22]. At the same time, the complexity, uniqueness or proprietary nature of the knowledge and skills of each professional department makes the communication and cooperation between the professions more difficult, and the professional barriers are serious [23, 24]. In addition, power grid enterprises have more redundancy in the organizational staff structure, cumbersome and complex work processes, and numerous approval links, which lead to low management efficiency [25]. These problems seriously constrain the high-quality development of power grid enterprises, and there is an urgent need to optimize the top-level design, under the enterprise architecture model, fully apply the information construction results in the power grid data, the entire professional data resources, to build the whole business, the whole link, the whole process, and the whole data online intelligent analysis management system, and to drive the change of the management mode and management process [26-29]. Therefore, this paper takes the enterprise architecture framework as the core theoretical and analytical basis, focuses on the digital and intelligent transformation needs of power grid enterprises, centers on the treasury system—the core component of corporate financial management—and constructs a digital transformation management framework suitable for power grid enterprises. In this process, practical cases and quantitative evaluation methods are adopted to conduct verification and analysis, which demonstrates the feasibility and value of innovating the digital transformation management mechanism of power grids by relying on the enterprise architecture framework, thus providing methodological support for enhancing the core competitiveness of power grid enterprises and improving their new productive forces.

2 Basic Theory

2.1 Meta-model of the Enterprise Architecture Framework

2.1.1 Enterprise architecture methodology

Enterprises can better undertake strategies through enterprise architecture, implement them into specific businesses through business architecture, and conduct them from the business side to the technology side, realizing the deep integration of business and technology, which helps to achieve corporate goals. It can be seen that enterprise architecture provides an important

guarantee for the consistency of IT and business goals, promotes business development and maximization of benefits, rational use of IT resources, and promotes the continuous adaptation of IT investment and business change, which is an important part of the construction of a modern IT governance system. At the same time, returning to the essential connotation of digital transformation, enterprise architecture has a key driving role in digital transformation, so it is an effective tool for digital transformation, a means not an end [30].

The core purpose of grid enterprise management digital transformation is to solve the problems in the implementation of enterprise strategy in order to reach the strategic goals. The use of enterprise architecture has two key points, one is to give full play to the role of enterprise architecture as a bridge for the implementation of strategy on the ground, aligning strategic objectives, analyzing business pain points, giving full play to the role of IT technology and data elements, optimizing and reshaping the business model, business processes, etc., to ensure that the direction of “doing the right thing”. Secondly, on this basis, the optimized business will be realized and operated through IT technology, following the principle of architecture control, avoiding repeated investment and construction, and ensuring “doing the right thing” when landing. Instead of taking the responsibilities of administrative organizations as the boundaries of system construction in the past, we take the enterprise architecture as the blueprint, set initiatives, boundaries and responsibilities through the enterprise architecture, define the corresponding organizations, roles and capabilities around the business processes, and adhere to one blueprint to the end.

2.1.2 Enterprise Architecture Metamodel

Enterprise is a whole, to jointly realize the development mode of high quality, high efficiency and high benefit, enterprise resources need to get the global synergy, so the enterprise should be viewed as a whole object for modeling, all the elements of the enterprise are part of the enterprise model, including every employee, every business, every process, every decision-making mechanism, through which the original model changes the original one unit for a certain business to buy a platform software to run independently. This model has changed the original mode of a unit purchasing a platform software to run independently for a certain business. Enterprise architecture meta-model is the use of systems engineering concepts and methods to study and deduce the relevant elements in a whole, forming the digital twin of the enterprise, and its specific framework is shown in Figure 1. The enterprise architecture meta-model helps the overall program design of digital transformation, provides methods for solving the problems of “silos” and duplicated construction, provides a solid public foundation for business operation, and realizes the requirements of business-finance integration, one plan, full-level management, unique data source, and centralized deployment [31].

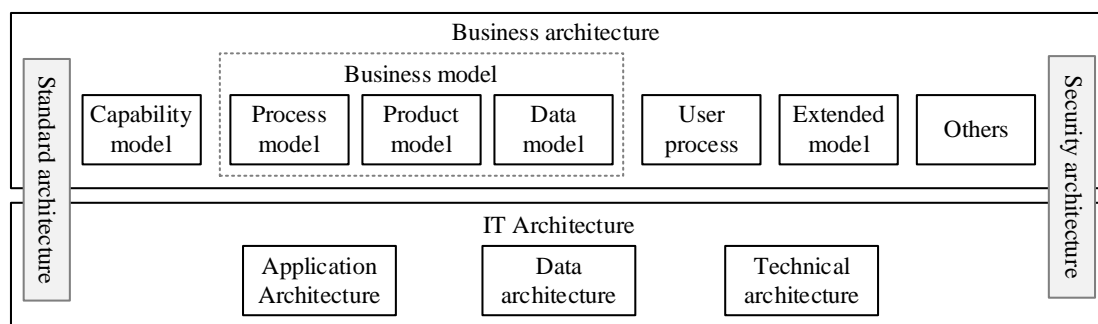


Figure 1: Enterprise architecture framework metamorphic model

The main roles of the enterprise architecture framework are as follows:

(1) Clarifying the architectural vision and defining the scope of architectural activities is an important guide for enterprise architecture work. First of all, it should be clear what work is being modeled to accomplish. Then, in-depth research and analysis of the overall needs of the group should be conducted, on the basis of which the requirements are accurately defined in professional terms.

(2) Tailor the enterprise architecture framework around incremental business value requirements to maximize enterprise value.

(3) Based on capability planning, carry out capability modeling to enhance the efficiency and effectiveness of business output.

(4) Based on business modeling methodology, build business models to drive enterprise architecture transformation.

2.2 Framework for digital management of the grid

2.2.1 Framework of the management model

In order to innovate the digital management mode of power grid enterprises, this paper takes the enterprise architecture framework as the basis, and constructs the digital management scheme of power grid enterprises as shown in Figure 2 from the difficult point of architecture design of power grid enterprises. The framework realizes the disassembly, refinement and landing of enterprise strategy from a global perspective, realizes multi-dimensional all-round linkage from business points, lines and surfaces, takes enterprise architecture as the key carrier for strategy landing, unifies language specifications and standards, strengthens the synergistic fusion of business and digital technology, empowers the enterprise to continuously respond to changes, realizes the adaptation of business and strategy, information technology and business, and promotes the digital transformation to push forward to the vertical and deep.

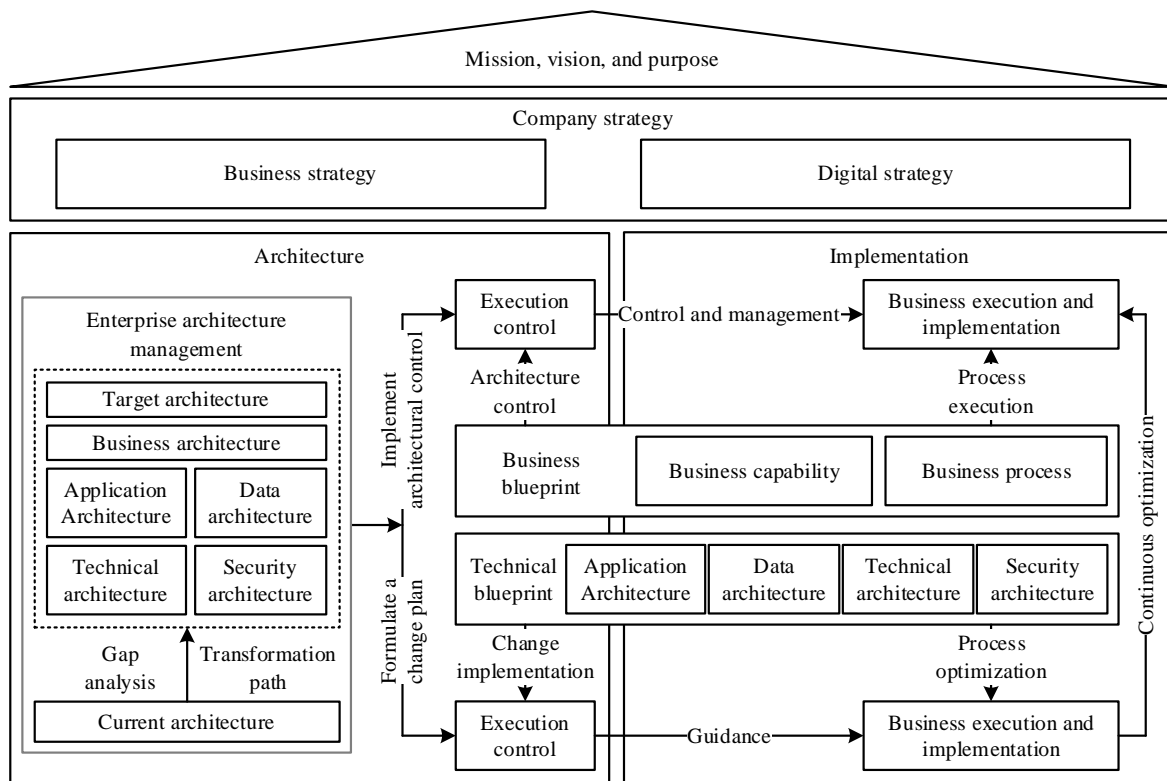


Figure 2: The framework for digital management of power grids

(1) Unified information description language. The enterprise architecture serves as a link between business and IT, and describes five types of information related to digital transformation, namely, business, application, data, technology, and security, in a unified and structured language, which helps the management layer, executive layer, and other stakeholders to obtain and understand the relevant information in a clear and complete manner, so as to support the implementation of the strategy from the top down and promote the digital transformation of business.

(2) Realize industry-technology linked governance. Design based on enterprise architecture can highly integrate business and technology in a unified language, realize digital design starting from business architecture, play a leading role in architecture, integrate key information of business and technology, and realize linked governance from business model, business requirements to application design, application development and deployment.

(3) Carry out R&D project development collaboration based on architecture design results. By docking and integrating the architecture results with the enterprise R&D platform, it facilitates the transformation of the architecture design results into project R&D goals and requirements. At the same time, the R&D platform provides real-time access to project R&D progress and feedback on architecture implementation results, so as to ensure that project requirements meet business requirements and project R&D meets IT architecture requirements, ensuring that digital transformation can follow architecture assets and truly play the role of architecture leadership.

2.2.2 SG-EA architecture controls

Architecture control is the management and control of the whole process and its effect of the overall architecture, system architecture and other objects at all levels of power grid enterprises. Architecture control aims to promote the institutionalization, standardization, structuring, modeling, refinement and automation of information technology construction. System architecture control is carried out by the company and its units, the information technology architecture management office of R&D units and third-party testing organizations, through conducting architecture reviews, technical decision reviews and system architecture compliance checks in the life cycle of information technology projects in the areas of requirements development, outline design and system on-line, so as to ensure the standardization and normalization of company-wide system construction. System architecture control includes:

(1) System architecture compliance. The system architecture should comply with the overall architecture design assets and the annual architecture evolution route, and accordingly organize and carry out architecture reviews.

(2) System architecture review. In the feasibility study phase, proof-of-concept work is carried out based on the overall technical architecture, and the architecture management organization reviews the solution. In the design phase, the R&D unit carries out architecture design and submits the architecture design results to the architecture management organization, which is responsible for organizing the pre-review and formal review of the system architecture design. In the on-line phase, a third-party testing organization is commissioned to carry out system architecture compliance checking.

2.3 Digital treasury system

Treasury management can be understood as the "chief steward" of central SOEs, taking charge of their capital. Introduced to China in the 1990s, it vividly draws on the concepts of the imperial treasury and state treasury dating back to the Sui and Tang dynasties, which is indeed an apt and vivid analogy. The implication of treasury management is defined in Document No. 1 of

the Opinions issued by the State-owned Assets Supervision and Administration Commission (SASAC): "The treasury management system is a modern corporate governance mechanism adopted by enterprise groups. By relying on management platforms such as financial companies and capital centers, and applying modern network information technologies, it focuses on the centralization of capital and information, aims to improve capital operation efficiency, reduce capital costs and prevent and control capital risks, and conducts real-time monitoring as well as overall allocation and scheduling of financial resources such as capital within the enterprises.". From the above definition, the policy places strong emphasis on the treasury management system as an integral part of modern corporate governance mechanisms. It is no longer merely a standalone capital management process; instead, based on dedicated platforms and supported by modern technologies, it focuses on the capital and information of enterprises, and conducts monitoring as well as overall allocation and scheduling of financial resources to serve corporate strategies, business operations and value creation.

Against the backdrop of digital transformation, treasury management is in urgent need of transitioning from the traditional single-dimensional capital management model to a comprehensive strategic management system. Digital treasury management is a capital management method that takes strategic guidance and value innovation as its core. By relying on financial shared service centers and a sound treasury system architecture, it deeply integrates digital tools and technologies, reconstructs financial management processes, and achieves integrated information management and intensive operation of financial resources. Its objectives are to reduce capital costs, improve capital efficiency, enhance decision-making capabilities, support the development of core businesses, and establish a risk prevention and control system. Ultimately, it realizes dynamic allocation and real-time monitoring of the group's financial resources, and builds an all-round capital control mechanism. The construction of a digital treasury management system constitutes an important component of an enterprise's digital transformation.

3 Construction of an innovative model for grid digitalization management based on enterprise architecture

3.1 Design principles and logic

3.1.1 Top-level Design

Based on the analysis of different phases in the construction of a treasury management system, when conducting the top-level design of such a system, an enterprise must make continuous positioning and updating decisions on its objectives according to its external political, economic and information technology environment, the industrial and sectoral ecosystem it is in, as well as its own business development phase, existing capital operation mode, management level and corporate strategy.

Document No. 1 issued by SASAC first requires enterprises to scientifically categorize and define their development objectives based on different stages. For start-ups or enterprises that have not yet initiated the construction of a treasury management system, they should start with formulating construction plans, revising management systems and establishing management mechanisms. Their objective is to achieve dynamic aggregation and penetrative monitoring of bank account information and capital flows of domestic affiliates, which is exactly the goal to be fulfilled by a cash flow-oriented treasury.

For enterprises in the development stage or those with an existing foundation for treasury development, they need to further refine the treasury management systems and mechanisms.

On the basis of fully standardizing and streamlining such functions as account management, capital pooling, financing and investment, capital budgeting and settlement, they shall aim to improve the management of capital and financial resources, strengthen the integration of business and finance, apply financial instruments in an integrated manner, efficiently manage working capital, and expand advanced services such as intelligent risk early warning and supply chain finance. This is the goal corresponding to a standardized and integrated treasury.

For enterprises in the mature stage or those with a well-established treasury management system, they should gradually shift their objectives toward leveraging the data resources generated by the interconnection between the treasury system and other peripheral systems. They need to build a data warehouse featuring unified standards, clear data sources and standardized data access. By relying on intelligent digital technologies, they shall deeply tap into data potential, improve the efficiency and effectiveness of management, operations and services, and provide robust support for strategic development, operational analysis and risk prevention and control. This is the goal to be achieved by a digital and strategic treasury.

As a systematic project, the construction of a treasury management system involves not only the financial line of an enterprise, but also multiple stakeholders including the business line and information technology development line. Given its wide coverage and considerable construction difficulty, both the recommendations of regulatory authorities on treasury system development and the construction practices of various enterprise groups have defined it as a top-priority initiative led by the top management. A working mechanism featuring "leadership oversight by senior executives, inter-departmental collaboration, internal-external coordination, and vertical alignment across all levels" has been established, forming an integrated organizational structure consisting of the decision-making and management level, service support level, and business operation level. Among these, the group headquarters usually sits at the decision-making and management level, formulating guidelines and policies for treasury system construction, and taking full responsibility for the implementation of capital strategies as well as decision-making on related capital operations and risk management.

3.1.2 Support System

The construction of a digital treasury management system must rely on cutting-edge information technologies to build a treasury management platform and realize the implementation and application of various functional modules. Therefore, information technology plays a pivotal role in the process of treasury system development. First of all, at the stage of formulating a treasury system construction plan, enterprises shall, in light of their own business needs, scientifically formulate short-term and long-term development plans from the perspectives of product architecture, business architecture, system architecture, data architecture and security architecture. These plans should fully support the existing full range of business categories while reserving sufficient room for future expansion. Enterprises need to integrate and consolidate existing systems such as capital management systems to achieve centralized business processing and integrated data sharing. Meanwhile, they shall connect with financial institutions such as banks and regulatory systems as needed to realize full-process information monitoring, full-tier penetrative supervision and all-round information interaction.

Meanwhile, in an era swept by the global wave of digitalization, enterprises should step up the innovative application of modern information technologies such as big data, cloud computing and artificial intelligence in the process of treasury system construction, so as to enhance the compatibility, adaptability and scalability of the system. The requirements for security and confidentiality shall be implemented throughout the entire process of planning, design, construction, implementation, operation and maintenance of the treasury information system. Enterprises should ensure centralized system deployment, hierarchical application,

internal and external network isolation, centralized data storage and off-site disaster recovery management. At the same time, they need to strengthen the security management of data assets and take necessary protective measures for data collection, storage, processing, utilization and other related activities.

3.1.3 Business Platform Construction

As a comprehensive platform supporting the efficient operation of an enterprise's capital and financial resources, the construction of a treasury platform shall first and foremost satisfy the needs of business support. In accordance with the requirements specified in Document No. 1 of SASAC on effectively strengthening the management of capital and other financial resources, the platform's functions are divided into eleven major categories, which are in sequence as follows: unified management of bank accounts, centralized management of group capital, budget-constrained management of capital, stringent management of debt financing, standardized management of capital settlement, efficient management of bill usage, management of receivables collection, management of loans and financing guarantees, capital management of overseas enterprises, management of supply chain financial services, and management of strategic decision support.

In addition, this paper argues that the function of external institution relationship management should also be incorporated into the business support process, so as to establish a comprehensive rating system for external institutions and assist enterprises in better conducting investment and financing businesses. The construction of the above functional modules covers multiple aspects such as cash flow, working capital, integration of business and finance, financial empowerment and data empowerment. This enables the integration of capital flow, business flow and information flow on the treasury management platform, and ultimately provides efficient support for business operations.

3.2 Optimization of digitalized management processes

After analyzing the existing problems in the current digital transformation management mechanism of the power grid company, the main issues lie in the incomplete overall management process of digital projects, inadequate project demand management, and low professionalization level of project testing management. Based on this, an optimization plan will be formulated and the following goals will be achieved through the implementation of optimization measures.

(1) Lean global account management

As a crucial component of fund management, account management plays an indispensable role and serves as the foundation for ensuring the security and efficient operation of corporate funds. With the advancement of the globalized operation of power enterprises, it has become particularly important to establish a refined global account management system that runs through all links of fund business, strengthen the dynamic monitoring of account information and risk control, and enhance the transparency and controllability of capital flows. Digital treasury builds an efficient global account structure through the design of standardized account management, streamlined account system, unified account processes, monitoring reports, assessment and supervision, etc. It realizes the management of account control rules, account opening, modification and cancellation procedures, and account standardization, ensuring that account information is accurate, standardized, complete and visualizable.

(2) Intelligent and secure green settlement management

As a high-frequency scenario in the construction of an enterprise treasury, capital settlement has a direct bearing on the overall effectiveness of fund management. In building the digital treasury management system for a power grid group, full use should be made of digital and

intelligent technologies to optimize capital settlement methods, standardize capital settlement processes, and prevent and control capital settlement risks.

(3) Efficient bill management

As an important means of payment and short-term financing for group enterprises, commercial bills are widely used within them, and the efficient operation of bill utilization is particularly crucial for enterprises. The digital treasury provides digital and intelligent capabilities such as automatic bill acceptance, automatic bill rejection, bill plan control, bill quota management, intelligent settlement bill matching, and bill maturity early warning, delivering smarter and more efficient services for enterprises' capital settlement and bill operation.

(4) Efficient centralized fund management

Efficient centralized fund management is a key link for enterprises to improve overall financial operation efficiency and optimize resource allocation. By intelligently configuring centralized fund management strategies, enterprises can enhance fund management efficiency and reduce fund operation risks. Through the formulation of flexible and diversified strategies for fund collection, allocation and transfer, a hybrid fund pool system integrating both physical and notional pools is established, which enables the efficient integration and precise allocation of funds across the entire group.

(5) Capital budget management with the integration of four flows

Capital budget management is the core means to achieve the efficient allocation of financial resources. Driven by the planning and control at the source of business, it takes business as the starting point and corporate operation objectives as the main thread, supporting the closed-loop management of capital plan formulation, submission, consolidation, balancing, decomposition, issuance and execution analysis for all levels of the group.

(6) Rigorous overall management of debt financing

Corporate debt financing management is one of the core components of financial management. It effectively connects the capital operation strategy of modern enterprises with daily financial management, and serves as a key means to ensure stable fundraising, optimize capital structure and reduce financing costs for enterprises. Against the backdrop of a complex and volatile financial market environment, it provides strong financial support for the sound development of enterprises.

(7) Refined loan and guarantee management

Loans and guarantees are key focus areas of business for group enterprises, as they effectively link corporate capital operation with daily financial management. Refined management of loans and guarantees serves as an important measure for enterprises to achieve optimal allocation of internal capital, reduce financing costs, and strictly control off-balance-sheet liabilities. Sound management of internal loan and guarantee businesses can effectively mobilize internal resources of the group and facilitate the steady operation and healthy development of enterprises.

(8) Full-process predictive risk management

Risk management is a core topic of treasury management. The philosophy of strict risk control has been embedded in all aspects of treasury management, evolving from the initial passive risk control to the current proactive identification and prevention, as well as ex-post evaluation and analysis and behavior management. Meanwhile, the introduction of advanced technologies has also brought new ideas to risk management.

3.3 Innovative management model based on the treasury system

Based on the preceding optimization analysis of the digital transformation of power grid enterprises by virtue of the digital treasury system, and for the purpose of establishing a digital

management platform for power grid enterprises, this paper adopts the construction principle of "multi-scenario and micro-application" to develop a digital financial management model that is based on the treasury system and integrates intelligent technologies such as machine learning algorithms. The specific framework is shown in Figure 3. This model enables the automation of information flow, the efficiency and convenience of process handling, the comprehensive compliance of processing methods, and the high efficiency and accuracy of business outcomes for power grid enterprises. It helps managers reduce manual operations, mitigate human-induced risks, and improve operational efficiency. In this way, they are freed from simple and mechanical repetitive work and transformed into high-value management tasks.

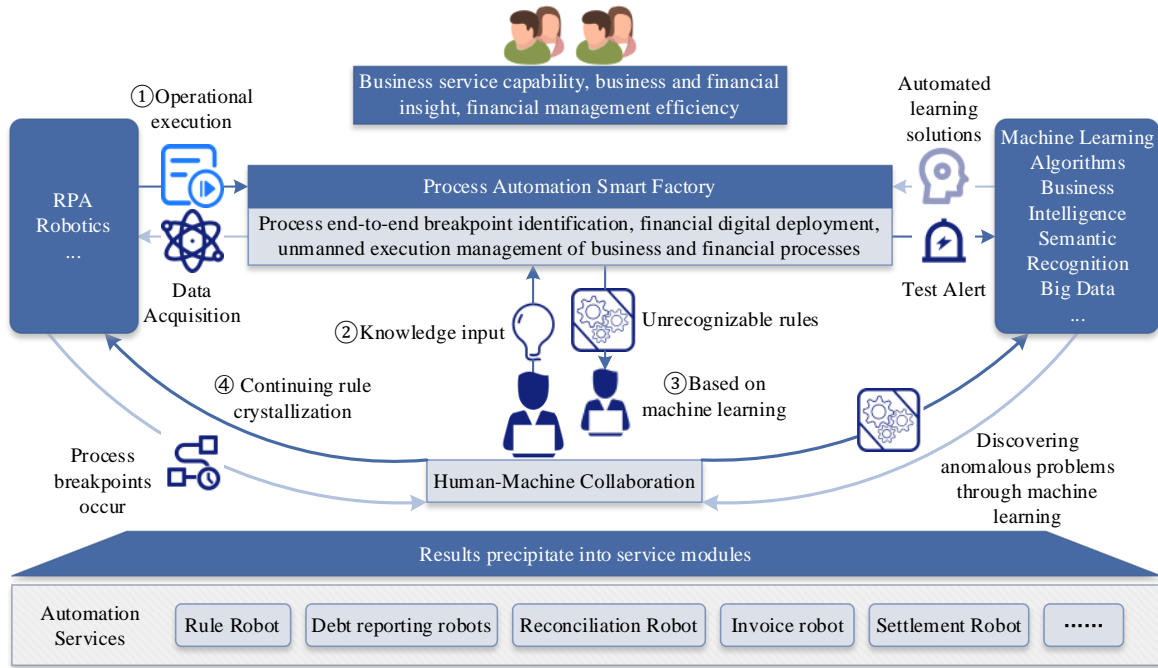


Figure 3: Digital operation mode of financial management

Based on the process automation intelligent factory of “professional ability + technical resources”, the input is fully structured and labeled data, including accounting documents, invoices, documents, contracts, and other input information through the direct extraction of data, image capture, natural semantic recognition and other technologies to form a highly structured label. Using treasury system features with machine learning algorithms, semantic recognition, big data and other intelligent technologies, software robots are constructed to form virtual employees, transforming the rules of thumb that previously relied on manual processing. Form automated processing rules based on data labels through expert analysis or machine learning methods. Construct an intelligent financial operation model that emphasizes technology and is light on human resources, accelerate intelligent real-time collection, online dynamic aggregation, and agile intelligent perception, and realize end-to-end process automation and operation intelligence.

3.4 Framework construction of the grid fund management system

3.4.1 Classification of capital business

In the fund management system framework constructed based on the digital Treasury system in this paper, the first-level business domain includes fund strategic management, fund operation management and fund execution management. The specific second-level business classification

is as follows :+ In the fund management system framework constructed based on the digital Treasury system in this paper, the first-level business domain includes fund strategic management, fund operation management and fund execution management The secondary business classification of the body is as follows :

(1) Capital strategic management, including capital planning and budget and capital risk management two secondary businesses. Among them, capital planning and budget are used to coordinate financial resources and ensure the implementation of strategies. Capital risk management, used to identify, evaluate and respond to capital risks.

(2) Fund operation and management, including three secondary businesses: fund settlement management, fund scheduling management and fund accounting management.

(3) Fund execution management, including three secondary businesses: fund payment management, fund monitoring management and fund analysis management.

The design of fund management organizational structure is the basis to achieve the goal of fund management and ensure the full implementation of fund management mode. The organizational structure design of fund management should start from the actual situation of power grid enterprises, and combine the objectives and modes of fund management. At present, China's power grid enterprises have many subsidiaries, involving a wide range of regions, and complex levels, so it is difficult to carry out large-scale and thorough organizational structure reform.

3.4.2 Organizational structure design

The Treasury management center is established in the headquarters of power grid enterprises, and the Treasury management platform is built on the basis of the original financial management mode, which is mainly divided into decision-making layer, operation layer and executive layer.

(1) Decision-making level

The decision-making level is the Treasury management center set up in the group headquarters. The Treasury Management Center is established at the group level, managed by the Group Fund Management Committee and guided by the Strategy Committee to comprehensively coordinate the group's fund management and is the decision-making center of the Treasury management platform. Its specific responsibilities are to formulate fund management strategies and internal fund allocation methods of the Group in combination with the group's strategies under the dual leadership of the Fund Management Committee and the Strategic Steering Committee; To coordinate the financial resources of the Group in all aspects; To control the strategic orientation of capital management and ensure the strategic support of capital management; Submit strategic amendments and promotion plans to the Group based on available information.

(2) Execution service layer

The execution service layer is the core of the capital management system. It is responsible for implementing the resolutions and deployment of the Treasury management center, leading the capital settlement centers at all levels and guiding the subordinate functional departments to carry out specific work. Specifically responsible for the construction of super capital pool of the Group; Account establishment and management; Highly collect group funds; Scientific allocation of internal funds of the Group; Summarize the annual fund management situation and report to the Treasury management center; Improve fund supply capacity according to the guidance of Treasury management center; Optimize the fund management process to improve work efficiency; Preventing capital risks; Organize business training and build talent team.

(3) Business operation layer

The business operation layer is the capital settlement center at all levels distributed in

various parts of the enterprise, mainly responsible for the account management of local member units; Report the capital plan of member units; Responsible for revenue and expenditure operation; Report to the member unit's external payment request; Assist to complete group internal credit granting.

3.4.3 Application architecture system

This paper divides the fund management application of power grid enterprises into four modules, including fund planning management, fund settlement management, fund scheduling management and fund monitoring and analysis. Fund plan management is mainly responsible for fund demand prediction, plan preparation and budget implementation monitoring; Fund settlement management undertake account management, receipt and payment processing and bank-enterprise docking; Capital scheduling management covers capital financing, investment and capital pool management; Capital monitoring and analysis is responsible for capital monitoring, risk warning and analysis and decision.

(1) The fund plan management module includes the fund demand prediction function, annual fund plan preparation function, monthly fund plan adjustment function, budget execution monitoring function and budget adjustment approval function. Together, these functions support the whole process management of the preparation, implementation and adjustment of capital plans.

(2) The fund settlement management module includes account management function, receipt and payment business processing function, bank-enterprise docking function, account reconciliation management function and bill management function, realizing automatic processing of fund receipt and payment settlement.

(3) The fund scheduling management module provides the fund position prediction function, financing business management function, investment business management function and fund allocation function to ensure efficient scheduling and optimal allocation of funds.

(4) The fund monitoring and analysis module provides the function of fund operation analysis, fund cost analysis, fund benefit evaluation and decision support report generation, providing data support for fund management decisions.

4 Case studies and pattern validation

4.1 Case study of N Grid Company

N Power Grid Co., Ltd. is a large state-owned enterprise affiliated to the SASAC. Its core responsibilities cover capital investment, construction and operation of power grids in five provinces and autonomous regions, namely Guangdong, Yunnan, Hainan, Guangxi and Guizhou. The company not only ensures the power demand of the above-mentioned five provinces, but also plays an important role in delivering cross-regional power to Hong Kong and Macao. The core business of N Power Grid involves electricity purchase and sale activities among all provinces in the southern region, and it is committed to regulating the operation and balance of the power market. The company has approximately 300,000 employees. Following the organizational structure adjustment, it has 21 relevant departments and 1 directly affiliated institution (Power Dispatching and Control Center). In addition, N Power Grid has established 7 regulated business units, 4 emerging business units and 11 shared platforms.

The large-scale power grid and massive user base have long been a major challenge to the operation and management of the power grid company. A full-dimensional, all-round and full-link digital transformation of the entire operation and production process will serve as an important means to improve its operational efficiency and cost control capability. Starting from

2019, N Power Grid has explicitly put forward requirements for digital development, identified digitalization as a key development strategy of the company, clarified the direction of digital transformation, and launched the construction of digital projects.

In 2022, the SASAC issued Document No. 1, vigorously promoting the construction of treasury management systems. Based on a robust enterprise-level middle platform, N Power Grid Co., Ltd. supports the horizontal collaboration and vertical integration of data, which effectively ensures the efficient operation of treasury management businesses and resolves the challenges of inter-system collaboration and information sharing. Empowered by the middle platform, the company has facilitated the efficient development of core scenarios for smart treasury management, including accounts receivable and payable management (contract execution analysis), SASAC treasury monitoring and reporting, fictitious trade risk monitoring, and unified key information management of counterparties. It has built an ecosystem where business and financial data are fully integrated, further improving the refinement, intensification, and intelligence of financial management. This helps transform treasury management from ex-post control to ex-ante control, and from passive management to actively creating value and providing strategic decision support, thus laying a solid middle platform foundation for the company's digital innovation.

4.2 Application Introduction

The enterprise-level middle platform of N Company is driven by enterprise architecture. Centering on various enterprise resources and capabilities, it provides global sharing both internally and externally in the form of services, achieving a unified data model, service reuse and data integration. By fully integrating the master data across the entire network, it provides capability support from multiple dimensions including business, customers, operations and processes, accumulates the core service assets of the enterprise, and has established 16 business centers such as the Project Center, Equipment Center, Contract Center and Supplier Center. It supports the unified management of the company's core business objects, including over 3.2 million projects, 210 million pieces of equipment and 3.15 million contracts, realizing the data principle of "single source, multi-scenario reuse". This supports the horizontal collaboration and vertical integration of data, and effectively guarantees the efficient operation of treasury business.

(1) Application 1: Full convergence of business and financial data effectively resolves data silos

In the past, accounts receivable and payable were confined to financial accounting management, resulting in information silos between business and financial data. Management standards for information such as contracts, projects and suppliers were inconsistent, and there was a lack of source governance and centralized responsibility management mechanisms.

Based on the data aggregation and sharing service capabilities of the middle platform, by unifying the data models of contracts, projects, suppliers and finance, the full convergence of business and financial data related to accounts receivable and payable is realized. This ensures that cross-domain processes such as project payment and material payment in the asset domain and the planning & finance domain share the same master data information carrier, breaking through the internal financial cycle and breaking down the boundaries between business and financial data. Ultimately, it achieves full-process traceability for project completion final accounts and risk early warning and prevention for the aging risks of accounts receivable and payable.

(2) Application 2: Improve the risk prevention and control mechanism for accounts receivable and payable to enhance risk prevention capability

In the past, risk prevention for accounts receivable and payable was incomplete, and

indicators failed to fully monitor risk events at the project, contract and supplier levels. By leveraging the enterprise-level data middle platform to aggregate full-process business data from business domains—including project payment, material payment, material warehousing and outbound, electronic handover, electricity sales and purchase in marketing, financial budget and capital—a risk analysis indicator system is established through the platform’s data factory and data mart. The rule engine is then used to configure and operate risk rules for pre-event, in-event and post-event risks, thereby improving the risk prevention and control mechanism. This drives comprehensive risk prevention and control from multiple perspectives such as accounts, account aging, counterparties and contracts, and achieves the goal of early risk detection, early warning and early resolution.

(3) Application 3: support intelligent early warning and prevention of fictitious trade risks in treasury management

By leveraging the risk prevention and control rule pool, a dedicated monitoring function targeting fictitious trade risks is established to build an intelligent early warning system. Through the rule model library of the middle platform’s rule engine, 17 categories of risk control models are configured, including fictitious trade identification, affiliated operation identification, and electricity fee fraud identification. A rule library covering more than 500 business and financial indicators as well as 71 risk items under 6 categories is developed, with three risk disposal methods configured—interception, early warning and notification. This system has successfully identified approximately 50,000 abnormal accounts, assisted public security authorities in the joint investigation of nearly 200 fraud cases, effectively deterred and cracked down on the dark and gray industry chain of electricity fee fraud, and provided robust protection against fund fraud risks, compliance risks, liquidity risks and financial market risks.

The smart treasury system is built on a middle platform technology architecture. Internally, it achieves interconnection and interoperability with multiple business systems including the asset domain, human resource domain and marketing domain, connects the full-chain data of business, finance and capital, and forms an *internal data ecosystem*. Externally, it links with a number of institutions such as governments, banks and tax authorities to create an *external data ecosystem*. It provides cutting-edge digital services such as panoramic overview, trend prediction and intelligent early warning of business performance, helping to enhance the company’s decision-making analysis and risk prevention and control capabilities.

The smart treasury system has cumulatively invoked more than 500 middle platform shared services. Through the collaborative and shared management of master data by the middle platform, it has effectively supported the construction of a smart treasury system featuring integration of business and finance, transparency of business and financial data, and precision of business analysis, contributing middle platform capabilities to accelerating the development of a first-class financial management system.

4.3 Pattern validation

This paper takes the Financial Shared Service Center of the power enterprise in Province N (a subsidiary of N Power Grid) as the research object, and conducts verification by relying on the digital management platform of N Power Grid based on the treasury system.

4.3.1 Expected benefits of digital transformation

In this paper, a survey was conducted to investigate the application effect of the digital transformation framework of N power grid enterprises, aiming to understand the expected benefits brought by the digital transformation framework by employees of a power grid enterprise. Designed questionnaires were mainly carried out from the six dimensions (QW1~QW6) of operation, product, organization, risk control, revenue, and service. The

questionnaire was designed using a five-point Likert scale, with 1~5 indicating strongly disapprove, disapprove, average, approve and strongly approve, respectively. A total of 450 questionnaires were distributed through the Questionnaire Star platform, and 427 questionnaires were validly recovered. The data obtained was organized to obtain the expected benefits brought by the digital transformation framework from the employees of power grid enterprises as shown in Figure 4. From the figure, it can be seen that more than 77% of the grid enterprise employees on the expected benefits brought by the digital transformation framework said that they recognized and very recognized, only 8.86% of the employees said that they did not recognize.

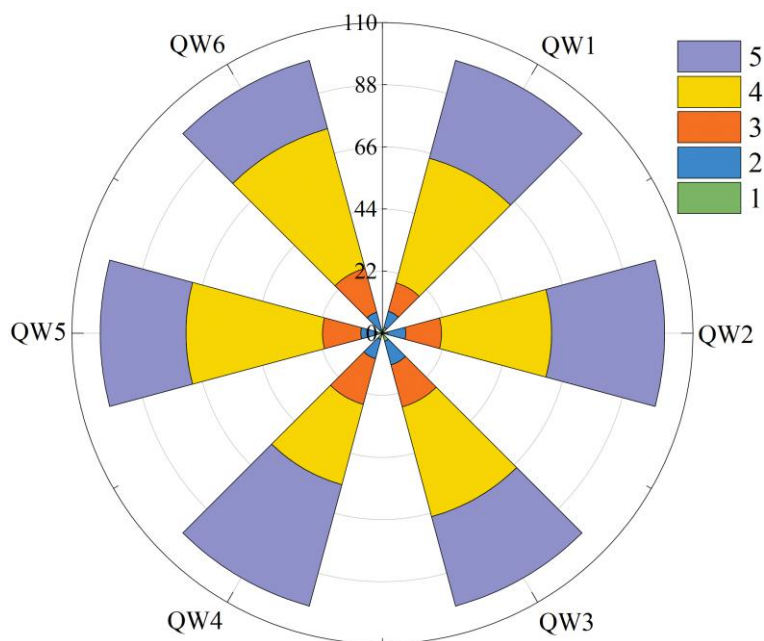


Figure 4: Expected benefits of digital transformation

The digital transformation management framework of grid enterprises designed based on the enterprise architecture framework can significantly improve the processing efficiency of grid enterprises in business processes, and the distribution network optimization scheduling model can further promote industrial innovation, accelerate the transformation of the industry and the upgrading of business models. And under the operation, distribution and dispatch through integration model, it can further simplify the business process, enhance the user service experience and the use of adhesion, and enhance the market response speed. The digital transformation management of power grid enterprises effectively improves the business standardization and risk control level of power grid enterprises, reduces the operational risk of power grid business, and to a certain extent, can optimize the organizational structure, laying a solid foundation for enhancing the skill level of personnel and business efficiency. Based on the results of the above analysis, it can be seen that relying on modern technical means can give the power grid enterprise digital transformation management efficiency, and then enhance the market competitiveness of the power grid enterprise.

4.3.2 Comprehensive assessment of architecture governance

The fundamental purpose of establishing a digital transformation management framework for grid enterprises is to enhance the architecture governance capability of grid enterprises, and the comprehensive assessment of architecture governance is mainly carried out from three domains, namely, architecture governance, enterprise architecture and informationization operation.

Among them, the informatization operation domain is the target domain, in which all the informatization phenomena that users can directly perceive are directly collected, such as the phenomena of scattered demand and slow technology. Enterprise Architecture Domain and Architecture Governance Domain are capability support domains, presenting the capability elements needed to solve the problems in the process of informatization operation.

On this basis, this paper selects three enterprises, Industrial and Commercial Bank of China (ICBC), Southern Power Grid (SG), and China Railway Construction (CIC), which are in urgent need of digital transformation, and assesses the effectiveness of their architecture governance, and the assessment mainly contains the dimensions of organization, system, process, tools, business, data, application, technology, planning, IT construction, operation cycle, and IT improvement (JG1~JG12) for Scoring, the scale is -2~2 points, i.e. very bad, bad, average, good, very good. A total of 20 experts in enterprise digital transformation are invited, and after five rounds of weighted assessment, the results of architecture governance assessment of different enterprises in enterprise digital transformation are obtained as shown in Figure 5. As can be seen from the figure, the mean value of the comprehensive architecture governance scores of Industrial and Commercial Bank of China (ICBC), Southern Power Grid (SG), and China Railway Construction (CIC) are 0.582, 1.095, and 0.285, respectively, which is comparatively better for Southern Power Grid in the process of digital transformation, while the architecture governance scores of the other two enterprises are generally low.

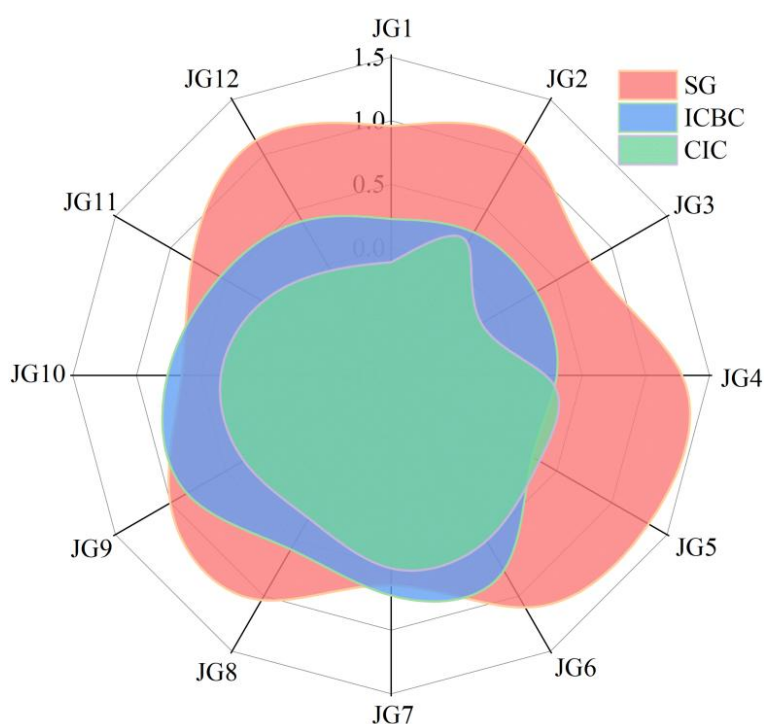


Figure 5: The results of the architecture governance assessment

This is due to the fact that Southern Power Grid relies on its enterprise architecture framework to actively carry out digital transformation and has formed a partially informal governance mechanism in the process of informatization construction, driven by daily business needs. In terms of governance organization, a partially informal architectural division of labor has been formed, laying a good foundation for the establishment of the formal architecture organization. In terms of systems and processes, although power grid enterprises have partially fragmented online and offline processes, as well as supporting management systems, they are still fragmented. It needs to be gradually refined and perfected as the architecture work is carried

out. In terms of tools, attempts have been made to build preliminary architecture governance tools, and then only to promote the digital transformation of power grid enterprises to improve management efficiency.

4.3.3 Analysis of management efficiency

Taking the efficiency of financial reimbursement as an example, after digital transformation is applied to improve the financial management of power enterprises, the improvement of financial reimbursement efficiency has become a top concern of the financial departments of power grid enterprises. The changes in the inter-departmental collaborative review time and fund disbursement time of power grid enterprises after the application of three methods are shown in Figure 6. In the figure, K1~K5 represent the approval of the person in charge, the approval of the chief financial officer, the audit of the audit office, the credit evaluation and the issuance of funds, respectively. As can be seen from the figure, the application of this paper's methodology in the integrated digital management of electric power enterprise finance has largely improved the efficiency of employee financial reimbursement, and it only takes about 5 working days to complete the optimal reimbursement process, which improves the efficiency of the reimbursement work of the enterprise finance department. Thus, relying on the digital management platform of electric power enterprises data sharing, can realize the optimization of the financial management process, and promote the transformation of the financial digital management of electric power enterprises.

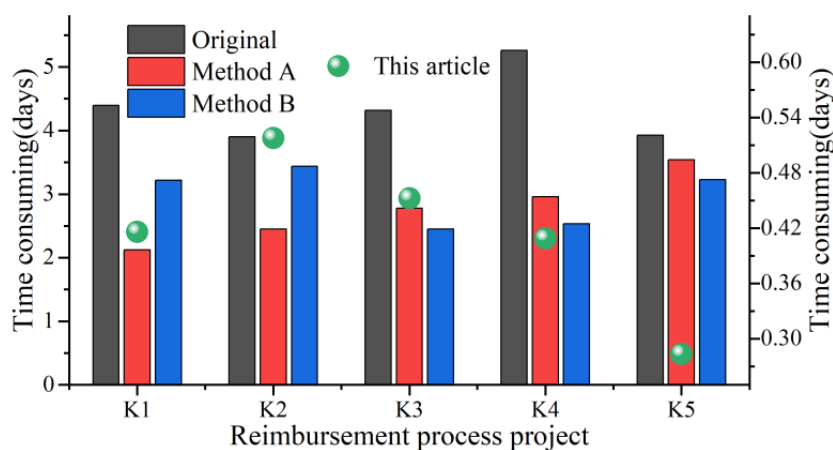


Figure 6: Results of financial reimbursement efficiency

5 Conclusion

Digital and intelligent transformation is an important symbol of the high-quality development of enterprises. In digital transformation, finance takes the lead, which endows financial work with new missions and tasks. As a core component of corporate financial management, the treasury system undertakes key responsibilities such as capital security, liquidity management and risk control. It also plays an irreplaceable role in driving corporate digital transformation, realizing the intellectualization of financial management and empowering high-quality development. Based on the enterprise architecture framework, this paper establishes a management framework for the digital transformation of power grids built on the treasury system. The research findings show that over 70% of respondents indicated that the digital transformation of power grid enterprises helps boost corporate revenue, and the comprehensive score of power grid enterprise architecture governance reached 1.095 points. Therefore,

carrying out the innovation of the digital transformation management mechanism of power grids by relying on the enterprise architecture framework will help enhance the core competitiveness of power grid enterprises and lay a solid foundation for improving their new productive forces.

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