Research on the Whole Life Cycle of Digital Construction of Power Grid Enterprises based on Product Concept

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Abstract. At present, the whole life cycle management stage of digital construction of power grid enterprises is generally set in one-way form, and the limitation of the control scope of power enterprises leads to the decline of the optimal ratio of life cycle management. Therefore, this paper puts forward the design and verification research on the whole life cycle of digital construction of power grid enterprises based on product concept. First, we can design the idea of life cycle management, adopt a multi-objective approach, break the restrictions on the control scope of electric power enterprises, establish a digital life cycle management stage of multi-objective enterprises, design a product concept life cycle management model based on this, and adopt a "demand library" to track and control and strengthen the practice of life cycle construction. The test results show that the final optimal ratio of life cycle management can reach above 16 for the 7 selected life cycle management test unit areas, which shows that with the assistance and support of product concepts, the currently designed life cycle practice management mode of digital construction of power grid enterprises is more flexible, changeable and effective, which can ensure the life cycle practice and effect of digital construction of power grid enterprises in different background environments and has practical application value.

Keywords: Product concept; Power grid enterprises; Digital construction; Whole life cycle; Digital platform; Power grid overlap;

1 Introduction

In the daily development of power grid enterprises, the construction of life cycle is very important and critical, which requires the overall management to be targeted and flexible [1] . At present, enterprises don't pay enough attention to this aspect, and some of them don't even rationally control the life cycle. This practice also leads to the slow development of enterprises, high correlation of built-in problems and lack of stability, which affects the subsequent development and transformation and upgrading [2] . In order to further promote the optimization and innovation of digital power grid enterprises, avoid the financial situation hindering the occurrence of enterprise operation problems, and build a life cycle [3] that fits the actual situation. In this part, the current and even future enterprise development plans are made mainly through the actual operation state of the enterprise, so as to control the cost of

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the enterprise and improve the staged economic benefits [4] . Although the initial life cycle construction method can achieve the expected enterprise processing tasks and objectives, its coverage is small and its impact is limited. For enterprises with great variability, the degree of control and the difficulty of scheduling are gradually improving [5] . Moreover, the current design of life cycle construction is not accurate, and it does not fit the practical needs of power grid enterprises, and eventually the development of initial digital enterprises appears uncontrollable defects. Therefore, this paper puts forward the analysis and research on the whole life cycle of digital construction of power grid enterprises based on product concept. The so-called product concept, in fact, is a kind of external packaging for the products currently sold. In the process, the image, state and efficacy of the products will be introduced. Integrating the product concept with the whole life cycle of digital construction of power grid enterprises can further expand the actual coverage of the whole life cycle, improve and optimize the digital construction structure from multiple angles, design a more flexible and changeable whole life cycle construction structure, and strengthen the practical effect of digital construction of power grid enterprises [6] . In addition, with the assistance and support of the product concept, compared with the traditional cycle form, the current designed life cycle structure is diversified and specific, with strong pertinence, and can be implemented in a multi-stage manner [7] . Different stages correspond to different digital construction structures, with the daily construction needs or goals of power grid enterprises as the guide, combined with the actual development of enterprises, and overall planning, so as to promote the healthy development of power grid enterprises [8] .

2 Design the whole life cycle construction method of digital product concept of power grid enterprises

2.1 Design life cycle management ideas

Generally, the whole life cycle management structure is built for each execution link of the enterprise in the design process [9] . After forming a complete and detailed idea, it is integrated with the daily management mechanism, and finally the expected enterprise management objectives are obtained [10] . In the specific implementation process, according to the current management status of power grid enterprises and regional differences, we can first formulate a basic management and control foundation, define the implementation objectives of the current digital life cycle, comprehensively control power dispatching, daily power generation, engineering project construction, operation and maintenance control, and design the initial management ideas of the whole life cycle in a vertical way [11] . As shown in Figure 1 below:

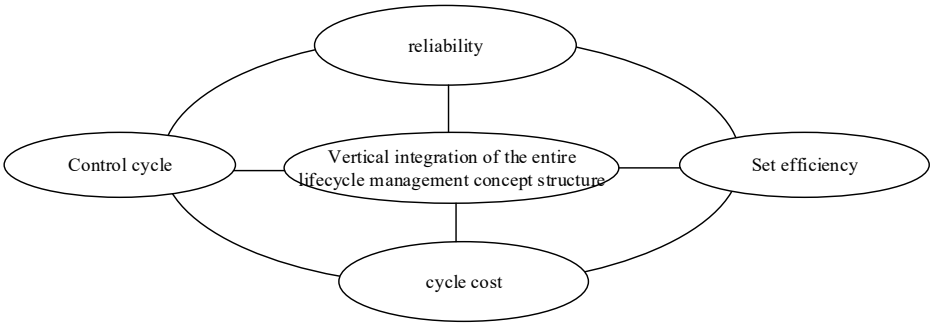

Fig. 1. Diagram of the idea structure of life cycle management.

According to Figure 1, the design and practical analysis of the structure of the whole life cycle management idea is completed. Next, based on the daily management and control requirements and standards of power grid enterprises, the comprehensive optimal links and standards are adjusted [12] . Due to the high variability of daily business of power grid enterprises, this time, it is necessary to add the management idea of "implementing step by step and reaching the standard in sections" [13] on the original basis. Step by step, establish a complete management process and system, realize the closed-loop control of the whole digital life cycle, and ensure the unity of management objectives [14] . However, it should be noted that the current life cycle management idea is not fixed, but can be adjusted with the actual operation status and development management needs of power grid enterprises, and it has strong stability and reliability [15] . It is convenient to coordinate the design of operation mechanism and create a good management environment .

2.2 The establishment of multi-objective enterprise digital life cycle management stage

The traditional life cycle management stage of power grid enterprises is generally set in the form of independent management and control, which can achieve the expected management tasks and objectives in a specific power grid environment, but the processing results are not accurate, which often hinders the implementation of the digital life cycle management designed by enterprises. Therefore, according to the selected management requirements, a multi-objective enterprise digital life cycle management stage is established. First of all, according to the change of life cycle management content, the management stages are divided into four levels. They are basic goal setting level, life cycle management content scheduling level, multi-objective collaborative execution level and cross-control analysis level. There are also great differences in the control index parameters corresponding to different levels. As shown in the following Table 1:

Table 1. Setting Table of Indicators and Parameters in Digital Lifecycle Management Stage of Multi-objective Enterprises.

Controllable indicators for full lifecycle management	Basic Goal Setting Level	Full lifecycle management content scheduling hierarchy	Multi objective collaborative execution hierarchy	Cross control analysis level
Directional evaluation mean	16.35	18.11	20.35	26.57

Improve quantization ratio	12.3	16.5	25.4	30.9
Total utilization rate/%	85.21	86.37	89.17	93.51
Difference ratio of full lifecycle control	4.5	8.1	10.9	18.7
Schedulable absolute difference	3.11	4.16	4.57	5.05
Assessment of control content	Cross control analysis level	Make phased adjustments to the content based on the set goals	Collaborative summary and dynamic integration of similar targets	Using a cross over approach to validate the obtained full lifecycle results

According to Table 1, the index parameters of multi-objective enterprise digital life cycle management stage are set. Then, on this basis, with the assistance of the current product concept, combined with the actual development of the enterprise, the management restriction standards of different classes are set, and the existing management and control problems are solved in the process to ensure the effectiveness and reliability of the whole life cycle management.

2.3 Design product concept life cycle management and control model

At present, the whole life cycle management and control is generally based on the system management pioneering model. From the perspective of overall management, we should make comprehensive planning and implementation, and implement all aspects of the whole life cycle. Based on the product concept, an organizational structure is designed in the initial model, and the management and control contents of the corresponding model are designed according to the current life cycle management standards of power grid enterprises with five key elements, as shown in Figure 2 below:

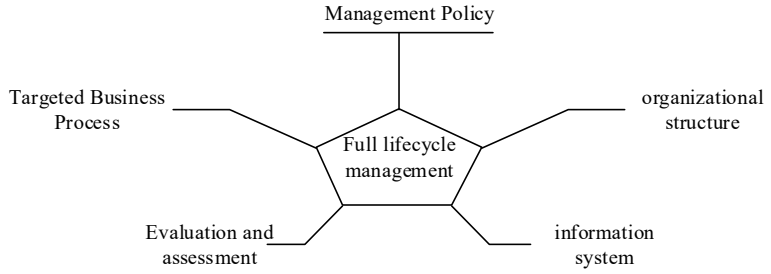

Fig. 2. Content setting diagram of product concept life cycle management and control model.

According to Figure 2, the content of the product concept life cycle management model is set. With the help of product concept, according to management strategy, oriented business process, organizational structure, assessment and information system, the actual life cycle management content is imported and adjusted at each stage, and the corresponding model management and control standards are set in combination with product concept, as shown in the following Table 2:

Table 2. Standard Setting Table of Product Concept Whole Life Cycle Management Model Framework.

Product concept full lifecycle control model framework process project	Basic control content standard value	Standard value of measured control content
Management Policy	Measures for independent target based control stage	Measures for collaborative goal based control stage
Targeted Business Process	Unit processing flow throughout the entire lifecycle	Full lifecycle overlay processing process
Organizational structure	Full lifecycle management one-way process	Full lifecycle management related links
Evaluation and assessment	Evaluate management projects	Conduct comparative testing through comparison
Information system	Independent use	Cross regional access usage

According to Table 2, the framework standard of product concept life cycle management model is set, and then, based on this, the corresponding management standards are clearly defined in the process of numerical construction of power grid enterprises, and finally the whole life cycle is improved and optimized.

2.4 "Demand Library" tracking control to strengthen the practice of life cycle construction

The so-called "requirement library" tracking management and control mainly refers to obtaining the data and information in the whole life cycle construction and implementation process through a numerical control link combined with tracking daily monitoring equipment, and storing them in the expected location for subsequent analysis and verification. First, the basic demand description can be realized according to the operation status of power grid enterprises, and the management plan and scheme formed in the whole cycle construction process can be transformed to form an identifiable model, and then the control demand target can be introduced into the "demand library", which is convenient for tracking the later control demand to some extent. Immediately, it is necessary to increase the control and screening of the information of life-cycle management and control elements, and make corresponding modification and processing in combination with product concepts in different cycles of power grid construction, and store the finally obtained data and information in the "demand library" to complete the construction of life-cycle and target management.

3 Experiment

This time, with the assistance and support of product concept, the practical application effect of the full life cycle method of digital construction of power grid enterprises is analyzed and verified. Considering the authenticity and reliability of the final test, the analysis is carried out in a comparative way, and the B power grid enterprise is selected as the main target of the test. Combined with professional devices and equipment, the current test environment and platform basic values and information are collected, summarized and integrated. According to the actual test requirements and changes in standards, the final test results are compared and studied, and then, specific tests and practical verification are carried out.

3.1 Experimental preparation

Combined with the product concept, the actual test environment of the whole life cycle method of digital construction of power grid enterprises is measured and shared with everyone. At present, the selected B power grid enterprise is a large-scale power grid coverage control enterprise. First, the actual coverage of the enterprise's power grid can be defined, divided into seven unit areas, and multiple monitoring nodes are set in each area, which are interrelated to facilitate the collection, summary and integration of data and information. Next, in the current test requirements, take the product concept as a target guide, first set the management control content of the current life cycle, and set the management control indicators and parameters, as shown in the following Table 3:

Table 3. Basic Life Cycle Management Test Indicators and Parameter Settings Table.

Basic full lifecycle management testing indicators	Initial management control standard value	Edge management control standard value
Control quantity value	10.25	14.35
Full life cycle directional limit	20.35	24.61
Demand ratio	3.25	2.65
Basic objectives of stage control	Basic control objectives+reverse control objectives	Basic control objectives+reverse control objectives+dynamic management objectives
Traceability ratio	21.35	26.51
Controllability/%	89.52	91.25

According to Table 3, the test indicators and parameters of basic life cycle management are set. At present, we have basically completed the construction of the life cycle control test environment for digital construction of power enterprises. Next, based on the actual measurement management requirements and product concepts, we will carry out specific and detailed test processing.

3.2 Experimental process and result analysis

In the above-mentioned test environment, combined with the principle of product concept, the selected life cycle method of digital construction of power grid enterprises is tested and verified. Firstly, the monitoring nodes of power grid foundation are laid out, and each node is overlapped to form a cyclic coverage monitoring program. Then, on this basis, according to the product concept, set the life cycle control objectives of multiple stages, and execute the processing in order. In the process of management and control, the current optimal ratio of life cycle management is calculated under the guidance of product concept after integrating the operation status of power grid and actual problems to ensure the feasibility of life cycle management content, as shown in the following formula 1:

$$D = (1 + m \times \frac{\sum_{i=1} \mu i - n}{\Im \eta}) - \sqrt{m\mu} \tag{1}$$

In Formula 1: D represents the optimal ratio of life cycle management, m indicates the control identification range, $\Im$ represents a cell integration value, η represents the management compensation ratio, μ represents the digital identification area of the basic power grid, μ indicates the number of recognition times, n represents the stacking range. Combined with the current test, the optimal ratio of life cycle management is calculated, and the final test results are compared based on the assistance and support of product concept, as shown in the following Table 4:

Table 4. Comparative Analysis Table of Test Results.

Full lifecycle management testing unit area	Risk assessment level for full lifecycle management	Unit control time/day	Optimal ratio of full lifecycle management
Manage Test Unit Areas 1	Level 3 risk	1.5	16.35
Manage Test Unit Areas 2	Level 3 risk	1	18.11
Manage Test Unit Areas 3	Secondary risk	1	20.13
Manage Test Unit Areas 4	Level 3 risk	2.5	21.36
Manage Test Unit Areas 5	Level 3 risk	1.5	19.24
Manage Test Unit Areas 6	Secondary risk	1.5	18.54
Manage Test Unit Areas 7	Secondary risk	2	17.46

According to Table 4, the comparative analysis of the test results is completed: for the seven selected life-cycle management test unit areas, the final optimal ratio of life-cycle management can reach more than 16, which shows that with the assistance and support of product concepts, the currently designed life-cycle practice management mode of digital construction of power grid enterprises is more flexible, changeable and effective, which can ensure the life-cycle practice and effect of digital construction of power grid enterprises in different background environments and has practical application value.

4 Conclusion

To sum up, it is the practice and research on the whole life cycle of digital construction of power grid enterprises based on product concept. Compared with the initial life cycle construction method, this time, according to the principle of product concept, the designed built-in management structure is more flexible and changeable, and it has strong pertinence. In the differentiated power grid background environment, we should strengthen the daily management measures and control mechanisms of power grid enterprises through product concepts and principles, build a more practical operation system, pay more attention to life cycle work, help relevant personnel to further clarify the management significance of life cycle, improve the perfection and stability of digital construction of power grid enterprises,

ensure the overall economic benefits, and push power grid enterprises into a new development stage.

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