World-Class Dispatching Management Practices Featured by KPIs Centered Self-Adaptive Management Process

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Abstract: This paper builds a self-adaptive management process in the power system dispatching area, aiming to effectively monitor the grid operation, dynamically adjust control strategy, optimize working process and ensure the continuous improvement of operational performance. By building a negative feedback and dynamic balanced management mechanism, ECPRCB (East China Power Regulation Center Branch) is able to keenly sense the internal and external changes, efficiently coordinate all kinds of resources and improve the operational performance. As a result, self-adaptive management effectively boosts ECPRCB to reach the goal of being a world-class dispatching center with high operational performance, competent internal operation, adequate resources support and strong growth motion.

Key words: World-class dispatching, self-adaptive, index system, KPIs (key performance indicator), balanced scorecard.

1. Introduction

ECPG (East China power grid), with peak load over 180 GW and major voltage level 500 kV, is one of the biggest regional power grids in the world [1]. Due to the characteristics of ultra-large-scale, ultra-long-range AC-DC hybrid and multi-fed large end, ECPG is also one of the most complex power grids to be operated. In recent years and the near future, accompanied by the progress of UHV (ultra high voltage) synchronous grid construction with other two Chinese large regional grids, the operating complexity of ECPG will get dramatically higher [2]. The control area will become wider and the electrical-magnetic effects will become more difficult to control, which is very likely to bring stability risks such as large-scale outage and large number of overload components. What's more, the operators will

face a new challenge of optimizing the resources allocation in a huge area [3, 4].

In the area of power system dispatch center and index system management, series of researches have been done. Refs. [5, 6] proposed control strategies in power system dispatch center, but complete index system is not introduced. Refs. [7, 8] discussed index system application in different industries, yet management process integrated with index system is not included. As a result, to introduce a complete index system for dispatch center of power system and to design management process integrated with the index system is the purpose of this paper.

The self-adaptive management process presented in this paper, aims to effectively monitor the grid operation, dynamically adjust control strategy, optimize working process and ensure the continuous improvement of operational performance. In this way, index system and management process are combined together.

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2. Self-Adaptive Management

The self-adaptive management concept is completely new to ECPRCB (East China Power Regulation Center Branch). A wide research on advanced management mechanisms was implemented before they take actions. Through research and analysis, ECPRCB found out that, long-term stable and effective management mechanisms have some common characteristics: keen perception and rapid response capability. And the most important issue that, ECPG faces are constant changes of internal and external environments. Therefore, in order to meet its own development requirements and move closer to be a world-class dispatching center, ECPRCB needs a set of “self-adaptive management” mechanism which is able to actively sense the problems, quickly make adjustments and realize sustainable development [9].

As a management mechanism, it firstly should have basic elements including architecture and content, and operation mechanism. In addition, it should have self-adaptive characteristics.

2.1 Architecture and Contents

Self-adaptive mechanism is consisted of eight management units, including one objective unit, three

functional units and four supportive units. Each unit is divided into several management modules as requires.

The objective unit is the core part of self-adaptive management mechanism, and includes 1 (index system unit). It realizes real-time and quantitative monitor, warning and assessment of ECPRCB’s business, organization, personnel, technology, etc.

The functional units define the major working contents and manners, and include 2 (monitor unit), 3 (analysis unit) and 4 (tracking unit).

The supportive units define the necessary supporting contents and manners, and include 5 (post-evaluation unit), 6 (incentive unit), 7 (document management unit) and 8 (index maintenance unit).

The architecture and contents diagram of self-adaptive management mechanism is shown below (Fig. 1).

2.2 Operation Mechanism

The operation mechanism is also one of the important parts of self-adaptive management mechanism.

According to different kind of trigger factors and influence ranges, it is mainly divided into two categories: inner loop cycle and outer loop cycle.

Fig. 1 The architecture and contents diagram of self-adaptive management mechanism.

Inner loop cycle's triggers include index deviations and rationalization proposals. ECPRCB should set up department—level flexible teams to analyze the cause of problems, implement the improvement plan, track the effect and complete the closed-loop feedback. Outer loop cycle's triggers include macro environmental changes and emergencies. ECPRCB should set up center—level flexible teams to analyze, implement, track, and as well, complete the closed-loop feedback.

In order to ensure the smooth operation of self-adaptive management process, it also clearly defines the supportive units which help it to coordinate and integrate with existing management mechanism, constantly improve the working effectiveness and perfect mechanism itself.

The operation mechanism of self-adaptive management mechanism is shown below (Fig. 2).

2.3 Self-Adaptive Characteristic

“Self-adaptive” is the basic characteristic of self-adaptive management mechanism. Specifically, it

should reflect the characteristics including keen perception, loop feedback and coordinated linkage.

2.3.1 Keen Perception

Firstly, it has comprehensive monitoring objects, which contain both quantitative index, and qualitative rationalize proposals, emergencies and macro environmental changes. Secondly, its index system covers operational performance, internal operation, resources support, and innovation and development which is balanced and integrity. Thirdly, cash and non-cash incentives stimulate all personnel to participate in the monitoring job positively, proactively and accurately.

2.3.2 Loop Feedback

Firstly, its inner and outer loop cycles have close-loop feedback, which ensure that, all the issues are truly solved. Secondly, post-evaluation continuously improves the work efficiency and mechanism itself. Thirdly, document management emphasizes issue records and introduces knowledge map, which provides necessary conditions for knowledge accumulation and heritage.

Fig. 2 The operation mechanism of self-adaptive management mechanism.

2.3.3 Coordinated Linkage

Firstly, it realizes seamless coordination with other existing management mechanism. Secondly, all management units jointly play a role. And all flexible teams, such as analysis team, implementation team and tracking team, work closely. Thirdly, by setting additional incentives, it encourages employees to support cross-department coordination enthusiastically.

3. Index System

The pivotal part of self-adaptive management is quantitative assessment—the index system.

Index system is also the core of self-adaptive management since accurate sense of operation deviation and effective adjustments strongly rely on comprehensive and quantitative evaluation. It is an important tool for monitoring work progress and guiding the work direction. It is also the effective management ruler for measuring achievements.

The design of the index system is divided into three parts: architecture design, index design and calculation method design [10].

3.1 Architecture Design

The architecture design focuses on its rationality and logicity, and references several methodologies such as AHP (analytic hierarchy process), BSC (balanced scorecard) and causal analysis.

The overall architecture design references AHP [11], and is divided into three layers: goal layer, criteria layer and factor layer. Goal layer explains the “world-class dispatching” target for ECPRCB. Criteria layer, the decomposition of target layer, explains the key construction content and direction. Factor layer explains the critical success factors of criteria layer.

3.1.1 Target Layer

The design of target layer references BSC [12] methodology which traditional has four dimensions, including financial, customer, internal business, and learning and growth.

Considering that dispatching organization is non-profit, financial condition is only seen as a kind of resources support. Therefore, finance, accompanied with personnel and technology, forms the first dimension—resources support.

Power system stakeholders, which are broad customers of dispatching organization, have a high degree of consistency of value demands. That is to maintain power grid with high performance, which forms the second dimension—operational performance.

Internal business covers the core business processes and activities, and is still important for dispatching organizations. Therefore, it forms the third dimension—internal operation.

And on the basis of learning and growth dimension, ECPRCB pays more attention on sustainable innovative capability, which forms the fourth dimension—innovation and development.

3.1.2 Criteria Layer

The design of criteria layer references causal analysis methodology.

In operation performance dimension, all stakeholders' value demands are quite the same that is having a securer, good quality, high efficient, environment friend and fair power grid. Therefore, the elements of this criteria layer are security, good quality, high efficiency, environment friendly and fair play.

In internal operation dimension, ECPRCB references the mature QQTC model [13], which are quality, quantity, time and cost, considers the actual business, and forms the elements of this criteria layer: comprehensive analytics, accurate decision-making, timely processing and normative procedure.

In resources support dimension, it mainly focuses on human resources, operation investment, and technology and equipment.

In innovation and development dimension, it mainly focuses on innovative practice and sustainable development.

Target layer and criteria layer of index system is shown below (Fig. 3).

3.1.3 Factor Layer

The design of factor layer also references causal analysis methodology. Due to the length limitation, it cannot be introduced in detail here.

3.2 Index Design

In order to ensure the progressiveness, typicality and versatility of index system, the design references SMART [14] principle and learns from other excellent dispatching organization.

The indexes are mainly from four sources. The first class of indicators is international commonly used, such as load shedding ratio caused by accident from NERC (The North American Electric Reliability Corporation). The second class of indicators is commonly used in China State Grid, such as the number of security liability accidents. The third class of indicators is from colleges, universities and other grid companies, such as maximum AGC (automatic generation control) reservation coefficient. And the fourth class is designed to reflect ECPRCB's features,

such as the secure and stable operation mode research in the early stage of UHV operation.

There are all together 297 indicators. According to the hierarchical relationship of index system, all indicators are divided into three types, including power system performance index, key index and detailed index, and respectively reflect the performances of whole value chain of power system, ECPRCB's construction effect and construction process.

3.3 Calculation Method Design

Because of the huge number of indexes, it is quite hard for managers to quickly and intuitively grasp the key issues. Therefore, ECPRCB designed a composite index which simplifies the management difficulty and reflects the overall level of performance.

Composite index uses percentile to score. It reaches 100 points when every indicator reaches target value. In addition, ECPRCB designed an indicator—index nonlinear calculation model based on exponential model. When an indicator does not meet the management requirement, its score would significantly

Fig. 3 Target layer and criteria layer of index system.

Fig. 4 The analog curve of composite index.

drive down the composite index and alarm the managers.

The analog curve of composite index is shown below. In 2011, the composite index is 90.78. After self-adaptive management system was applied, the composite index was improved to 93.00 (Fig. 4).

4. Conclusions

The KPIs (key performance indicator) centered self-adaptive management mechanism is an effective management tool for ECPRCB to capture, deal with and improve all kinds of issues. The mechanism combined index system in power system dispatch center with close-loop self-adaptive management process together.

It is trialed in ECPRCB and proves its value. It will ultimately help ECPRCB remain a high performance no matter how grid morphology, industry policy and technology trend change.

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