

## Research on the Business Integration Method of Township Power Supply Stations by Considering the New Business and Cluster Analysis

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**Abstract:** Township power supply stations are often confronted with the problem of "more indicators, fewer personnel and weak informatization ability". The current research on business integration model is not suitable for the business demand and development direction of township power supply station under the new situation. A new business and cluster analysis method is proposed for the business integration of township power supply stations, considering the business demand, the constraints of the number and structural of township power supply stations' employees, and the business integration scheme of typical township power supply stations is given. The case study shows the rationality of the proposed method.

### 1. Introduction

Nowadays, China's township power supply stations are facing new situations and requirements: the state implements of rural revitalization strategy, deep supports for developments of new energy and electric vehicles, as well as promotes the big data strategy. The demand for new rural businesses requires higher demands on the services of power supplies, the advanced management needs further improving the quality and efficiency, saving labour costs; the data application and innovative development in grass-roots power supply stations are needed to be greatly improved. The existing business organization and integration of power supply stations mainly focus on traditional power supply business, and the business organization structure is mainly formed by administrative instructions. Therefore, there is an urgent need of studying business demands and development directions of typical township power supply stations under the new situation. Giving business integration models and typical schemes can improve power grid company's service levels and social responsibilities.

With the help of the technology of large data, the whole power quality monitoring and analysis framework is constructed, and the lightweight visual monitoring and analysis tools are developed<sup>[1]</sup>, with a view to supporting the continuous improvement of the distribution network operation level in paper 1. Based on the full-service unified data center and unified power distribution model, the enterprise-level power supply service command function is developed<sup>[2]</sup>, which integrates functions of customer service command, business collaborative command, power distribution operation control and service quality supervision in paper 2. Based on the data collection from intelligent terminals in the area, paper 3 constructs a low-volt-age monitoring and analyzing framework from the management level, and without increasing the construction cost, it aims to fully excavate the value of 96 electric load data, carry on the objective, comprehensive, accurate and timely monitoring and analysis of the problems of data acquisition quality and low voltage, and assist and support the leadership decision-making and basic-level unit management<sup>[3]</sup>. Based on the management status of distribution network reliability, paper 4 combines the big data technology and corporate management strategy, uses visualization tools, establishes the distribution network

reliability monitoring and analysis framework with cross-professional core data fusion, and achieves automatic kneading of power blackout accidents and blackout implementation details, so as to complete the automatic discrimination between power outage and contingency plan, reducing artificial error and promoting the power supply reliability<sup>[4]</sup>. Aiming at the problem of internet of things service function chain deployment, network function virtualization and software defined networking are combined to optimize resources<sup>[5]</sup>. Considering forwarding cost and traffic load balance, a joint optimization model of virtual network function placement and service function chain routing is given in paper 5. The business integration model method in the above research is not suitable for the business demand and development direction of township power supply station under the new situation, so it needs to be improved.

In this paper, a new business and cluster analysis method is proposed for the business integration of township power supply stations. Considering the business demand, the constraints of the number and structural of township power supply stations' employees, the business integration cluster analysis model is constructed, and the business integration scheme of typical township power supply stations is given in chapter 2. The case study is given to show the rationality of the proposed method in chapter 3. Conclusion is given in chapter 4.

## 2. Methodology

This paper proposes a business integration method of township power supply stations by considering the new business and cluster analysis, which include:

1) business demand forecasting of township power supply stations: collect the existing business demand status of typical township power supply stations. Construct a quantitative relationship model to describe the relationship between power supply service quantity  $D_b$  and economic and social development  $s_d$ , including the relationship between the number of people  $n_p$  and day of power supply services  $t_s$  (such as expansion  $e_x$ , emergency repair  $e_r$ , patrol  $p_a$ , payment  $p_y$ ) and local GDP  $g_{dp}$ , industrial structure  $s_i$ , electricity sales  $s_e$ , etc. The rationality of the above relationship model is verified by historical data of power supply services and local economic development of other township power supply stations. Based on the regional economic and social development trend as well as the development trend of new power supply services such as rural distributed power supply and electric vehicles to predict the power supply services demand scale in township power supply stations.

$$D_b = f(n_p, t_s, e_x, e_r, p_a, p_y, g_{dp}, s_i, s_e, s_d) \quad (1)$$

2) prediction of the number of employees in township power supply stations: According to the number of employees  $e_m$  in typical township power supply stations and the number of power supply service orders  $d_b$  in recent years, as well as the staffing standards  $s_t$  and changes of power supply stations stipulated by superior departments, a forecasting model of the number of employees  $E_m$  in power supply stations is constructed by using data fitting method  $f_m$ . The rational model is verified by historical data of the number of employees in other township power supply stations and the number of power supply service orders. Combining the power grid companies' advanced management requirements and township power supply stations' business demand forecast results to predict reasonable demand for the number of employees of typical township power supply stations in the next 5-10 years .

$$E_m = f_m(e_m, d_b, s_t) \quad (2)$$

3) construction of business integration cluster analysis model: Design survey table. From the power station area, the number and distribution of users, meteorology, annual average power supply service time, frequency, technical category, complexity and other dimensions, invite power supply service experts to carry out quantitative evaluation of specific power supply service content, such as power supply expansion, emergency repair, patrol, payment. Using standardization treatment  $f_d$  forms multi-dimensional space of power supply service and spatial distribution of various services  $D_f$ . Through repeated investigations and analytic hierarchy process, the rationality of multi-

dimensional space of power supply service and spatial distribution of various service contents in typical power supply stations is tested. Using the existing business organization of typical power supply stations as the initial cluster value, considering the power supply service's working staff number in step 2 as the upper limit constraint, aiming to improve service quality (such as reducing the number of service links and invalid service time, etc.) and according to the number of service orders predicted in step 1, the single-linkage clustering algorithm based on Euclidean distance is adopted to integrate all services of power supply level. The business integration scheme of typical township power supply stations is calculated on a trial basis. Experts of the power supply stations are invited to evaluate the results of business integration and to verify the rationality of the business integration cluster analysis model.

$$D_f = f_d(e_x, e_r, p_a, p_y) \quad (3)$$

4) case study: Township power supply stations' cluster analysis is carried out and a business integration scheme is proposed in Zhejiang province. According to the data of operation area, electricity sales, profit, average number of employees and power supply reliability of power grid company, the economic and social benefits of township power supply station after business integration are calculated by analogy method.

### 3. Case study

A town is located in the east of Zhejiang Province, covering an area of 381 square kilometers, with 24 10kV-lines, 416 low-voltage stations, 587 high-voltage users, 49 thousand low-voltage users and 230 million kWh of electricity sold in 2016. There are 67 employees with an average age of 49. They are responsible for the operation and maintenance of distribution network of 10kV and below, marketing business processing of 10kV and 0.4kV low-voltage users, whose capacity are 315kVA and below.

The main strategy of business integration of the township power supply station is to take the initiative to adapt to the needs of local governments and the needs of social and economic development. Applying the "Internet +" means, combined with the quality conditions of their own personnel, it creates a power supply matching mechanism with power and responsibility, operation and distribution, and comprehensive service. It has the ability of full coverage of territorial business, full integration of operation and distribution terminals, full support of professional management, full channels of service mode, and full process of work control

The results show that township power supply stations should take power supply services such as supply expansion, emergency repair and patrol as work focus, and concentrate on new business such as integrated energy services, energy substitution and power finance. Integrating hundreds of specific business such as electricity inspection, meter reading verification, payment, survey and acceptance of power supply expansion projects, to achieve the coordinated operation of power supply service business, multi-functional personnel, one-time service in place.

Through business integration, the problem of "more indicators, fewer personnel and weak informatization ability" of township power supply stations has been effectively solved. The comprehensive monitoring of equipment and indicators of 27 million meters, 220 thousand intelligent general insurance, 290 thousand intelligent public transformer terminals, 2184 charging piles, 160 thousand photovoltaic users has been realized.

After the business integration of the above township power supply station, its number of business lines has been reduced by about 20%, the number of power supply service personnel has been

reduced by 12%, the annual labor cost has been saved by about 900 thousand yuan, the annual average electricity sales has increased by about 9%, the reliability of power supply has been improved by about 0.03 percentage points, and the amount of complaints from users has been reduced by 26%, and the getting electricity index has been improved significantly in 2018. The case shows the rationality and feasibility of the proposed model.

Table 1. Calculation of the business integration of a township power supply station in 2018

number of business lines reduced	number of power supply service personnel reduced	annual labor cost saved	annual average electricity sales increased	reliability of power supply improved	amount of complaints reduced
20%	12%	¥ 900 k	9%	0.03%	26%

#### 4. Conclusion

To solve the problem of "more indicators, fewer personnel and weak informatization ability" of township power supply stations, a new business and cluster analysis method has been proposed for the business integration of township power supply stations. Considering the business demand, the constraints of the number and structural of township power supply stations' employees, the business integration cluster analysis model has been constructed, and the business integration scheme of typical township power supply stations has been given. The case study has shown the rationality of the proposed method.

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