Study on Selection of Centralized Maintenance Point for Process Computer Control System Based on AHP

Lao Zhao-li[1], *Liao Wen-zuo*[2], *PAN Er-shun*[2]

(1、 Department of Equipment, Baoshan Steel Co. Ltd., Shanghai 200030, China

2、 School of Mechanical Eng.，Shanghai Jiaotong Univ.，Shanghai 200030，China)

Abstract：The factors that affect the location of centralized maintenance for process computer control system are first analyzed in this article based on the thinking of ITIL and the importance of location. Evaluation system is built and the AHP is used to qualitatively analyze the factors for providing the basis for decision. The optimization process and an example are given.

Key words：ITIL；AHP；location；evaluation index

ITSM is a cooperation process assured by SLA for good IT service quality. It includes many management activities such as system management, network management, system development management and etc. In addition, it also considers other processes such as change management, asset management and problem management. ITSM is a process-oriented and customer-centered method which improves service capacity and service level by integrating IT services and business organizations[1][2]. This paper studies centralized maintenance based on IT service management. Maintenance point as the important part of centralized maintenance system should be well selected to keep good efficiency and quality.

Baoshan Steel Co. Ltd. has adopted process computer control system for more than 20 years and had its own operation management process. Now, L2 has a total of 168 sets of process computer control systems located in 47 labs that mainly take responsibility for the automatic control of production lines about raw materials, iron-smelting, steel-smelting, hot-rolling, cold-rolling, plate, pipe and etc. It is the key point for the whole production control. With the development of planned projects, the coverage of process control computers continuously expands. Moreover, besides the maintenance tasks for process control computers, the technicians have some other independent development work, which will bring huge work loads. Hence, they bring pressure and challenges to the traditional operation management methods. In order to enhance the efficiency and quality, the intelligent centralized operation maintenance management should be studied.

Analytic Hierarchy Process (AHP) is a decision method proposed by Thomas L. Saaty in 1971[3][3] and is widely used after great improvements. AHP considers the complex problem through different hierarchies, which can simplify this problem. Usually, it divides the influencing factors into

several hierarchies to construct simple subsystems. Then, compare these influencing factors to obtain their weight values. Finally, judge the object by comprehensive estimation method to provide the support for decision making. This paper takes AHP to develop a systematic method for the selection of centralized maintenance point.

1 Foundation of evaluation index for centralized maintenance point

1.1 Principles of selection

The principles of selection of centralized maintenance point are based on:

(1) Consider convenient location for region division;

(2) Give priority to main lab with strong real-time operating ability;

(3) Merger the process computers for new and improved production line;

(4) Separate the specialized system until great improvement.

1.2 Evaluation index for centralized maintenance point

Delphi investigation method is chosen to determine the evaluation index. The selected targets for the questionnaires are the technicians for process computer control system and responsible leaders that have rich experiences. The framework of AHP can be improved by using Delphi method to obtain the final estimation model. According to the investigative results from Delphi method, the initial evaluation index is built that can be divided into three parts: service quality, operation difficulty, cost and expansibility. Service quality represents quick response, real-time quality, solving rate for failures and regional concentration. Operation difficulty represents machine importance, machine using rate, failure rate and system usage. Cost represents recessive cost and dominant cost. And expansibility represents new and improved production lines.

2 AHP process

2.1 Foundation of AHP model

Analytic hierarchy structure is mostly used in AHP method, and the analytic hierarchy structure model of this study is as below.

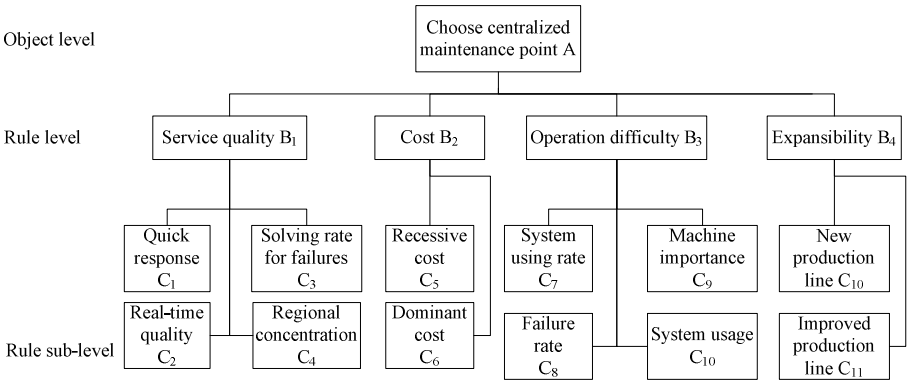

Fig.1 Analytic hierarchy structure model

2.2 Construction of reciprocal matrix

Because the influencing factors have different importance, this study chooses the yardstick from 1 to 9. Then, with the weight values determined by questionnaires, the reciprocal matrix is constructed.

2.3 Computation of weight value and consistency test

Compute the weight value:

$$\lambda = \frac{1}{4}\left(\frac{2.34}{0.59} + \frac{0.87}{0.22} + \frac{0.49}{0.12} + \frac{0.29}{0.07}\right) = 3.972 \quad (1)$$

Then perform consistency test:

$$CI = \frac{\lambda - n}{n-1} = \frac{3.972 - 4}{4-1} = 0.009 \quad (2)$$

With *RI =0.90*, there is:

$$CR = \frac{CI}{RI} = \frac{0.009}{0.9} = 0.01 < 0.1 \quad (3)$$

After consistency test, the abovementioned results can be chosen as weight value shown in Table 1.

Table1 Weight value of reciprocal matrix for A ~ B

Choose centrelized maintenance point A	Service quality B1	Cost B2	Operation difficulty B3	Expansibility B4	W
Service quality B1	1	3	5	7	0.59
Cost B2	1/3	1	2	3	0.22
Operation difficulty B3	1/5	1/2	1	2	0.12
Expansibility B4	1/7	1/3	1/2	1	0.07

Meanwhile, the weight value of reciprocal matrix for those subsystems can be also solved. And the combined weight value is shown as below.

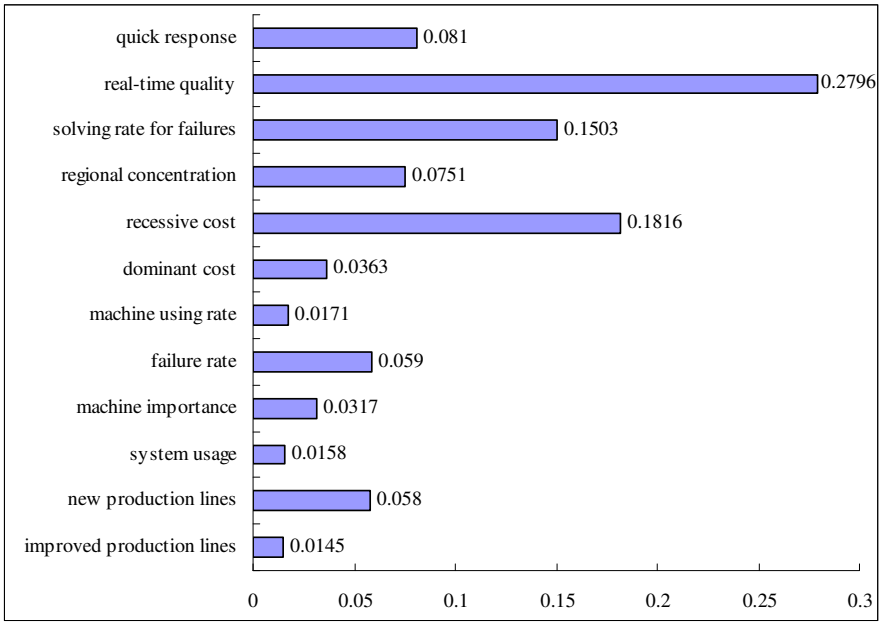

Fig.2 Combined weight value of evaluation model

According to the combined weight value about rule level, the optimized evaluation model is built in Figure 3. With this optimization model, the available solutions can be estimated. Hence it provides great support for decision making.Finally, based on this model, the optimization search process is developed. by using VB.NET and SQLServer. Some fundamental functions are designed: add, delete and modify the influencing factors; compute combined weight value, do consistency test and etc. Through computation, the ranking of evaluation index are listed:

⑴service quality; ⑵cost; ⑶operation difficulty; ⑷expansibility.

And the evaluation index for rule sub-level are listed:

⑴real-time quality; ⑵recessive cost; ⑶solving rate for failures; ⑷quick response; ⑸regional concentration; ⑹failure rate; ⑺new production lines; ⑻dominant cost; ⑼machine importance; ⑽machine using rate; ⑾system usage; ⑿improved production lines.

Formázott: Hasábok száma: 2, 1. hasáb szélessége: 6.79 cm, 1. hasáb térköze: 0.75 cm, 2. hasáb szélessége: 6.79 cm, Nem Azonos hasábszélesség

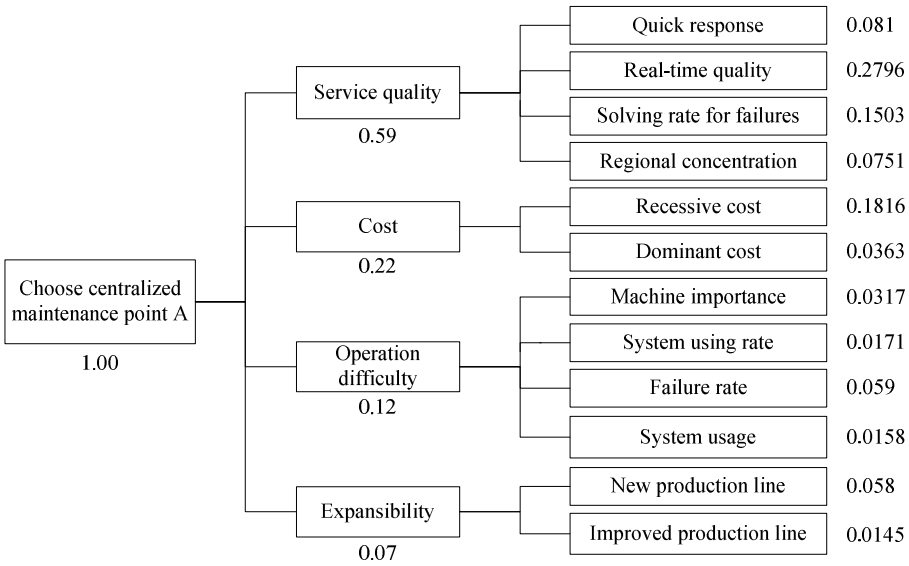

Fig.3 Optimized evaluation model

Formázott: Kezdőpont: folyamatos, Hasábok száma: 2, 1. hasáb szélessége: 6.79 cm, 1. hasáb térköze: 0.75 cm, 2. hasáb szélessége: 6.79 cm, Nem Azonos hasábszélesség

3 Conclusions

This study adopts AHP method to build an optimized estimation model to select the centralized maintenance point for process computer control system. According to Delphi method, make the ranking for the influencing factors by questionnaires. From the results, service quality is the most important factor, which satisfies the real situation that companies should provide good service to customers. In addition, cost is also the important factor. Besides, this optimization results can provide great support for decision making, And it can be further researched for other maintenance location.

Acknowledgement

The authors are grateful for the financial support from National Science Foundation of China Grant # 70671065.

Reference

【1】 Zuo Tianzhu, Sun Qiang, Liu Wei. IT FUWU GUANLI [M]. Beijing: China Machine Press, 2004.

【2】 Jie Qingsheng, Luo Yanke, Li Yi. JIXIE GONGCHENG MOHU YOUHUA FANGFA [M]. Beijing: China Machine Press, 2002.

【3】 Xu Jie, Zheng Kai. Research of Logistics Center Location and Case Analysis [J]..Journal of Beijing Jiaotong University, 2001.

【4】 T.L.Saaty. The Analytic Hierarchy Process [M] .McGraw-Hill Company, 1980.

【5】 Wang Wei, Zhao Fujun, Zheng Jinzhong. Study on Logistics Center Location Based on AHP [J]. Logistics technology, 2005.