Research on Lean Production Mode Evaluation of Railway

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Abstract. To evaluate the manufacturing lean production mode scientifically and objectively will help the development of it effectively, standardly and systematic, also provide strong guarantee for enhancing the competitiveness of manufacturing industry. Lean production model of manufacturing management is of great significance. By studying the content of lean production mode, then put forward the evaluation index system and set index weight method based on Analytic Hierarchy Process. Using PHP and MYSQL database to develop a mobile terminal evaluation system which based on WeChat platform. Aiming to provide business leaders with more scientific and objective evaluation of the scale of the enterprise lean production.

1. Introduction

With China's rapid economic development, traffic congestion, increased emissions, noise pollution and energy shortage problem has become increasingly significant, safety and convenience of public transportation are paid more attention by people. Therefore, according to series of problems of the city traffic, China needs to promote the rapid development of rail transportation equipment manufacturing industry.

However, with the rapid development of China's manufacturing industry under the market economy, the enterprise production management mode faces severe ordeal. As the scientific methods of lean production methods conform to the development of the times and can make the enterprise adapt to the change of the market, has been developing rapidly and widely used in domestic manufacturing enterprises[1].Lean production is often seen as a set of tools that reduce the total cost and improve the quality of manufactured products[2]. But there are still relatively many problems in the implementation of lean production management, and most enterprises do not have a relatively perfect lean production model evaluation system to test and improve the implementation process of lean production in reality. Based on the analysis of the existing academic achievements of lean production evaluation and the combination of analytic hierarchy process and Delphi method, this paper establishes a lean production model evaluation system based on departmental responsibility system, The system uses the computer language compiled into micro-platform-based mobile terminal lean production mode evaluation system.

2. Lean Production Model Evaluation Index

Establishing a complete evaluation index system is a necessary condition for establishing a lean production evaluation system. Rail transportation equipment manufacturing enterprises are generally large enterprises, in the global market, intense competition in the environment, and gradually developed into a group enterprise[3]. So there are many factors that affect the rail transportation equipment manufacturing industry, with a multi-level structure. Through the on-site investiga-tion and study of the production sites of the group companies, the relevant information was collected, and the impact factors of the enterprises in the actual implementation of lean production management were comprehensively summarized, and the relation between the factors

was compared one by one. Finally, the importance of each index is ranked by AHP, and the specific weight value corresponding to each evaluation index is calculated. According to the principles of departmental responsibility system, on the basis of implementing the lean production method to meet the requirements of the evaluation index of traditional lean production mode, the Delphi method, the preliminary formulation, the anonymous feedback and the iterative process. Table 1 is the final establishment of the evaluation index system.

Table 1 Lean production model evaluation index system

First level indicator	Second level indicator	Third level indicator
B_1 Equipment department	C_1 Equipment planning	D_1 Overall Equipment Effectiveness D_2 Equipment rationalization design level
	C_2 Maintenance	D_3 Equipment operating rate D_4 Equipment movable rate D_5 Equipment utilization rate
B_2 Quality department	C_3 Prevention and control	D_6 Quality control method system D_7 Exception management level D_8 Scientific Methods for Preventing Defects D_9 Repair rate
	C_4 Evaluation	D_{10} First pass rate D_{11} Total Customer Satisfaction D_{12} The proportion of total loss of quality to the income from main business
B_3 Logistics department	C_5 Production	D_{13} Rationalization of distribution materials D_{14} Logistics smooth degree D_{15} Equalization of Logistics D_{16} Rationalization of logistics layout
	C_6 Supplier	D_{17} Stowage rate D_{18} Supplier delivery on time
B_4 Process department	C_7 Production line optimization	D_{19} Production line U - layout ratio D_{20} The scientific level of the process
	C_8 Production line balance	D_{21} Degree of man - machine separation D_{22} Employee workload level
B_5 Production department	C_9 Site management and continuous improvement	D_{23} 6S management D_{24} One Piece Flow D_{25} Kanban management D_{26} Production site safety level D_{27} Visual management
		D_{28} Standard job sequence D_{29} Standard WIP inventory

		D_{30} The settings for the timer point
	C_{10} Standard Operation	D_{31} Job repeatability
		D_{32} Job Standard Coverage
		D_{33} Feature Job Time
		D_{34} Assign workload by beat
B_6 Human resources department	C_{11} Training and education	D_{35} Personnel training system
		D_{36} Personnel assessment system
		D_{37} Skill evaluation method of rationalization level
		D_{38} Multi - skill level
		D_{39} Annual per capita training hours
	C_{12} teamwork	D_{40} Number of team members
		D_{41} Skills complementarity
		D_{42} The prestige of the team leader
	C_{13} Morale and mental outlook	D_{43} Rationalization proposals
		D_{44} Rationalization proposal adoption rate
		D_{45} Reward and punishment system
		D_{46} QC group and other activities carried out

The index system for the model index system, each evaluation can be based on this system, according to the corresponding evaluation of the different objectives of the appropriate focus on the increase and deletion.

3. Lean Production Model Evaluation Method

In recent years, with the domestic and international mathematics and applied mathematics in different areas of the development of mature, comprehensive evaluation of practice in the system has obvious results. At present, there are many kinds of comprehensive evaluation methods, such as principal component analysis, analytic hierarchy process, clustering analysis, fuzzy comprehensive evaluation and so on[4]. Which method is used to calculate the weight value of the indicator depends

on the characteristics of the method and the characteristics and contents of the evaluation system. Lean production model evaluation is a multi-objective index system composed of several factors, which is multi-level and complicated. Therefore, using the analytic hierarchy process, this method has the consistency of testing links, can reduce the subjective influence of the expert group to the greatest extent, and have the role of unified view[5]. Specific steps are as follows:

(1) build the judgment matrix

Assuming the establishment of rail transportation equipment manufacturing lean production model evaluation index system for the target level A, First level indicators for the department level B, the second level indicators for the responsibility level C, the third level indicators for the index level D, the structure of the judgment matrix is generally taken as shown in Table 2.

Table 2 the form of the judgment matrix

A	B_1	B_2	...	B_n
B_1	b_{11}	b_{12}	...	b_{1n}
B_2	b_{21}	b_{22}	...	b_{2n}
.	.	.	...	.
.	.	.	...	.
.	.	.	...	.
B_n	b_{n1}	b_{n2}	...	b_{nn}

(2) hierarchical single sort

The largest eigenvalue of the judgment matrix λ_{max} and the corresponding eigenvector ω are calculated by square root method.

$$B\omega = \lambda\omega \tag{1}$$

The obtained vector is normalized, and the resulting vector value is the weight value of the corresponding factor of the same level to the relative importance of the corresponding factor of the previous layer, By multiplying by one, the relative importance index weights for each sector relative to total objective A can be calculated.

(3) consistency of the single-level test

Random Consistency Ratio

$$CR = \frac{CI}{RI} \tag{2}$$

When CR<0.1[6], Then the results of the hierarchical single sort have satisfactory consistency, otherwise the elements of the judgment matrix need to be adjusted. Among them, the consistency index:

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{3}$$

The value of the average randomness consistency index RI has different fixed values according to the judgment matrix of 1-9 order, as shown in Table 3.

Table 3 RI value table

1	2	3	4	5	6	7	8	9
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

By calculation, CI<0.1. The calculated index values have satisfactory consistency. Table 4 shows the index weights of each level relative to the previous level.

Table 4 The weight of each indicator

Level B	B	B_1	B_2	B_3	B_4	B_5	B_6
indicator	1	1/6	1/6	1/6	1/6	1/6	1/6

Level C	C_1	C_2	C_3	C_4	C_5	C_6	C_7
indicator	0.25	0.75	0.75	0.25	0.5	0.5	0.5
Level C	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	
indicator	0.5	0.25	0.75	0.5842	0.2808	0.1350	

D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8
0.5000	0.5000	0.6000	0.2000	0.2000	0.4799	0.1215	0.1215
D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}
0.2771	0.3196	0.5584	0.1220	0.1051	0.1644	0.4457	0.2848
D_{17}	D_{18}	D_{19}	D_{20}	D_{21}	D_{22}	D_{23}	D_{24}
0.6667	0.3333	0.3333	0.6667	0.6667	0.3333	0.0522	0.3499
D_{25}	D_{26}	D_{27}	D_{28}	D_{29}	D_{30}	D_{31}	D_{32}
0.1104	0.3706	0.1169	0.0542	0.1693	0.0660	0.1693	0.2317
D_{33}	D_{34}	D_{35}	D_{36}	D_{37}	D_{38}	D_{39}	D_{40}
0.0818	0.2278	0.2721	0.1753	0.1408	0.3390	0.0728	0.1350
D_{41}	D_{42}	D_{43}	D_{44}	D_{45}	D_{46}		
0.5842	0.2808	0.3715	0.3715	0.0941	0.1629		

(4) the evaluation of comprehensive evaluation of the score

According to the evaluation index in Table 1, The evaluation criteria of each index of level D are excellent, good, medium and poor, the corresponding scores were 100,85,60,40, So if an indicator score of the level D is 85 points, then this indicator for the total weight of the target A is multiplied by 85 .

4. Mobile Terminal Evaluation System Based on Micro Message Platform

Relative to the computer, Mobile phone has the advantages of easy to carry. You can online at any time any place and will not be constraint by time and place. In recent year, with the use of smart phones to reduce the threshold, almost a staff of a mobile phone. As a feature-rich mobile phone applications, WeChat has a huge number of users. At the same time, WeChat public platform has a rich application interface for developers to call, which provides a good way to develop mobile micro-applications. And the WeChat platform, with the advantages relative to the APP, is not limited to the mobile phone operating system and do not need to develop the appropriate architecture for different systems.

Evaluation system uses PHP language, the application of MYSQL database for data management. Figure 1 is the storage of primary and secondary indicators of the data sheet. The use of HTML5 display page and realize the function, the system used in the INTERNET network environment, Figure 2 shows the system interface. System docks the WeChat platform. In addition to self-evaluation function, the WeChat platform can regularly collect industry information and subscription to the user regularly. Users can query and browse knowledge of the lean production and rail on the public platform, It saves time searching for data on the Internet. WeChat platform interface is shown in Figure 3.

Figure 1 Data sheet

Figure 2 Evaluation index system

Figure 3 WeChat public platform interface

5. Summary

According to on-the-spot investigation and study in the rail transportation equipment manufacturing enterprise, depth research on the lean production of enterprises and combined with lean production and process management and other related theories. This paper establishes a set of evaluation index system for evaluating lean manufacturing mode of rail transportation equipment manufacturing enterprises. On this basis, the Delphi method and analytic hierarchy process are used to determine the weight of the index, and the mobile terminal evaluation system based on the WeChat platform is designed. It can improve the level of lean production in the rail transportation equipment manufacturing enterprises .And has a good demonstration effect on lean manufacturing evaluation of manufacturing industry.

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