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Construction Machinery and Equipment Management in the Existence of Deficiencies and Coping Strategies

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Abstract: After years of development, the target enterprise has already had a large number of CM put into use. With the development of information technology and the continuous progress of science, CM continues to move towards the direction of information and intelligence, and the pace of integration of information technology and CM is gradually accelerating. In order to ensure the safety of the company's equipment assets, improve the project construction quality, and provide data support for purchasing and upgrading equipment, it is imperative to conduct more detailed processing and analysis of the data generated during the construction process. The main purpose of this paper is to study the deficiencies and coping strategies in the management of CM and equipment. This paper analyzes the functional and non-functional requirements in detail according to the research background, determines the goal of the platform, and divides the design of the platform into three parts: the Internet of Things access platform, the Internet of Things management platform, and the database. Then, the CM service management platform is divided into three parts: data access module, security management module and function module, and their implementation processes are described respectively. Finally, the usability and stability of the platform are verified by functional testing and stress testing.

1. Introduction

Driven by the development tide of the construction machinery (CM) industry, remote information management of engineering equipment has become more important, which has gradually become the main direction of the development of CM by promoting the progress of CM in intelligence and informatization. This paper hopes to build a fully functional CM management service platform based on the current communication network system. Through the collection of

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geographic location information and construction status information of CM, and the processing and analysis of a large number of data information, on the one hand, it provides security for the target enterprise's equipment assets, on the other hand, it provides strong support for the enterprise's business promotion [1-2].

In relevant research, Michelino et al. conducted content analysis based on patent data to extract information about component knowledge of original equipment manufacturers (OEMs) and module suppliers (MS) [3]. The survey results show that although its components are purchased from an external MS, the OEM should maintain the general and specific concentration of component knowledge and final products to obtain greater market satisfaction. Sule et al. used exploratory factor analysis and partial least squares structural equation model to analyze the data [4]. The survey results show that industry dynamics are the leading factor for off-site construction in Ghana. Therefore, the rapid increase of housing deficit, the high cost of permanent land acquisition, the high cost of cast-in-situ construction, the use of prefabricated containers for construction, and the strong demand of the construction market restrict the development of the construction industry

At present, the scheduling of a large number of CM and equipment is generally difficult, and the equipment cannot be reasonably allocated to different construction areas in a timely manner [5-6]. In order to solve this difficulty, this paper establishes an information management platform based on global positioning service to conduct real-time positioning and effective monitoring of CM and equipment, so that nearby equipment can be found in time when equipment scheduling is needed, and equipment scheduling can be completed as soon as possible.

2. Design Research

2.1. Problems in Equipment Management (EM)

In general, the symptoms of the fault are abnormal function, excessive temperature, excessive oil and gas loss, abnormal lubrication, electrical problems, abnormal vibration and noise, leakage, abnormal smell, etc. [7-8]. These problems seriously hinder the smooth progress of production. The impact of specific equipment failures is reflected in the following aspects:

1) Obstruct normal production [9-10]. Equipment failure will lead to production stoppage, and too long equipment maintenance period may lead to order delay; The order delay has an impact on the production schedule and delivery of auto parts; At the same time, it is not conducive to establishing the brand image of the enterprise. The normal operation of the equipment and the production of auto parts according to the production plan nodes are the basic conditions for the smooth delivery of orders. Frequent or too long equipment failure maintenance cycle will hinder normal production.

2) Reduce production efficiency. Equipment failure must lead to maintenance time. During the maintenance time, other related equipment will be stopped and workers will stop working. After the equipment is repaired and resumed, the preparation time of all equipment, raw material supply time, workers' preparation time, etc. will increase production time. On the whole, the time of equipment failure will reduce the output value of auto parts in unit time, which is very unfavorable to order delivery [11-12].

3) Increase production management costs [13-14]. The increase of equipment failure cost is mainly reflected in the following aspects: first, the increase of equipment maintenance cost and the decrease of service life; The second is the cost of personnel slowdown and related equipment shutdown caused by shutdown; Third, the increase of inventory management cost of finished products and semi-finished products; Fourth, the price of raw materials will rise in the short term

and the price of finished products will fall; Fifth, other expenses arising from production plan changes.

4) Reduce the service life of the equipment. The equipment is heavy, the main production equipment is expensive, and the required maintenance technology is high. Problems caused by untimely maintenance and improper operation will inevitably reduce the service life of the equipment and increase the production management cost of the enterprise [15-16].

5) Impact on environment or occupational health. The noise and waste gas pollution generated by some equipment will affect the environment and the health of relevant personnel. The noise and waste gas pollution cannot be ignored, and the impact on human health should be paid attention to by managers. It is an unshirkable responsibility to reduce the service life of equipment, improve the failure rate of equipment, and protect the environment and the physical and mental health of employees [17-18].

2.2. Learning Algorithm of BP NN

The learning algorithm of BP network can be described as follows:

1) Initialize the parameters of the NN to determine the weights and thresholds of each layer and node of the network;

2) Determine the input vector and expected output vector of the NN, and train the network;

3) The input vector is transmitted forward through the network, and finally the output vector of the network is obtained. The output vector is compared with the expected output vector to determine the error value. If the error value is greater than the set error value, step (4) is performed. Otherwise, this training sample is ended, and step (2) is returned to train the next sample;

4) The error value is transmitted reversely from the output layer of the network to the output, and the weights and thresholds of each layer and node are modified;

5) Repeat steps (2) and (3) until the error between the output vector and the expected output vector is less than the set training error.

The specific learning process of BP network is shown in Figure 1:

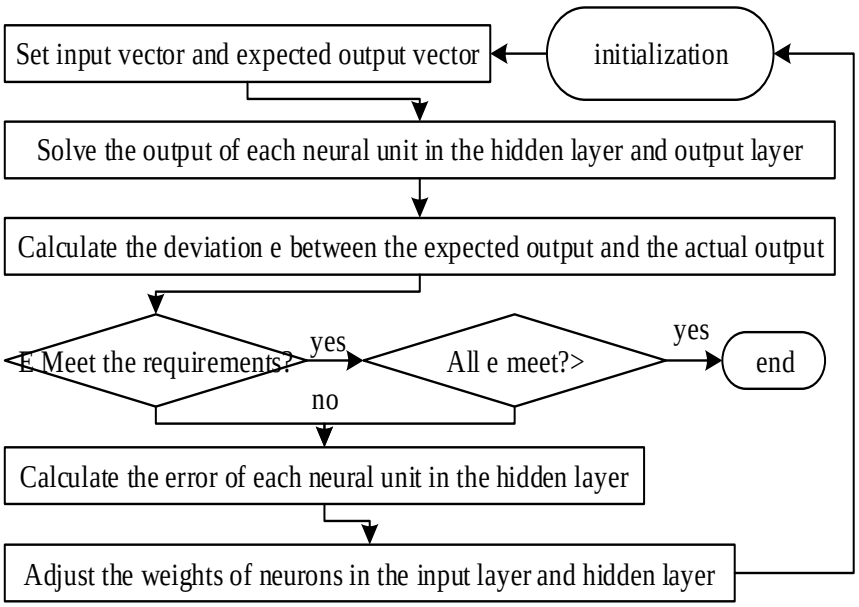


Figure 1. Learning process of BP NN

The formula of the learning algorithm is as follows:

Forward transfer from input to output

Initialize the network. Give each network node a random threshold with a range of (- 1,1), and set the training error function e and precision value ε And training steps M.

Calculate the input and output of each neuron in the hidden layer and output layer.

Input and output of hidden layer node

$$hi_l = \sum_{l=1}^{m} w_{il} * x_i - b_l \qquad l = 1,2,\Lambda\ , p \tag{1}$$

$$ho_l = f(hi_l) \qquad l = 1,2,\Lambda\ , p \tag{2}$$

Node input and output of output layer

$$yi_k = \sum_{k=1}^{p} w_{lk} ho_l - b_k \qquad k = 1,2,\Lambda\ , q \tag{3}$$

$$yo_k = f(yi_k) \qquad k = 1,2,\Lambda\ , q \tag{4}$$

Reciprocal of transfer function f (x)

S-type function $f(x) = \frac{1}{1+e^{-x}}$

Be

$$f'(x) = f(x) \cdot (1 - f(x)) \tag{5}$$

For input layer nodes

$$yo_l = f(hi_l) \tag{6}$$

$$f'(hi_l) = f(hi_l) \cdot (1 - f(hi_l)) \tag{7}$$

To output layer nodes

$$yo_k = f(yi_k) \tag{8}$$

$$f'(yi_k) = f(yi_k) \cdot (1 - f(yi_k)) \tag{9}$$

3. Experimental Study

3.1. Basic Implementation Steps of BP Neural Network (NN)

When using BP NN to forecast the demand of spare parts for CM, it is necessary to first determine the input, output and hidden layer structure of the NN, then select a training function, train the network, detect the training results, adjust the number of training steps and convergence errors, or adjust the number of hidden layer nodes, so that the training results can achieve the desired effect, and finally determine the network structure, After the network structure is determined, the demand for spare parts is predicted. In the implementation process, the following five issues need to be considered:

1) Understand the demand characteristics of spare parts of the enterprise, determine the various influencing factors related to the demand for spare parts of CM, and quantify each factor;

2) The historical usage data of the existing spare parts are processed, and the input and output training samples of the NN are established;

3) Determine the network structure, training function and convergence error of the NN;

4) Establish a forecasting model, and use the model to forecast the demand;

5) The demand forecast results of BP NN model are analyzed.

3.2. Optimization of EM Process

The management process of equipment mainly includes the mobilization stage, operation stage and scrapping stage.

1) Process optimization in equipment mobilization stage

Before optimization, the review work in the equipment mobilization stage only exists in the mobilization inspection, installation and commissioning, and is simple and suitable for the relevant materials of equipment mobilization. Most of the materials are not archived.

After optimization, economic and applicable equipment types shall be selected in strict accordance with the use parameters and production requirements when selecting or manufacturing equipment, and the environmental protection and safety of equipment shall be comprehensively considered. The specific process is shown in Figure 2:

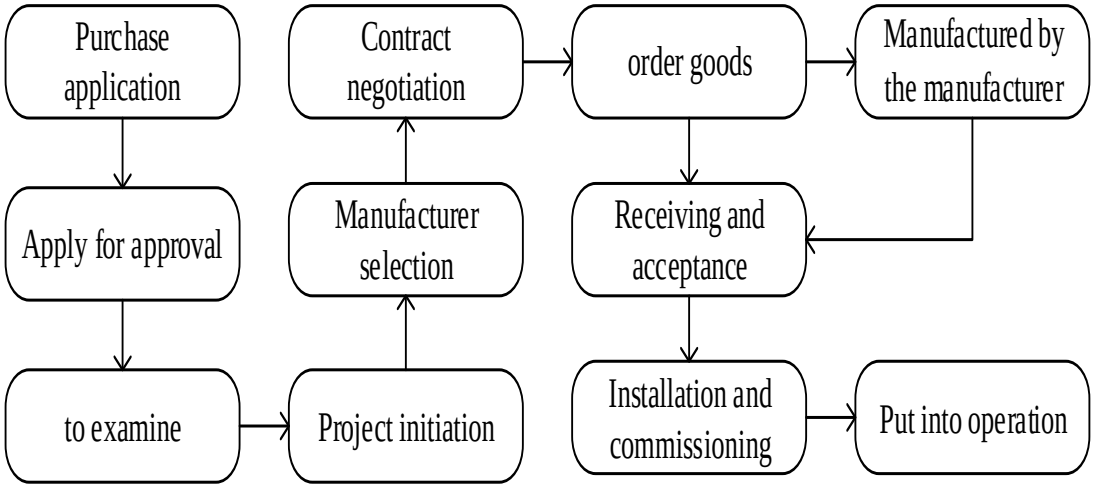


Figure 2. Process optimization diagram of equipment approach stage

All links shall be provided with written materials, mainly including: purchase application, purchase price comparison table, purchase contract, equipment acceptance report and acceptance form, equipment archives, etc. All processes before the equipment is put into use shall be carried out according to the EM regulations, and the management process at the birth stage of the equipment shall be continuously improved and perfected.

2) Management optimization in operation stage

In the equipment operation management, all management means, including repair, maintenance, maintenance, renewal and transformation, are designed to extend the service life of the equipment and enable the equipment to give full play to its maximum value to serve the production of the enterprise. In the modern EM, the safety and environmental protection management of EM are also

added, and the potential safety hazards of equipment are investigated and evaluated. This coincides with the value concept of "people-oriented" and the development of a harmonious society in China, and also reflects the production concept of "prevention first, safety first". In the optimized equipment operation management process, the management is always around the operation inspection - status inspection - performance inspection and other links, and the daily point inspection report, maintenance notice, safety inspection report, violation punishment list and other paper materials are finally formed and archived.

The process of equipment maintenance mainly includes checking and registering the equipment name, specification, installation date, manufacturer and service life; Evaluate and predict the main performance and safety risks of the equipment, and formulate prevention strategies and maintenance plans; Carry out daily inspection, formulate inspection plan, and carry out periodic, fixed-point and professional inspection according to equipment performance and failure rate; Repair and maintain the detected faults. The main written archive materials formed in the maintenance phase shall include daily inspection form, inspection result handling opinion, repair report, repair record, etc.

3) Management optimization in scrap stage

Before optimization, there was no detailed regulation on equipment scrapping. Equipment that reached its service life or was scrapped due to accidents should be handled by the Equipment Department in a unified way, and waste products should be recycled or put into the warehouse. This scrapping method will waste resources to a large extent, and also occupy inventory space, which is very unfavorable to the development of enterprises.

After optimization, the equipment scrapping management system is formulated, and the scrapping process is constantly updated and improved in the process of EM. As the service life of the equipment increases, the performance of all aspects gradually declines, and the cost of daily maintenance and maintenance becomes higher and higher. If the equipment still does not meet the renewal and transformation conditions after the evaluation of the equipment expert team, it will enter the scrap stage. For the scrapped equipment, the loss report and scrapping application form, evaluation report, scrapping process sheet, and scrapping approval opinion sheet shall be retained.

4. Analysis of Equipment Classification Management

The implementation of ABC classification method for EM according to certain principles will help improve the management efficiency. Improve the overall management level of equipment. To implement the ABC classification management method, a scoring table should be prepared according to certain standards to classify various equipment, and a classified maintenance method should be developed according to various classified equipment. The equipment classification scoring is shown in Table 1. Three levels of scoring criteria are set for the operation of equipment, the impact of equipment failure on other equipment, the impact on production operation and product quality, the difficulty of maintenance, and the purchase price of equipment. The scoring criteria are 5, 3, and 1, respectively. The scoring criteria for each level are quantified.

According to the above scoring table, the equipment is divided into three categories: A, B and C. Class A equipment plays a key role in the production of the enterprise, which affects the production efficiency and product quality; Class B equipment is the main equipment that must be used in the daily production of the enterprise; Class C equipment is general equipment, which is occasionally used and indispensable in the production process. Class A equipment accounts for 20% of the total equipment, Class B equipment accounts for 30%, and Class C equipment accounts for 50%. The

classification of main equipment is shown in Table 2:

ABC classification management should follow the principle of focusing on protection and giving consideration to all, pay attention to the management of Class A equipment, and do not relax the management of Class B and Class C. Focus on maintenance and repair of Class A equipment to avoid large losses caused by large-scale production stagnation due to shutdown of key equipment, and avoid high maintenance costs caused by overhaul; Class B equipment, which undertakes 50% of the company's production tasks, shall be repaired and maintained with secondary emphasis. Special personnel shall be assigned to regularly maintain such equipment, so as to avoid equipment failure and affect local production; General repair and maintenance shall be carried out for Class C equipment. Damage to Class C equipment will not affect the operation of the whole production, but attention shall be paid to the repair and maintenance of Class C equipment from the perspective of economy and environmental protection.

Table 1. Equipment classification rating table

Serial number	Equipment	Score	Scoring criteria
1	Workings	5	P 100 units/month
		3	50 units/month or more
		1	10 / month or more
2	Impact on other devices	5	Large area impact
		3	Local effects
		1	Does not affect the
3	Impact on production	5	Large degree of influence
		3	General Impact
		1	No effect
4	Ease of repair	5	⩾30 days maintenance cycle
		3	10-30 days maintenance cycle
		1	⩽10 days maintenance cycle
5	Equipment price	5	P 300000
		3	10-300000.
		1	100000 or less

Table 2. ABC classification of major equipment

Classification	The main equipment	Proportion
Class A	The main equipment on the production line	20%
Class B	Steel processing equipment, cutting equipment, welding equipment, cold processing equipment, melting equipment, pouring equipment, etc	30%
Class C	Grinding equipment, coating equipment, plastic equipment, sorting and packaging equipment, shear equipment, etc	50%



Figure 3. Analysis of ABC classification proportion of major equipment

The management of Class A equipment should start from the perspectives of standing book, coding, specialist management, spare parts storage, key maintenance, assessment, responsibility system, skill training, etc., and increase the management and maintenance system of Class A equipment to ensure that important equipment related to production efficiency operates well. The management contents of Class B and C equipment shall refer to Class A, and corresponding management contents shall be taken into account to ensure the overall improvement of EM level. The management of Class A, B and C equipment is detailed in Table 3 below:

Table 3. Equipment classification management and maintenance methods

Assessment items	Class A	Class B	Class C
Equipment archives	Key management, complete data	Complete information	No mandatory requirements
Management responsibility system	Strict implementation to people	To people	Does not require
Are qualified	A certificate is required	A certificate is required	Does not require
Operating rules	Special regulations	General rules	General rules
Maintenance regulations	Special regulations	General rules	General rules
Maintenance requirements	The key of maintenance	Preventive maintenance	After the repair
Maintenance plan	Priority repair	Tight after repair	Later maintenance
Maintenance record	Information is complete	Complete main information	Does not require
Accessories for	Reserve 100% spare parts	Reserve 80% spare parts	Does not require
Assessment indicators	Focus on technical and economic indicators	General assessment of technical and economic indicators	No assessment
The security check	1 time/month	1 times/seasons	1 time/year

All equipment maintenance shall be classified, and equipment maintenance plans shall be formulated according to the actual situation of EM, as shown in Table 4:

Table 4. Equipment maintenance plan

category	Maintenance level	Maintenance frequency	Fund input	Repair sequence	Standards and effects	Main responsible department
Category A	Level I	January	70%	Priority maintenance	As shown in Table 3	Equipment Department
Category B	Level II	March	20%	After maintenance	As shown in Table 3	Equipment Department
Category C	Level III	December	10%	Repair later	As shown in Table 3	Equipment Department

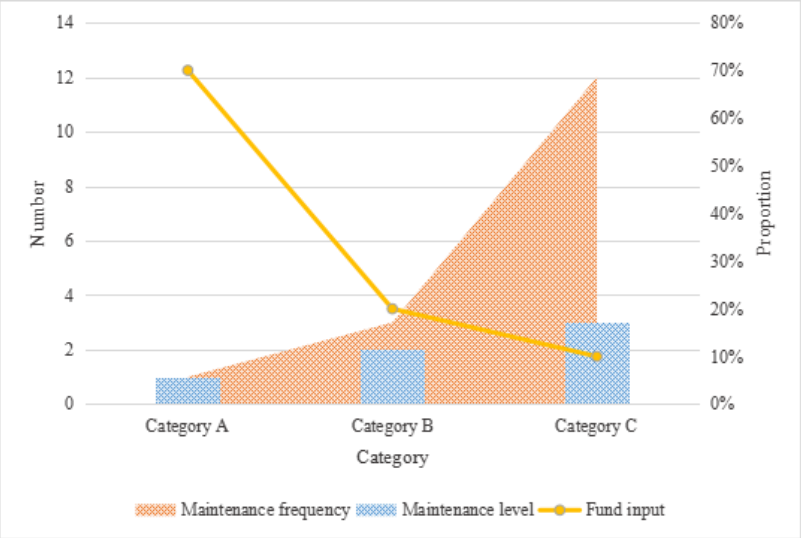


Figure 4. Equipment maintenance plan analysis

After using ABC classification method, the Equipment Department can formulate a detailed maintenance plan according to the importance of EM. In the maintenance level, Level I is the highest. Level I maintenance standard is adopted for Class A equipment, and the investment accounts for 70% of the total funds. Priority maintenance is adopted, especially the storage of sufficient spare parts. The Equipment Department is fully responsible for equipment maintenance, and is responsible for the use and operation of the equipment in production.

5. Conclusion

EM is an important part of enterprise management in manufacturing industry, which is related to the smooth progress of enterprise production and the economic lifeline of enterprise development. In the future, EM will pay more attention to the management of people and equipment. The future

enterprise competition is not only the competition of products and services, but also the competition of talents. We have formally grasped the general trend of future enterprise development, paid attention to the introduction and training of talents, and improved the overall management level by relying on the strength of talents. With the rapid development of the manufacturing industry, the traditional manufacturing mode: the traditional manufacturing mode in which each manufacturing workshop works independently and the upper planning layer is not closely connected with the lower control layer, cannot meet the new demand brought by the rapid and continuous development of the manufacturing industry. New demands, such as increasingly diversified customer needs, small batch customization, increasingly complex product processes, increasingly shortened production cycle requirements, and increasingly lean enterprise management, have forced the traditional manufacturing model to transform and upgrade to an integrated and intelligent direction.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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