Evaluation System and Implementation Countermeasure of Automobile Green Maintenance

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Abstract. Green maintenance research is in the beginning of our country, the work is being explored. Based on the existing research results at home and abroad, this paper learns and draws lessons from the experiences and lessons of foreign advanced countries and domestic advanced enterprises. In the face of the challenges brought by economic development and energy saving and emission reduction, this paper discusses the green maintenance theory and security system , And the research status of green maintenance content and system at home and abroad, through the deletion and selection of green maintenance index, through the AHP method to determine the green evaluation criteria, and the introduction of C equivalent evaluation system, the use of fuzzy synthesis Evaluation method to build a green maintenance evaluation model, and the actual validation, put forward the implementation of green maintenance feasibility programs and related security recommendations, vehicle maintenance enterprises to carry out green maintenance, improve business efficiency and reduce environmental management costs to provide theoretical basis. And to achieve effective reduction of environmental pollution, reduce maintenance costs of the target, a reasonable promotion of maintenance and environmental protection and sustainable development. Promote green maintenance from research to practice, from the laboratory to the maintenance of enterprises, from the pilot to the overall development and transformation.

1. Introduction

With the continuous shortage of various mineral resources, environmental pollution problems have become increasingly prominent, and now the green car repair has become a hot topic. As the traditional maintenance technology on the use of unreasonable resources for environmental impact is not conducive to environmental resources and social sustainable development. Implementation of vehicle green maintenance, can effectively reduce environmental pollution, improve resource utilization and enhance the comprehensive competitiveness of enterprises.

As the current green industry in China's auto industry in the development of the initial stage, maintenance evaluation criteria still need to discuss and explore the current industry there are many problems, and maintenance units and individuals to deal with green maintenance attitude and fuzzy, environmental protection awareness, In the environmental protection initiative is poor, weak sense of responsibility, not active, or even conflict. Enterprises did not put green maintenance and environmental protection as their own self-conscious behaviour, the emergence of this situation so that China's green maintenance has received a serious obstacle to the maintenance of the sustainable

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development of enterprises is very large. But with the environmental problems become increasingly prominent and serious, will force the car repair enterprises to increase investment in environmental pollution control, resulting in increased vehicle maintenance costs, corporate burdens increase. The benefits of the implementation of green maintenance is not only reflected in the waste through the excavation of the residual value to reduce resource consumption and reduce maintenance costs to obtain direct economic benefits; but also, can be indirectly on the economic benefits, through energy conservation to enhance corporate environmental image, Get more customer welcome. Therefore, on the basis of the development of green maintenance at home and abroad, this paper also draws lessons from the practical experience of green maintenance at home and abroad, and discusses the development of green maintenance evaluation system and implementation plan according to the actual characteristics of automobile maintenance point in China. Promote green maintenance to provide a strong reference, has important practical significance.

2. Green Maintenance Technology and Present Situation of Automobile

2.1. Introduction to green maintenance

Automotive green maintenance technology is a complex and diverse, all-round three-dimensional project, which mainly reflects the maintenance of environmental friendliness, efficient use of resources and can be fully controlled, effective control of environmental pollution and so on. Green maintenance technology, which is a scientific and rational use of maintenance resources to reduce environmental pollution, to avoid energy waste, all aspects of multi-form to improve vehicle maintenance operations green maintenance means. It can also be understood that the use of parts cleaning technology, environmental protection material replacement, heat treatment, machining, surface engineering and other advanced maintenance technology and other technical processes alone or in combination with the method in order to effectively reduce or eliminate the car in the maintenance process activities on the surrounding the adverse effects of the environment. Its main maintenance techniques include: green diagnostics, quick maintenance, thermal spraying and green cleaning and other technical means. Compared with the traditional maintenance, green maintenance should follow the following five points: the rational use of resources, the effectiveness of pollution control, labour protection and friendly, advanced technology and comprehensive benefits of the best.

2.2. Investigation on Green Maintenance Condition of Automobile in a City.

This article mainly to a city 4s shop for the statistical station to a small family car as a statistical object, through the stay statistics and collection of accessories sales data combined with the way to statistics. This article collected a total of 4s shop 12 months of maintenance data.

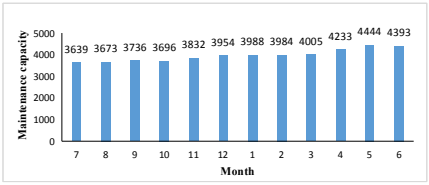

Figure 1. Statistics of household car maintenance in a city

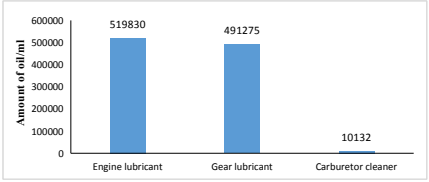

Figure 2. A city household car repair waste oil statistics

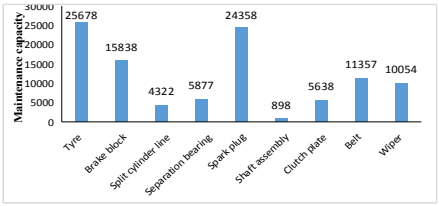

Figure 3. A city household car waste accessories statistic

The statistical data into the annual output of the bicycle, more intuitive to determine the maintenance process in the vehicle, the largest amount of waste oil, followed by waste accessories. According to the composition of materials are waste oil, waste metal and waste rubber.

3. Construction of Green Maintenance Evaluation System

3.1. Construction principles

Through the basic connotation of green maintenance evaluation system analysis of the principle of analysis, only consider the green and maintenance success rate is far enough, but should consider the environmental protection, maintenance attributes at the same time, should further consider the economic, environmental, resource and energy and safety and other factors, to achieve the ecological environment and maintenance of sustainable development of enterprises. Therefore, the evaluation objectives of green maintenance are divided into points: maintenance attribute index, resource attribute index, energy attribute index, environmental attribute index, economic attribute index and dynamic attribute index. Green maintenance evaluation In determining the evaluation index and the weight of the process must be clear to the green as the prerequisite to ensure that the evaluation index has a typical representative, as accurately as possible to reflect the maintenance process of green characteristics.

3.2. Evaluation method

3.2.1. Introduction and Construction of Carbon Equivalence Evaluation. In order to better quantify the green maintenance of comparative analysis, this paper will be introduced C equivalent, so as to better quantitative analysis. By quantifying the environmental impact, that is, the degree of environmental friendliness, it simply reflects the green level of vehicle maintenance. The so-called green carbon equivalent is a concept closely related to environmental impact, that is, with the degree of environmental compatibility, simply means that the car repair process generated by the conversion of carbon into the size of the waste. The smaller the carbon equivalent, the greater the positive impact of the maintenance business on the environment, and vice versa.

3.2.2. Construction of carbon equivalent evaluation index system. Through the environmental management system standard, combined with the principles of comprehensive, scientific and operational principles and plans of green maintenance evaluation index system framework, classification and level analysis of vehicle maintenance enterprises to implement green maintenance effect of all factors, after consulting the views of scholars, the carbon equivalent evaluation index system is divided into three layers, as shown in Table 1.

Table 1. Green maintenance C equivalent evaluation

Target layer	Criterion layer (level 1)	Sub-criteria layer (secondary indicator)
Green maintenance business C equivalent (V)	Repair the C equivalent (V_1)	Maintenance technology green advanced (V_{11})
		Hybrid equipment green advanced (V_{12})
	Resource attribute C equivalent (V_2)	Material utilization (V_{21})
		Material recovery rate (V_{22})
		Use of toxic materials (V_{23})
		Use of toxic materials (V_{24})
		The proportion of professionals (V_{25})
		The popularity of green knowledge (V_{26})
	Energy attributes C equivalent (V_3)	Renewable energy utilization (V_{31})
		Energy clean (V_{32})
		Clean the raw materials (V_{33})
	Security attribute C equivalent (V_4)	Maintenance of the safety level (V_{41})
		Post-maintenance user safety level (V_{42})
		Through the proportion of environmental management related certification qualifications (V_{43})
	Environment attributes C equivalent (V_5)	End of the "three wastes" recovery (V_{51})
		Process "three wastes" control ability (V_{52})
		Noise pollution control capability (V_{53})
	Economic attribute C equivalent (V_6)	Annual environmental investment as a percentage of sales revenue (V_{61})
		Maintenance costs (V_{62})
		Environmental pollution control costs (V_{63})

3.2.3. Fuzzy Analytic Hierarchy Process. Select 20 experts, through the expert evaluation according to the level of factors between the elements of the comparison between the establishments of a comparative judgment matrix, and determine the next layer relative to the importance of a factor on a layer, given a certain score. Establish judgment matrix:

$$U = \begin{Bmatrix} D_{11} & \cdots & D_{1n} \\ \vdots & \ddots & \vdots \\ D_{n1} & \cdots & D_{nn} \end{Bmatrix}$$

When the judgment matrix satisfies the condition of $D_{ij} = \frac{1}{D_{ij}}(i \neq j)$; $D_{ij} = 1(i = j)$; $D_{ij} \bullet D_{jk} = D_{ik}$, it can be regarded as a completely consistent matrix. The mean and deviation of each element in the judgment matrix are solved by the relevant judgment results given by the $\overline{D}_y = \frac{1}{20}\sum_{p=1}^{20} D_{pij}$ and $\overline{D}_y = \frac{1}{20}\sum_{p=1}^{20}(D_{py} - \overline{D}_y)^2$ recovery experts. Repeatedly reclaiming experts to determine the results and supplementary materials, re-establish the matrix until the elements of the mean and the deviation is not greater than the first standard value can be regarded as experts agree.

Weight calculation: first solve the eigenvector in the judgment matrix, and then use the normalization method to meet the $\sum_{i=1}^{n} bn = 1$ conditions. The resulting feature vector $B = [b_1, b_2 \cdots, b_n]^T$ is the weight vector network. And calculate the maximum eigenvalue $\lambda_{\max} = \sum_{i=1}^{n} \frac{[UB]_i}{nB_i}$.

The consistency index of the judgment matrix is obtained, and the consistency is detected. Calculate the consistency index: $DI = (n - \lambda_{\max})/(1-n)$. If the formula $D_{ij} \bullet D_{jk} = D_{ik}(i, j, k = 1,2,\cdots,n)$ holds, the remaining matrix eigenvalues of $n = \lambda_{\max}$ are zero. If n is slightly smaller than the rest of the eigenvalue is approximately zero, then the judgment matrix has good consistency.

Green maintenance business carbon equivalent evaluation set as follows:

$$W = \{W_1, W_2, \ W_3, \ W_4\}\{\text{excellent,good,medium,difference.}\}$$

The scores are defined as:

$$W = \{W_1, W_2, \ W_3, \ W_4\} = (1.2,1,0.8,0.6)$$

From the implementation of the green maintenance of enterprises to select some of the business management familiar with the management or technical staff, so that they give evaluation of green maintenance, the formula $S_{ij} = W_{ij} \Big/ \sum_{i=1}^{n} W_{ij}$ to calculate all the indicators corresponding to the membership of each comment. In the formula, $j = (1,2,\cdots,m)$ can get fuzzy judgment matrix:

$$S_i = \begin{Bmatrix} S_{11} & \cdots & S_{14} \\ \vdots & \ddots & \vdots \\ S_{i1} & \cdots & S_{i4} \end{Bmatrix}$$

First, the single factor fuzzy evaluation is carried out, and the calculated fuzzy evaluation matrix is used to find the corresponding single factor evaluation vector according to the formula $C_i = B_i \bullet S_i(c_{i1}, c_{i2}, \cdots, c_{i4})$. The same method is used to combine the weight coefficients of the matrix b_i and S_i. Use the formula $X = C \bullet D^T$ to find the comprehensive evaluation value. In the formula, D^T is the transpose matrix of D, which is the green matrix of the green maintenance evaluation grade. C is the final comprehensive evaluation vector. If X <1, it means that the implementation of green maintenance business green maintenance degree is greater than the industry scholars believe that the standard value.

4. Study on the Implementation of Green Maintenance

Through the analysis of carbon equivalent evaluation index and the corresponding improvement measures and suggestions, the implementation plan and suggestion of green maintenance are put forward from the aspects of maintenance management, "three wastes" control, recycling and so on, and the status of automobile maintenance in this city.

First of all from the green management requirements of maintenance management point of view:

a). Improve the awareness of environmental protection practitioners, and enhance professional quality

Green vehicle maintenance personnel should establish the concept of green maintenance, in accordance with the test results before maintenance to develop a scientific and effective operation program to reduce the unnecessary repair in the process. At the same time should also be responsible for communication with customers to promote green maintenance concept, green maintenance concept, in the case of customer feelings, and obtain their identity, maintenance companies can use to achieve the use of standard repair parts and quality of the renovation of the tire Replacement repair, but absolutely not shoddy, so greatly improve resource utilization. In the sheet metal painting, it should control the operation of noise pollution; reduce dust and volatile toxic and hazardous substances

emissions. Modern vehicle green maintenance requires a large number of outstanding management personnel and technical personnel, professional and efficient vocational skills training is not only an urgent task of China's auto repair industry, but also an important source of business maintenance personnel.

b). Equipped with green maintenance equipment, improve maintenance efficiency

With the continuous development of science and technology, decentralized independent maintenance testing equipment in the electronic technology to achieve information transmission, to the integration of the conditions, is moving in the direction of mechanical and electrical integration. Advanced automotive green maintenance technology must be based on advanced scientific diagnostic technology, really does the diagnosis. Increase investment in green equipment, the table is currently on the market the main green equipment and energy saving. In the maintenance process to pay attention to the maintenance of personnel, especially in some key processes, to properly wear ventilators, safety glasses, gas masks and so on. To prevent sheet metal, welding, grinding and polishing, cleaning parts and painting operations caused by injury.

c). Improve the organization and leadership system, strengthen management efficiency.

Through the sound system, the establishment of the organization and improve the information and other means to achieve the establishment of a sound organization and leadership. Responsibilities of the departments and the responsibilities of the responsible persons, including the treatment of waste gas, waste water and waste, must be responsible for the equipment, facilities and storage of the recycling sites. Collect and maintain updated laws, regulations and policy documents on energy conservation and environmental protection. The establishment of a comprehensive staff environmental knowledge training records, enterprise energy conservation and environmental events record, environmental protection facilities and total items purchase, maintenance, use and management records, as well as the collection of waste, processing and recycling records.

From the maintenance activities arising from the "three wastes" control point of view:

Standardize vehicle maintenance business and personal maintenance activities. To repair the car into the maintenance field after the first inspection, and then sent to the corresponding maintenance workshop, and then check out the fault or the problem of the corresponding removal, repair or replacement of damaged parts, the need for surface repair to the first sheet metal Shop repair, and then sent to the paint room to implement paint or paint, if no surface repair, then sent to the repair shop for repair.

For tail gas and welding dust control, should be poor ventilation in the workshop and the workshop to install smoke and exhaust collection device, the effective discharge of exhaust and soot, if the collection of exhaust and dust without purification also installed with a purification function Device. For the control of the spray paint exhaust gas, it should be equipped with a water film type paint mist treatment device and an activated carbon adsorption device in the paint room to absorb and purify the spray paint exhaust gas. Maintenance of the waste is mainly waste oil and waste water; the general maintenance stations have carried out a special recycling of waste oil. Maintenance of the enterprise drainage facilities should be implemented rain sewage pipe network separation, living, office waste water to be discharged into the sewage pipe network; car wet grinding, car washing, cleaning and maintenance workshop ground generated waste water should also be discharged into the local sewage pipe network, Row to the rainwater pipe network or directly into the river and soil. The waste generated during the repair process should be stored separately and classified according to the hazard classification by the professional recycling department.

5. Summary

The research on evaluation system and implementation plan of green maintenance of automobile is mainly focused on the following aspects: from the analysis of green maintenance evaluation objectives, put forward the construction principle and based on the AHP method to establish the vehicle green maintenance evaluation index framework; try to introduce carbon equivalent evaluation index, The model of green maintenance evaluation was established by fuzzy comprehensive evaluation method,

and the calculation method of carbon equivalent was used to evaluate the carbon equivalent of a maintenance station by using the model. , The evaluation conclusion, feedback maintenance business green maintenance level, to promote the maintenance of enterprises to improve maintenance methods and vehicle maintenance enterprises to implement green maintenance has a reference and reference value.

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