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New Power Machinery Manufacturing Incorporating Sustainable Development Principles

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Abstract: Green manufacturing is the embodiment of human sustainable development principles in manufacturing industry, which considers the environment and resources to meet the needs of economic development as well as to make them directly meet the needs of human long-term survival as one of the elements of human survival, thus forming a comprehensive development strategy. In order to solve the shortcomings of the existing research on new power machinery manufacturing integrating sustainability principles, this paper briefly discusses the application of weight analysis and life cycle evaluation for the new power machinery manufacturing service platform integrating sustainability principles proposed in this paper, based on the discussion of sustainability principles, problems of new power machinery manufacturing and fuzzy hierarchical analysis. The design of the service platform is also discussed, and finally the manufacturing solution integrating sustainability principles is experimentally analyzed with the original solution. The experimental data show that the manufacturing solution integrating sustainability principles has a better impact on environment, energy, resources and economy, where the impact on environment reaches 0.768, which is greater than the overall score. Therefore, it is verified that the integration of sustainability principles can bring good benefits to new power machinery manufacturing companies and society.

1. Introduction

Since the new century, although the new power machinery manufacturing has been developed rapidly, the phenomenon of environmental pollution and resource shortage has become more and more serious, and it is urgent for people all over the world to change the development mode and take the route of sustainable development. Among them, the research and design of sustainable improvement of machinery products is particularly important.

Nowadays, more and more scholars are conducting a lot of researches and practical researches

through various technologies and system tools in the manufacturing of new power machinery integrating the principles of sustainable development. The aim of Duan D is to propose a model and indicators to evaluate the energy efficiency of the foam ceramic filter sintering process selection for smart sustainable product manufacturing through ceramic and metal-ceramic products manufacturing examples, discussing the implementation of energy-intensive technological processes in such clusters. Manufacturing ceramic and cermet products in high-temperature furnaces is associated with increased power consumption. The use of modern ceramic micropowders and nanopowders makes it possible to shift to more energy-efficient technologies by reducing sintering temperatures and shortening process cycles. This requires the use of additional activating and inhibiting additives in the initial powder mixture to obtain products with the necessary physical and mechanical properties [1]. Lapka M The lean production management in the mechanical manufacturing industry is characterized by many problems such as high investment in machinery and equipment, high pollution caused by waste, and poor production planning. Sanitation problems at production sites are serious. The idle and waste materials do not meet the standards and cause problems such as waste of materials. It is not in line with the concept of sustainable development of machinery manufacturing industry. The guiding ideas and objectives of deepening lean product manufacturing management, establishing a unified product manufacturing management platform, improving manufacturing processes, and strengthening the application of computers in the machinery manufacturing industry were proposed to improve the level of sustainable development in the machinery manufacturing industry [2].The purpose of the study by Salimova G was to identify the sustainable manufacturing strategies commonly used by multinational companies in Nairobi and to establish the relationship between sustainable manufacturing strategies and productivity. A descriptive research design was used. Regression analysis was used to determine the relationship between production strategies and productivity. The study revealed that it is recommended to adopt and implement sustainable strategies to improve production efficiency as it will enable manufacturing MNCs to optimize their production efficiency in terms of unit production cost, product quality and product development time. MNCs should effectively integrate their resources to enhance their operations and adopt manufacturing models that are developed to match their operations and target customers [3]. Although there is a wealth of existing research on new power machine manufacturing, there are limitations in the research on new power machine manufacturing that integrates sustainability principles.

In this thesis, a new power machinery manufacturing service platform based on sustainability principles is designed and implemented. The platform is designed to reduce the cost of using and maintaining the new power machine manufacturing for enterprises. The platform can help machinery manufacturing enterprises to improve efficiency, so that enterprises can share resources, information sharing, and effectively reduce the costs of enterprises.

2. Sustainable Development Principle of the New Power Machinery Manufacturing

2.1. Sustainable Development Principles

(1) Fairness within the generation

Mainly refers to the generation of the enjoyment of a good environment and the use of natural resources have equal rights, regardless of their nationality, race, culture and economic development level differences [4].

(2) Sustainable manufacturing

Sustainable manufacturing refers to the manufacturing of resources that can continue and are not

depleted [5]. For renewable resources, sustainable manufacturing refers to the normal continuous manufacturing under the condition that its regenerative properties are guaranteed [6].

(3) Integration of environment and development

The integration of environment and development refers to the organic integration of environmental protection with other aspects such as society and economy to promote their simultaneous and coordinated development [7]. It is required that this element of protecting the environment must be taken into account when planning the development of other aspects such as the manufacture of new power machinery [8].

2.2. New Power Machine Manufacturing

In this paper, we focus on the impact of the new power machinery manufacturing product life cycle process on four aspects: environment, economy, energy, and processing as a surface issue [9]. Then, the technical and economic problems appearing in the manufacturing stage are analyzed and summarized, and the main problems are summarized [10]. The two main parts include processing and manufacturing and assembly.

(1) Processing and manufacturing stage.

1) Economic aspects: high processing and manufacturing costs; low product qualification rate; long processing and manufacturing time; serious waste of raw materials in the manufacturing process [11].

2) Energy and resources: high consumption of energy and resources in the manufacturing process; high emissions of waste in the manufacturing process, which not only pollute the environment and waste resources but also have dangerous waste; poor renewable nature of the resources or energy used, pollution, and low storage capacity [12].

3) Processing technology: processing and manufacturing processes, sometimes requiring multiple processes to complete; complex structure of parts, long processing time, processing difficulties, and sometimes require secondary processing of some parts [13].

(2) Assembly stage:

1) Economic aspects: the complexity of the mechanism causes high assembly costs, low assembly efficiency and long assembly time, and the difficulty of assembly [14].

2) Technical aspects: assembly of irregular parts, poor precision, low strength, complex structure, and large number of parts increase the difficulty of assembly [15].

2.3. Fuzzy Hierarchical Analysis Method

The top-down multi-level fuzzy hierarchical analysis method is used for the sustainable and comprehensive evaluation system of mechanical products. This paper focuses on the construction steps of the weight judgment matrix [16].

On the basis of establishing the comprehensive evaluation index, the judgment matrix $C=(c_{xy})_{m\times m}$ of a certain level F_n is obtained by comparing the elements of the same level in two discriminations, and the specific steps for calculating the weights are as follows:

Calculate the product H_x of each row in the judgment matrix of order m, is:

$$H_x=\prod_{y=1}^{m}c_{xy},x=1,2,...,m \tag{1}$$

Where c_{xy} denotes the element in row x and column y.

Compute the m th root $\overrightarrow{Q_x}$ of H_x, so:

$$\overrightarrow{Q_x}, = \sqrt[m]{Q_x}, x = 1,2,...m \tag{2}$$

The eigenvalues Q_x are obtained by normalizing $\overrightarrow{Q_x} = (\overrightarrow{Q_1}, \overrightarrow{Q_2} ... \overrightarrow{Q_m})$, is:

$$Q_x = \frac{\overrightarrow{Q_x}}{\sum_{x=1}^{m} \overrightarrow{Q_x}}, x = 1,2,...m \tag{3}$$

That is $Q = (Q_1, Q_2 ... Q_m)$, is the desired eigenvector, and also the element $C_x (x = 1,2,...m)$ weight. Calculate the maximum eigenvalue $\gamma_{\max}$:

$$\gamma_{\max} = \frac{1}{m} \sum_{x=1}^{m} \frac{(CQ)_x}{Q_x} \tag{4}$$

In the above equation, C is the $m \times m$-order judgment matrix Q is the weight vector, and $(CQ)_x$ denotes the x th element of the column vector obtained by the product of matrix C and vector Q.

3. Survey Study of New Power Machinery Manufacturing Integrating Sustainability Principles

3.1. Weighting Analysis under Sustainable Attributes

The weight analysis under sustainable attributes is based on the comprehensive sustainability evaluation system. After the comprehensive sustainability evaluation of the product, several indicators with the highest hazard index are identified, and then the causes of these indicators are analyzed, and finally the above information is integrated to conduct weight analysis for each stage of the product life cycle [17-18]. For example, the judgment matrix for each stage of the life cycle was constructed as shown in Table 1.

Table 1. Sustainability judgment matrix

Category	Material development	Product manufacturing	Product transportation	Products use	The weight
1	2	4	5	5	0.6547
2	2/3	2	5/3	5/3	0.4325
3	1/3	2/5	2	2	0.2352
4	1/3	2/5	2	2	0.1092

3.2. Application of Life Cycle Assessment

As an environmental management tool, LCA is conducted for the whole product system with the aim of identifying opportunities for improvement and ultimately improving the environmental performance of the product itself without additional cost. The ISO14000 standard divides the technical framework of life cycle assessment into four parts: the technical framework of life cycle is shown in Figure 1:

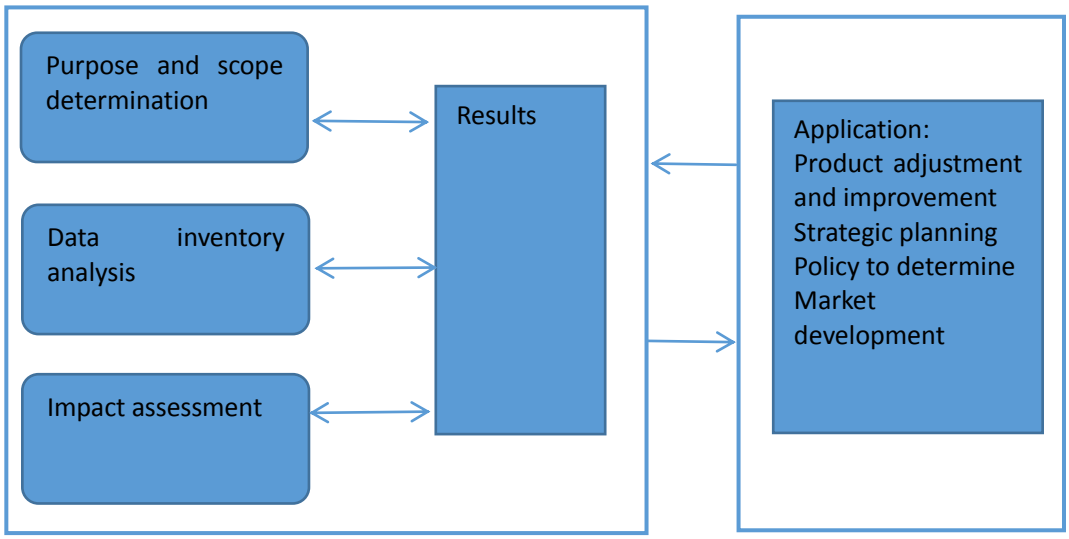

Figure 1. LCA technology framework

4. Research on the Application of New Power Machinery Manufacturing Integrating Sustainable Development Principles

4.1. New Power Machinery Manufacturing Service Platform Integrating Sustainable Development Principles

(1)Resource analysis of energy waste and environmental impact caused by by-products: The by-products in the process are generally waste water, exhaust gas, waste heat and processing residues, etc. These by-products not only contain their own energy but also mostly affect the environment, so we can analyze the resources of the whole system and consider the by-products as available resources and apply them to the system, which will reduce the by-products and thus improve the utilization rate of materials and thus This will reduce by-products and thus improve material utilization, thus reducing waste of material and energy resources. Resource analysis can be performed by creating a resource analysis list (Figure 2).

(2) Subsystems or parts with complex or irregular structures lead to difficult machining processes

1) Conflict matrix and the principle of invention: the structure to be processed for improved design or innovative design often encounter design contradictions or conflicts, such as simplifying the complexity of the structure of the part but cannot guarantee the effective realization of the function of the part, or a more effective realization of the function of the part.

2) Physical conflict and separation principle: we hope that in the use of all parts of the stage of function can be better achieved, which requires the complexity of the relevant parts to be high, in

the processing and manufacturing stage we hope that the processing process is simple, which requires the complexity of the relevant parts to be simplified.

(3) Tailoring: the core of tailoring is to analyze the function of the product system under the premise of removing some components, and then use resources to reallocate to ensure the realization of the function, the role of tailoring will generally simplify the structure and reduce costs.

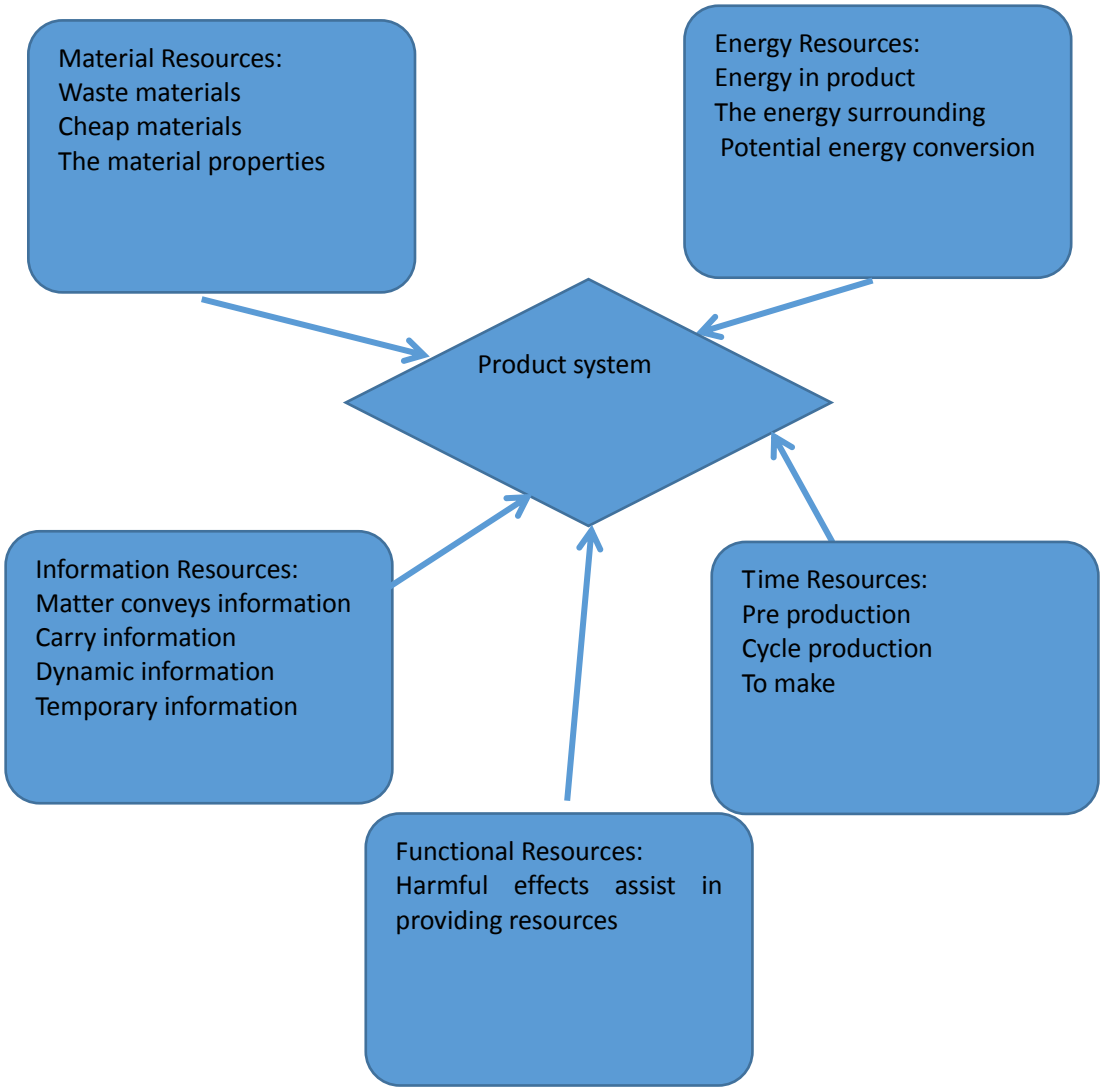

Figure 2. Product resource analysis

4.2. Integration of Sustainable Development Principles of New Power Machinery Manufacturing Applications

We can use the effect to improve from the functional point of view, or we can use the resource analysis and standard solution to improve the design from the technical point of view. We choose the product improvement solution that is formed by the combined effect of resource analysis methods in Figure 1. The new solution incorporating sustainability principles is then re-evaluated for sustainability in a comprehensive manner, and Table 2 can be obtained.

Table 2. Sustainability evaluation results

Project	Original plan	New scheme
Environmental properties	0.356	0.768
Economic attribute	0.217	0.245
Resource properties	0.319	0.326
Energy attributes	0.189	0.217

According to Table 3, we can see that the total environmental impact index of the product is EI=0.3579, so the comprehensive sustainability evaluation score of the new solution is T=0.768>0.6, so the improved product meets the requirements of sustainability. In order to better compare the difference between the new solution and the original product, the data in Table 3 was imported into EXCEL to generate a bar chart.

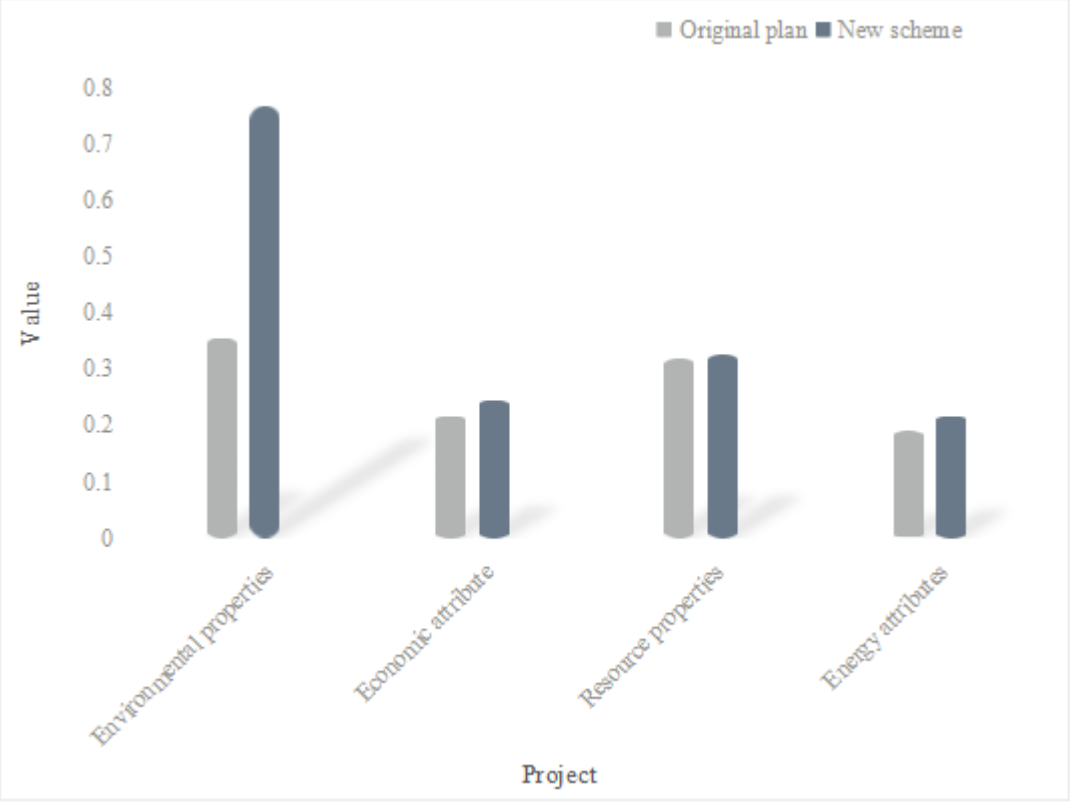

Figure 3. Comparison of sustainable development indicators

Through Figure 3, we can clearly see that the new scheme has significantly improved each attribute (environmental attributes, economic attributes, resource attributes, and energy attributes) in the comprehensive sustainable evaluation system compared with the original scheme, thus achieving the purpose of sustainable development. The most significant improvement is the impact on the environment. The new scheme has improved the economic impact to 0.245, the resource impact to 0.326 and the energy impact to 0.217 compared to the original scheme. The overall data above shows that the new power machinery manufacturing scheme integrating the principles of sustainable development has a sustainable effect on the whole process of product manufacturing.

5. Conclusion

Based on the theoretical research and exploration, this paper introduces the basic principles and application methods of the sustainable manufacturing assessment tool for new power machinery manufacturing, elaborates the steps of constructing the judgment matrix of the tool for sustainable manufacturing evaluation, and shows the judgment matrix of specific weights. On this basis, a new power machine manufacturing product was selected as an improvement object, and the main process of its manufacturing was taken as an example. The analysis and product improvement methods for sustainable resource and energy under different subsystems and parts processing were analyzed, and the results were in line with the actual experience, which proved that the sustainable development method for new power machine manufacturing was practical and feasible, and the designed and developed sustainable assessment tool The design and development of the sustainability assessment tool has achieved the expected results.

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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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