

Article

Evaluation of Economic Security and Environmental Protection Benefits from the Perspective of Sustainable Development and Technological Ecological Environment

Jingtong Li ¹ and Qing Hai ^{2,*}

¹ School of Marxism, Harbin University, Harbin 150086, China

² Department of Civil Engineering, Hetao College, Bayannur 015000, China

* Correspondence: htxyhaiqing@126.com

Abstract: Under the concept of sustainable development, problems such as high resource consumption, serious environmental pollution and ecosystem degradation are the main factors restricting the sustainable development of economy. This paper aims to analyze the benefits of economic security and environmental protection from the perspective of sustainable development and scientific and technological ecological environment. This paper puts forward the construction of the indicator system for the coordinated development of eco-technology innovation and economic environment, and analyzes the experimental results of economic security and environmental benefits on this basis. The experimental results of this paper show that after the implementation of the eco-technology innovation management system (hereinafter referred to as IEIMS for convenience), the material utilization rate and unit cost are essentially stable, and the cost is significantly lower than before.

Keywords: economic and environmental benefits; sustainable development; technological ecological environment; environmental protection; China science and technology



Citation: Li, J.; Hai, Q. Evaluation of Economic Security and Environmental Protection Benefits from the Perspective of Sustainable Development and Technological Ecological Environment. *Sustainability* **2023**, *15*, 6072. <https://doi.org/10.3390/su15076072>

Academic Editors: Amrit Mukherjee, Ranjay Hazra and Rudolf Vohnout

Received: 3 February 2023

Revised: 6 March 2023

Accepted: 28 March 2023

Published: 31 March 2023



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1. Introduction

With the development of human society, a large number of natural resources have been consumed and destroyed. Especially after the Second World War, the process of industrialization and urbanization in the world has gradually accelerated, and the rapid economic development has made the excessive use of natural resources exceed the normal load of nature, causing great adverse effects. With the rise in increasingly serious environmental problems, many economists began to question the value of economic growth in a narrow sense. They believed that only pursuing the growth of gross national product and ignoring social welfare would damage the living environment, living conditions and social welfare of human beings, resulting in the reduction of overall quality. In order to solve the problems of high resource consumption, serious environmental pollution and ecosystem degradation, this paper puts forward the concept of harmonious development of economy and environment, and uses the comprehensive evaluation index system to establish the system of harmonious development of economy and environment. SD involves all links and processes of social development. Economic safety and environmental protection benefits are the most direct and realistic benefits of economic development achievements. The technological ecological environment is an important guarantee and supporting condition for achieving sustainable economic and social development.

Based on the existing research results, scholars have carried out relevant research on economic and environmental benefits. Matthew Carmona discussed the relationship between architectural environmental quality and its value from four aspects of health, society, economy and environment [1]. The interaction between environmental pollution and economic development is related to the extent to which developing countries achieve the goal of green growth. In economic development, if social, political and economic factors

effectively curb pollution, then the economy would be based on the inverted U-shaped Kuznets curve. Therefore, Samuel Egbetokun took Nigeria as a case to study the environmental Kuznets curve and combined it with six environmental variables (carbon dioxide, nitrogen monoxide, suspended particulate matter, rainfall, temperature and greenhouse gas emissions) [2]. Joseph S. Shapiro developed and evaluated a quantitative model linking trade and environment to better understand the economic forces driving these changes [3]. Vikas Kumar aimed to analyze the problems in the development of manufacturing industry from the aspects of social politics, economy, law and environment [4]. However, these scholars' research on economic and environmental protection benefits lacked a certain technical demonstration. Through research, it was found that SD was of better help to economic and environmental protection benefits. In this regard, relevant documents on SD were consulted.

Some scholars have also conducted some research on Syed Abdul Rehman Khan, from the perspective of emerging economies in Asia, and discussed issues related to green logistics index and economic, environmental, social and other aspects. This would help policy makers and researchers recognize the importance of environmental protection concepts for improving social, economic and environmental performance [5]. Patrick Schroeder determined the relevance of circular economy practice to the achievement of SD goals. Through the relevant research on the practice of circular economy and SD goals, it was found that the practice of circular economy can make a direct contribution to many SD goals [6]. However, these scholars did not analyze the benefits of economic security and environmental protection from the perspective of SD and technological ecological environment, but only discussed them from a shallow level.

To solve the problems of high resource consumption, serious environmental pollution and ecosystem degradation, this paper puts forward the concept of coordinated development of economy and environment, builds a system of coordinated development of economy and environment through comprehensive evaluation index system, and conducts a simulation experiment on the eco-technology innovation management of the production department of a residential building materials industry limited company. It can be observed that after the implementation of the management system of eco-technology innovation, the material utilization rate and unit cost essentially tend to be stable, and the cost is significantly lower than before.

2. Evaluation Methods of SD and Technological Ecological Environment

2.1. Connotation of Economic Safety and Environmental Protection Benefits

The connotation of economic safety and environmental protection benefits refers to enterprises taking measures to eliminate potential unsafe factors, control and reduce risks, and reducing the occurrence rate and consequences of accidents in the production and operation process in order to obtain the expected value [7,8]. The evaluation of economic safety and environmental protection benefits is a multi-objective function decision-making problem. Under different circumstances, there may be different results or expectations. Risk and uncertainty are the main sources of risk. In risk decision making, enterprises may make unsafe decisions or implement correct preventive measures. At the same time, it is also faced with uncertain factors, which affect the production and operation activities of enterprises and even the normal operation of the entire social system. Economic safety and environmental protection benefits refer to value creation activities that bring expected losses or benefits to enterprises within a certain period of time [9,10]. Among them, losses include direct losses and indirect losses; income includes excess profit, extra profit and excess cash flow (economic net present value), etc. For enterprises realizing economic safety and environmental protection benefits, the following two aspects need to be considered: the first is to reduce the accident risk that may exist in production and operation activities; the second is to minimize the additional costs or benefits arising from the emergency measures or remedial measures taken to prevent the occurrence of accidents [11,12].

2.2. Ecological Technology Innovation

Ecological technology is a scientific and technological innovation aiming at the harmonious development of human and nature and pursuing the coordinated development of economic, social and ecological benefits. Figure 1 shows eco-technology innovation. Ecological technology is a green technology of “active control or pre-control” [13]. Eco-technical innovation is the fundamental requirement for realizing the “Scientific Outlook on Development”. The scientific concept of development emphasizes the harmony between man and nature, which is a comprehensive, coordinated and SD concept. To realize the scientific concept of development, it is necessary to develop ecological technology from technological innovation to environmental protection, strengthen scientific research and development, and develop low energy consumption and low pollution technologies [14].

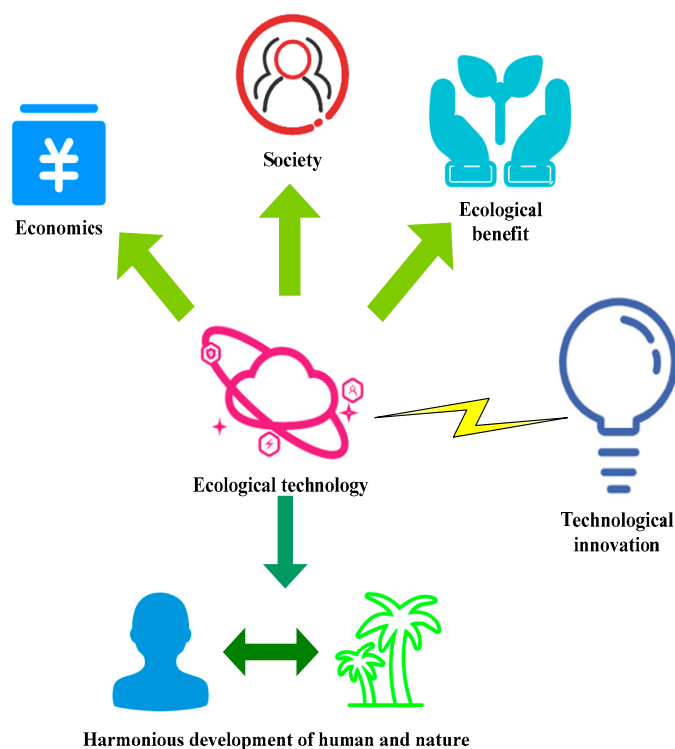


Figure 1. Ecological technology innovation.

Ecological civilization is a new form of civilization that requires not only political, economic and cultural support, but also technical support, namely the innovation of ecological technology. Due to the continuous growth of the population, the people’s demand for material life is becoming higher and higher. Many resources have been depleted and even exhausted. Developing countries can no longer follow the development model of “pollution before treatment” as developed countries. China has a large population and a lack of resources, and needs to develop its economy. However, the extensive management mode of excessive resource exploitation, high pollution and high consumption of enterprises has caused great pressure on the environment, which has brought about “crisis syndrome”, and the traditional technological innovation of enterprises is facing development difficulties. Therefore, from traditional technology innovation to eco-technology innovation, people must remove the traditional economic development dilemma through eco-technology innovation, and the green technology innovation of enterprises is also an urgent problem to be solved. Eco-technical innovation of enterprises can achieve the coordinated development of economic, social and ecological benefits of enterprises in the short term, which may have a certain impact on the economic benefits of enterprises in the short term. However, in the long run, the development mode of green competition can establish a good ecological image for enterprises, and improve their ecological awareness and requirements for ecological

products. Enterprises must carry out eco-technological innovation in order to change the extensive development mode of traditional technological innovation, which is based on economy, so as to achieve SD of enterprises and promote the circular development of economy [15].

2.3. Construction of Indicator System for Coordinated Development of Economy and Environment

The coordinated development of economy and environment is a comprehensive system with wide coverage. The establishment of the evaluation index system is the basis for the study of the coordination between the enterprise economy and the environment, and also an important basis for the comprehensive evaluation of the SD of enterprises [16]. In order to better evaluate the coordinated development of economy and environment, this paper analyzes the indicators of constructing an ecological economic environment.

(1) Basic principles for establishing indicator system

There are many indicators to measure the degree of coordination between economic development and the ecological environment system, with complex relations and large differences in characteristics. In order to select the most representative and sensitive indicators, the following basic principles must be followed. Figure 2 shows the basic principles of the indicator system.

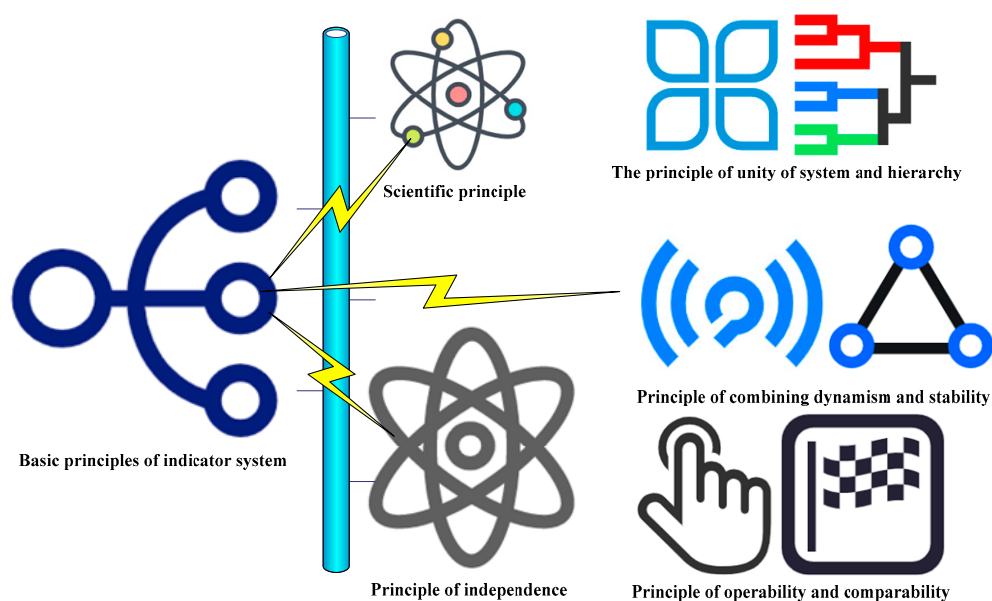


Figure 2. Basic principles of indicator system.

Scientific principle: the construction of the indicator system cannot be separated from the scientific concept of development and the concept of SD. Therefore, the indicators selected must have scientific connotations. When selecting indicators, it is necessary to fully understand and study the system science to reflect the connotation and realization level of SD of enterprises.

The principle of unity of system and hierarchy: the systematic theory requires that the enterprise carrying the economic and environmental development should be regarded as an open system of mutual connection, mutual exchange and information exchange. No subsystem is independent, and it is an organic whole with multiple levels.

Principle of operability and comparability: the objective of the indicator system is to guide the actual work. The comprehensive evaluation indicators for evaluating the enterprise's economy and environment should be operable. The indicator system should take into account the change of indicators and the difficulty in and reliability of obtaining data, and select representative indicators and main indicators as much as possible. It is

not that the larger the scale, the better [17]. The indicator system should be concise, clear, easy to operate and easy to understand. The development of cities in different regions is compared horizontally and vertically, and reasonable adjustments are made according to the problems reflected by the indicators and the development of each functional group.

Principle of independence: in order to make a correct assessment of regional economic and environmental development, it is necessary to carry out an in-depth exploration of the minimum indicators. Therefore, in the indicator system, each indicator should be as independent as possible, and in the same indicator, duplication should also be avoided.

The principle of combining dynamic and stability: the indicator system should maintain its relative stability within a certain period of time, and its content should not change too frequently. However, the evaluation indicators must be dynamic and constantly adjusted with the development of the enterprise zone system.

(2) Method of empowerment

Index weight is the importance of each index in the evaluation index system. In general, its weight is divided into subjective and objective. The subjective weighting method is based on the preference of the evaluator for each index, and adopts the Delphi method, fuzzy comprehensive evaluation method, analytic hierarchy process, etc. The objective weighting method is used to determine the weight of each index by analyzing the variation information and relevant information between each index, such as the coefficient of variation method, entropy method, factor analysis method, complex correlation coefficient method, etc.

When evaluating the coordinated development of the environment and economy, the entropy method in the objective evaluation method is used to weigh each index. With the increase in information, the uncertainty and entropy of information become smaller. The smaller the amount of information, the greater the uncertainty of information and the greater the entropy.

It is assumed that c_{ok} represents the value of the k -th index of sample o . Among them, m is the number of indicators.

The proportion of indicators is changed:

$$D_{ok} = \frac{c_{ok}}{\sum_{o=1}^m c_{ok}} \quad (1)$$

The entropy value of the index is calculated:

$$j_k = -\sum_{o=1}^m D_{ok} \ln D_{ok} \quad (2)$$

Entropy is reversed:

$$h_k = 1 - j_k \quad (3)$$

The weight of indicators is calculated:

$$e_k = \frac{h_k}{\sum_{k=1}^q h_k} \quad (4)$$

(3) Comprehensive evaluation index system

In order to comprehensively evaluate the economic and environmental development of an enterprise, the comprehensive evaluation method of multiple indicators can be used. The weights can be integrated layer by layer to obtain an evaluation index at the system level, and the overall evaluation of an enterprise can be obtained according to certain rules.

The hierarchical recursive method is used to solve the comprehensive development indicators of each system. The specific calculation formula is as follows:

Calculation of tertiary indicators:

The value V of the third-level indicators is multiplied by the value of the fourth-level indicators and their weights and summed up. The formula is as follows:

$$v_o = \sum_{o=1}^m e_o F_o \quad (5)$$

Among them, F_o is the fourth level index value.

Calculation of secondary indicators:

The second-level index N_o is the sum of the third-level index value multiplied by the corresponding weight, and the formula is as follows:

$$N_o = \sum_{o=1}^z i_o v_o \quad (6)$$

Among them, i_o is the weight of a third-level indicator, and z is the number of items of the fourth-level indicators included in the second-level indicators.

Overall development degree of economic environment system:

The comprehensive development degree of the economic and environmental system is obtained by adding the development degree of the economic system and the development degree of the environmental system.

$$G = \gamma M_1 + \delta M_2 \quad (7)$$

On this basis, G is the overall development index; M_1 is the economic system development index; M_2 is the ecosystem development index; γ and δ are their respective weights. Because the indicators are normalized, the data obtained using this method vary from 0 to 1. When the development degree of the evaluation target is close to 1, the development degree of the evaluation target would increase, and vice versa.

3. Evaluation of Experimental Results of Economic Safety and Environmental Protection Benefits

3.1. Enterprise Benefit Evaluation Based on Eco-Technology Innovation Management

The key to the construction of ecological technology innovation management system is to continuously improve and prevent pollution, and always adhere to the concept of “prevention first” in business activities. Its prominent function is to save energy, reduce pollution, improve the market competitiveness of small and medium-sized enterprises, and promote the SD of enterprises. Through the establishment and IEIMS, people address the harmonious development of factory and habitat environment, shape the green image of SMEs and improve the invisible equity of enterprises. Establishing a good reputation among customers and thus expanding the market has laid a solid foundation for the SD of the company.

In this paper, the production department of a residential building materials industry limited company implements the management system of ecological technology innovation, and carries out qualitative analysis on the product output after implementation.

3.2. Product Output Change

Since January 2020, the eco-technology innovation management system has been officially launched, and the company's product output has changed significantly. As shown in Figure 3, Figure 3a is for 2019 and Figure 3b is for 2020. At the beginning of 2019, before the company implemented the eco-technology innovation management system, the company's production scale had not exceeded 7000 square meters. This is mainly because the company adopted the traditional quality management system. However, in the process of production, because the management level of managers and departments is not high, and the training of employees and departments is not in place, many production and management behaviors are not controlled systematically, resulting in the product output having difficult in exceeding 7000 square meters. When implementing the eco-technology innovation management system, the company's system promotion team pays attention

to the traceability of product behavior from the two levels of environmental management and quality management to control environmental behavior and production activities. In the process of production, the quantity of rework caused by production operations and the management of customer customized orders absorbed the essence of eco-technology innovation management, reduced many management loopholes, and greatly increased product output.

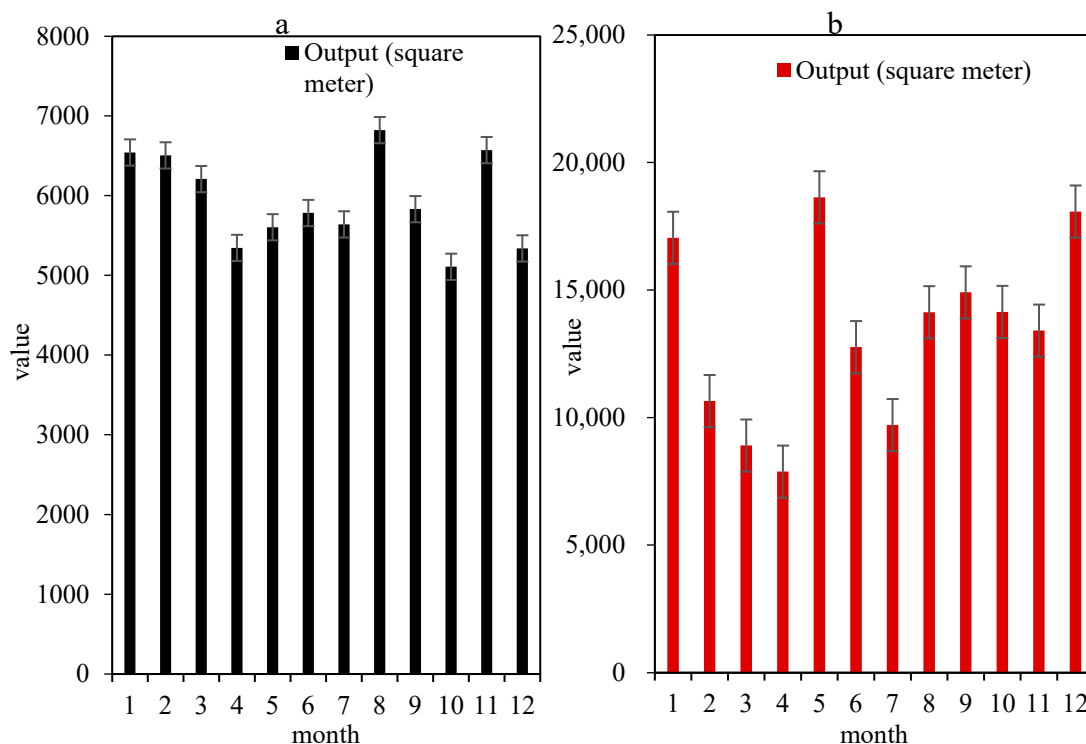


Figure 3. Production data of the company. (a) Changes in the output of the company's products in 2019. (b) Changes in the output of the company's products in 2020.

3.3. Product Cost Evaluation

Based on the comprehensive evaluation index system, this paper calculates the production material cost, auxiliary material cost, labor cost and other costs, and calculates the product cost of the whole plant. The cost changes before and after implementation are compared. Table 1 shows the average product cost.

Table 1. Average product cost.

	2019	2020
Paint	18.64 CNY/square meter	13.66 CNY/square meter
Carton	2.3 CNY/square meter	1.88 CNY/square meter
Labor cost	11.4 CNY/square meter	9.15 CNY/square meter
Total cost	46.66 CNY/square meter	34.45 CNY/square meter

As shown in Figure 4, the unit cost of paint was analyzed, in which Figure 4a is 2019 and Figure 4b is 2020. From the comparison of the cost per unit of finished paint consumption in the year before and after the establishment of the eco-technology innovation management system, it can be seen that the average cost per ton of paint was 18.64 CNY/square meter in the year before the implementation of the environmental protection system. Through the establishment and implementation of the ecological technology innovation management system, the utilization rate of paint has been improved,

and the loss of paint has also been reduced. The average production unit cost was 13.66 CNY/square meter, and the unit cost has been reduced by about CNY 5. The saving of production factors and chemical products in the eco-technological innovation system can reflect the direct economic benefits of enterprises here.

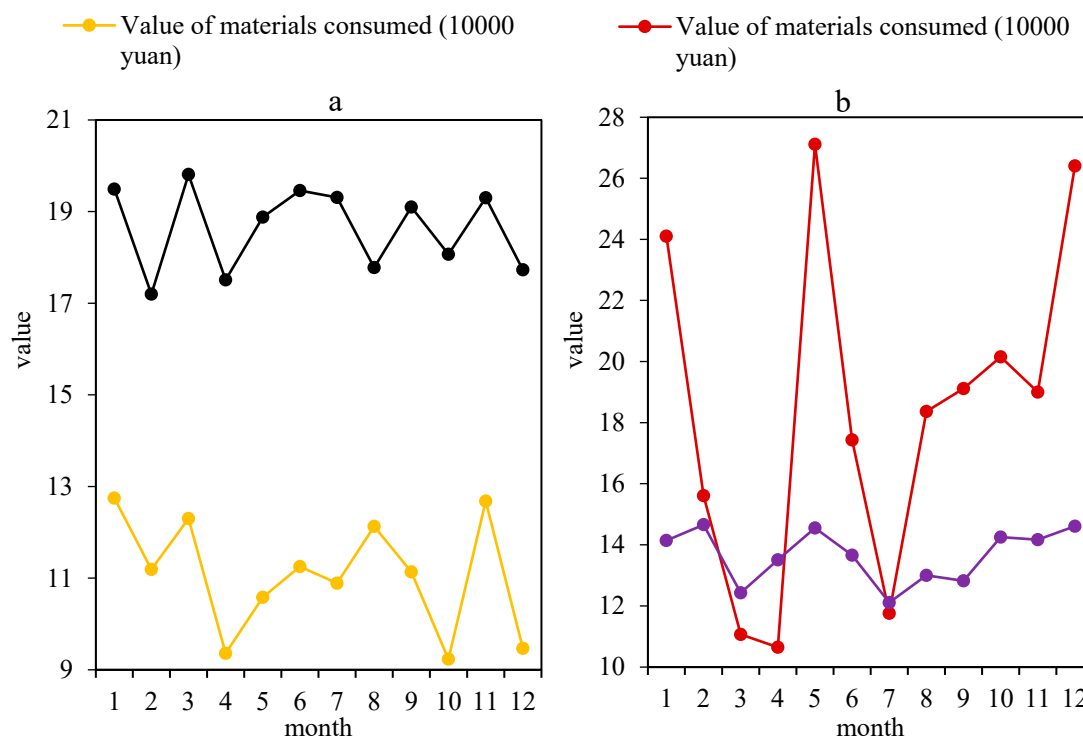


Figure 4. Unit cost analysis of paint. (a) Unit cost of paint in 2019. (b) Unit cost of paint in 2020. The black line represents the cost unit price of paint in 2019; the purple line represents the cost unit price of paint in 2020.

As shown in Figure 5, the unit cost of carton was analyzed, in which Figure 5a is 2019 and Figure 5b is 2020. From the cost analysis table of packaging materials, it can be found that before the IEIMS, the packaging cost was about CNY 2.3 per square meter, and the fluctuation was large, indicating that the use of materials was uncontrolled and improper. After the IEIMS, the control indicators for the use of packaging materials were formulated, and the employees were encouraged to put forward reasonable suggestions. The utilization rate of materials had become stable, and the unit cost was also relatively fixed, at CNY 1.88 per square meter. Compared with before the IEIMS, the cost was significantly reduced.

Figure 6 shows the manpower cost analysis, in which Figure 6a shows 2019 and Figure 6b shows 2020. In terms of human costs, the IEIMS has not led to an increase in the cost of enterprises. Before the IEIMS, the cost of employees in enterprises was generally high, with a maximum of CNY 12.28 per square meter and a minimum of CNY 9.87. The IEIMS is ostensibly used to increase costs. Although the production of the enterprise has increased, the personnel cost has not decreased significantly compared with that before the implementation. This is mainly because in the early stage of the implementation, some workers with good performance had received corresponding rewards, resulting in more labor costs. After the normal operation of the system, the production efficiency of the enterprise would also be improved.

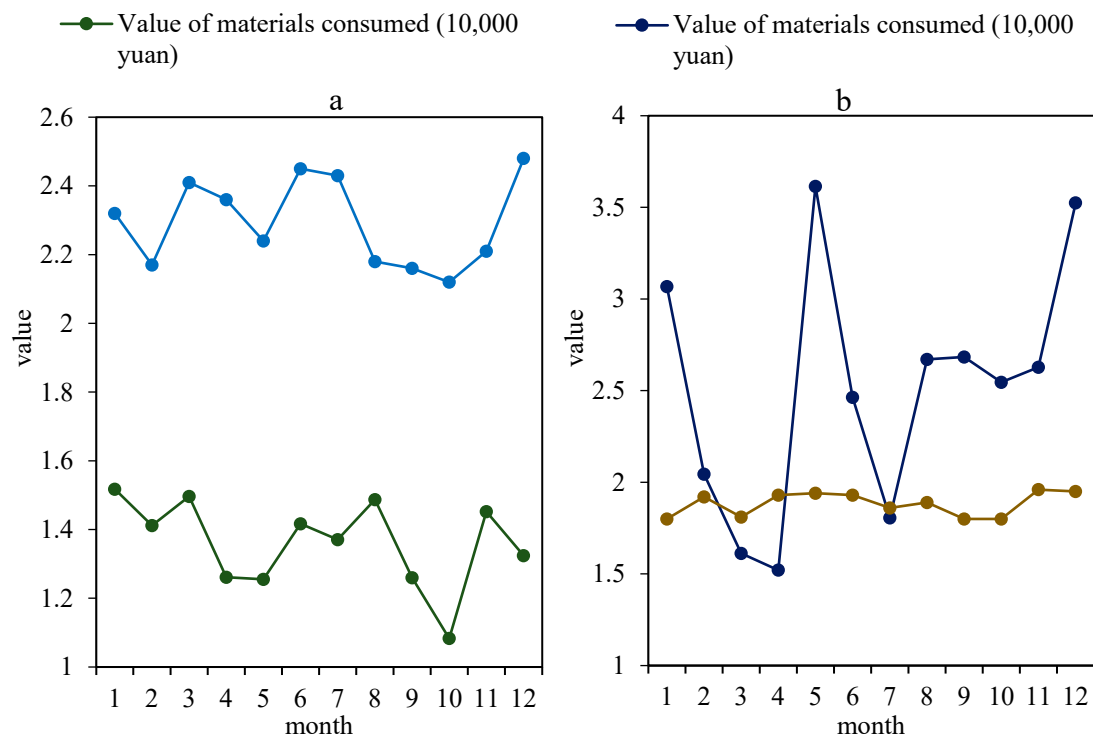


Figure 5. Unit cost analysis of carton. (a) Unit cost of carton in 2019. (b) Unit cost of carton in 2020. The blue line represents the unit price of carton packaging cost in 2019; the brown line represents the unit price of carton packaging cost in 2020.

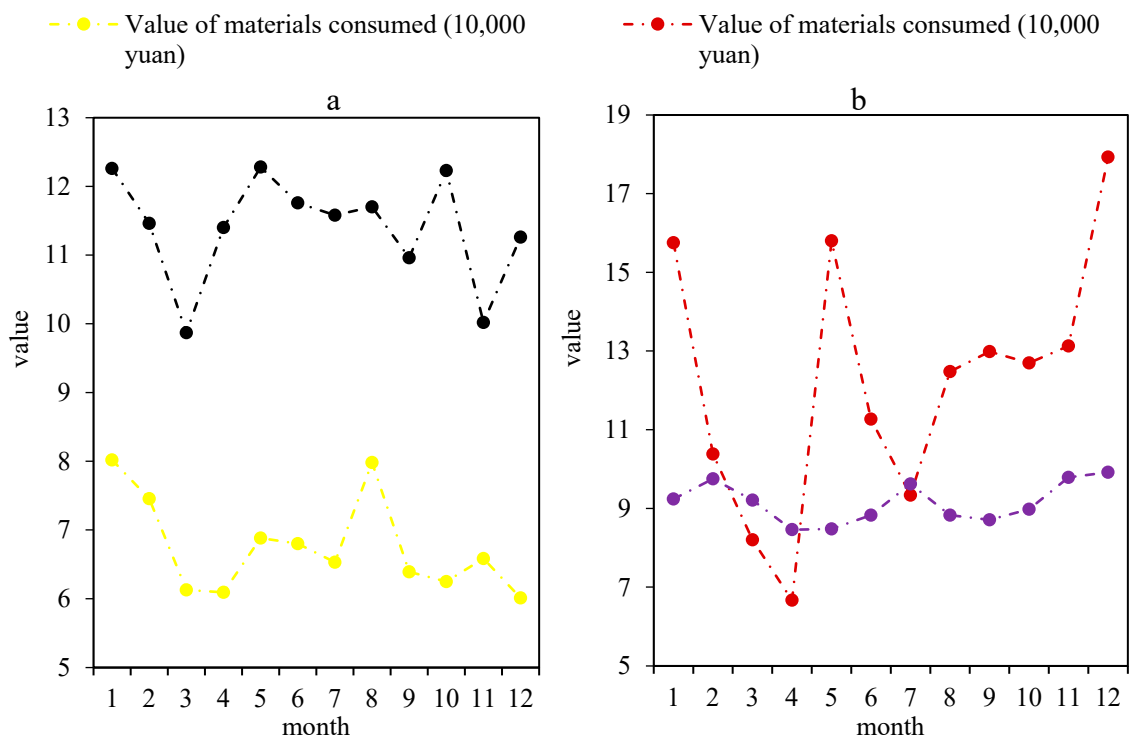


Figure 6. Labor cost analysis. (a) Labor cost analysis in 2019. (b) Labor cost analysis in 2020. The black line represents the unit price of enterprise labor costs in 2019; the purple line represents the unit price of enterprise labor costs in 2020.

By comparing the change of the total cost of products within one year before and after the IEIMS, the impact of the IEIMS on enterprises was investigated. As shown in Figure 7, Figure 7a shows 2019 and Figure 7b shows 2020. According to the change of the unit cost of the enterprise, before the implementation of the management system of eco-technology innovation, the total unit cost was CNY 46.66 per square meter. After the implementation of the management system of eco-technology innovation, the unit cost began to decline significantly, and was finally about CNY 34.45 per square meter.

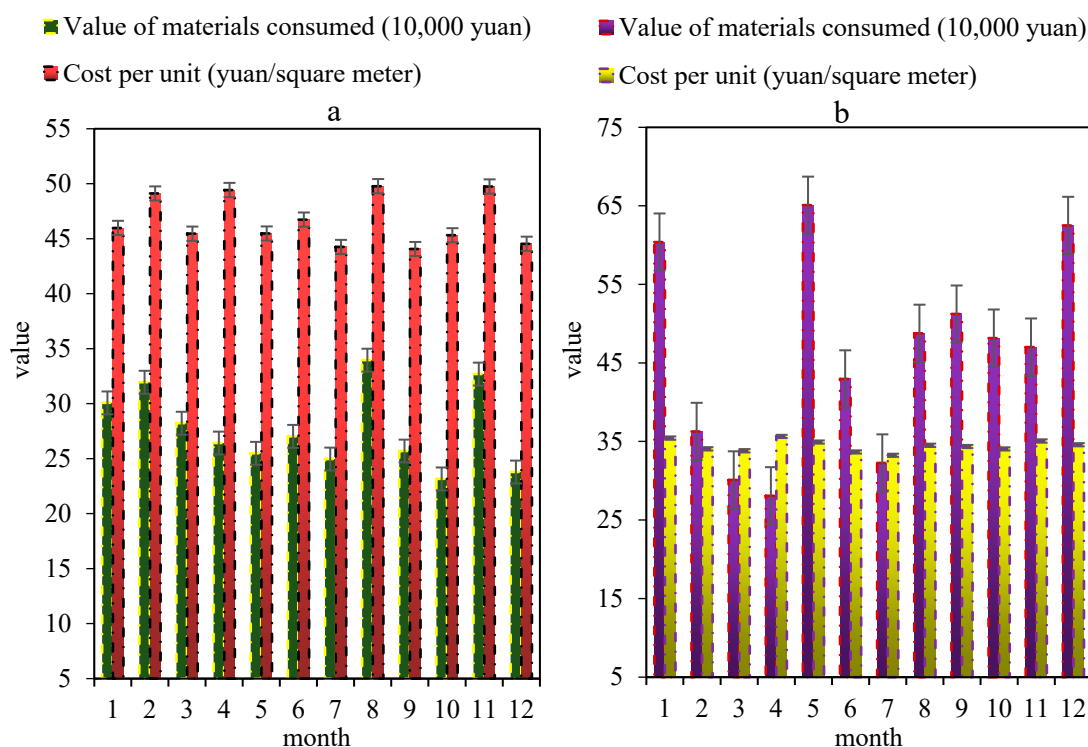


Figure 7. Total product cost analysis. (a) Changes in total product cost in 2019. (b) Changes in total product cost in 2020.

The theory of SD came into being under the background of the increasing problems between human beings and the natural ecological environment and the restriction of social and economic development. It requires realizing the harmony of population, resources, environment, society and economy, which should not only conform to the interests of the present, but also ensure the interests of future generations. SD is the organic unity of ecological, economic and social development, and is an important part of enterprise eco-technology innovation. The eco-technological innovation of enterprises must be based on the idea of SD, and enterprises are not only the main body of its implementation, but also its bearer, and play an important role in SD. Ecological technology is a kind of SD technology, which can promote the SD of technology, economy, ecology and society. Sustainable technological innovation is the organic combination of SD theory and technological innovation, and is the premise of achieving SD. It is a new method of technological innovation and a practical method of ecological culture adopted by human beings on the basis of pursuing SD and advocating ecological civilization. The technological innovation of the enterprise can make the new products of the enterprise continuously commercialized and obtain better economic benefits, thus laying a solid economic foundation for the SD of the company. Sustainable technological innovation is a new innovative way to promote the coordinated development of enterprises, society and nature. The purpose of this paper is to explore the impact of eco-technology innovation management system on the development of enterprises, and find that it can significantly improve the efficiency of enterprises.

4. Discussion

In the production process, only by strengthening safety and environmental protection, establishing a good brand image, and improving the credibility of the enterprise, can the enterprise's economy continue to grow. At present, the safety and environmental protection of most enterprises are not sound enough, and there are many problems. In this context, the government has issued a mandatory plan that requires enterprises to pay attention to safety and environmental management in the development process. If a company has made outstanding achievements in safety and environmental protection, it would receive attention at the provincial and national levels, and spread its own safety and environmental protection management system, which can not only improve the company's popularity but also improve the company's reputation so that it can quickly establish a foothold in the increasingly fierce market.

In addition, with the development of social economy and the improvement of people's living standards, the public's attention to the safety and environmental protection management of enterprises is also increasing, and enterprises can also improve customer loyalty by publicizing their safety and environmental protection management efficiency to the people. Through the active promotion of the company itself and the government, the brand awareness and credibility can be improved, which is very important for enterprises in the changing market. For example, in its development process, Ashley has used its relationship with the government to occupy a place in the market.

While improving the safety and environmental management level of employees, improving the employment and resignation of employees would greatly help improve the work efficiency and enthusiasm of employees. Human resources are the top priority. Enterprises can start from strengthening the management of safety and environmental protection. The production environment of a factory is guaranteed and safe, which can attract many talents. With the intensification of market competition, employees are increasingly likely to suffer from occupational diseases, and no one is willing to suffer from occupational diseases under the condition of high salary. Therefore, people should pay more attention to safety and environmental management, and establish a perfect and safe environmental management system according to the needs and work characteristics of employees, so as to attract more talents to enter, improve the production efficiency of enterprises, and obtain greater economic benefits. The eco-technology innovation management system proposed in this paper can promote the development of enterprises well and bring higher benefits to enterprises.

5. Conclusions

Eco-tech innovation management is an important part of an enterprise. However, when building an eco-technology innovation management system, it is necessary to evaluate it, analyze its existing business processes, and develop corresponding environmental management procedures to control it. In enterprises with low management level, this behavior can greatly promote the update and improvement of other management methods, thus speeding up the management level of the whole enterprise. It can not only effectively control the environmental protection behavior of enterprises, but also improve other management behaviors that are linked to the benefits of enterprises. The establishment of ecological technology innovation management system has reduced the number of unexpected accidents in the enterprise, ensured the life safety of employees, and improved the enthusiasm of employees. At the same time, the excellent working environment would attract a large number of skilled workers and operators to join, ensure the physical quality of the company's employees, and then promote the company's product quality. From the perspective of SD and based on value creation activities, this paper analyzed the current situation and existing problems of SD of enterprises, evaluated its influencing factors in depth, and put forward policy recommendations for improving economic security and environmental protection benefits. The main contributions of this paper are as follows: first, the definition of technological ecological environment and its relationship with economic

security were analyzed in detail to lay a foundation for the study of economic security and environmental protection benefits; the second was to establish a theoretical model of the relationship between economic ecological environment and technological ecological environment, and verify the effectiveness of the model. However, due to the limitations of time and technology, the problems encountered in the research of eco-technology innovation management in this paper have not been analyzed in detail. In order to address this, further analysis will be conducted in the future.

Author Contributions: J.L. and Q.H. designed, performed and prepared this manuscript. All coauthors contributed to manuscript editing. All authors have read and agreed to the published version of the manuscript.

Funding: Heilongjiang Province Philosophy and Social Science Research Planning Project: Research on Economic Security Issues in Northeast China in the Post-epidemic Era Project approval number: 20KSB093; Supported by the longitudinal project of Academician Expert Workstation of Ecological Governance and Green Development in Bayanzhur City, Hetao College, “Support Project of Pilot Project of Ecological Protection and Restoration of Mountain, Water, Forest, field and Lake Grass in WuliangSuhai Basin” (2019HYYSZX) in 2019.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

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