

# Electric Vehicles: Air Quality, Atmosphere, and Health

Lead Guest Editor: Amit Gupta

Guest Editors: Ramani Kannan and Puneet Verma





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Journal of Environmental and Public Health

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



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Stevo Popović , Montenegro  
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---

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# Contents

---

**Retracted: Innovating a Practical Teaching Base of Landscape Architecture Major Based on the Campus Environment: A Case Study of Xuzhou University of Technology (China)**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9826761, Volume 2023 (2023)

**Retracted: Analysis of the Relationship between Employee Health Level and Building Office Space and Environment**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9769108, Volume 2023 (2023)

**Retracted: Improved CEEMDAN, GA, and SVR Model for Oil Price Forecasting**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9757510, Volume 2023 (2023)

**Retracted: The Construction of National Image of China by English World Media in Public Health Emergencies**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9834764, Volume 2023 (2023)

**Retracted: Construction of Teaching Supervision System of Applied Undergraduate Colleges and Universities under the Perspective of "Internet+"**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9817067, Volume 2023 (2023)

**Retracted: Ecological Landscape Design and Evaluation in Public Charging Facilities for Electric Vehicles**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9809023, Volume 2023 (2023)

**Retracted: A Study on Parents' Attitudes towards Middle School Students' Online Learning Based on Statistical Analysis**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9804809, Volume 2023 (2023)

**Retracted: Multiple Influences of Intelligent Technology on Network Behavior of College Students in the Metaverse Age**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9785812, Volume 2023 (2023)

**Retracted: Protection and Inheritance of Traditional Culture in Urbanization Construction Based on Genetic Algorithm under the Concept of Environmental Protection**

Journal of Environmental and Public Health

Retraction (1 page), Article ID 9897101, Volume 2023 (2023)

**Retracted: Research on Haze Image Enhancement based on Dark Channel Prior Algorithm in Machine Vision**

Journal of Environmental and Public Health  
Retraction (1 page), Article ID 9864154, Volume 2023 (2023)

**Retracted: Ant Colony Algorithm-Based Audit Supervision to Promote the Optimization of New Infrastructure Investment Environment**

Journal of Environmental and Public Health  
Retraction (1 page), Article ID 9857270, Volume 2023 (2023)

**Retracted: Consumption Pattern and Mental Health of Employees Based on Big Data Analysis**

Journal of Environmental and Public Health  
Retraction (1 page), Article ID 9852714, Volume 2023 (2023)


**Retracted: Benefit Modeling and Analysis of Wind Power Generation under Social Energy Economy and Public Health**

Journal of Environmental and Public Health  
Retraction (1 page), Article ID 9852404, Volume 2023 (2023)





**Retracted: The Effects of Exercise Interventions on Mental Health in Chinese Older Adults**

Journal of Environmental and Public Health  
Retraction (1 page), Article ID 9849045, Volume 2023 (2023)


**[Retracted] Research on Haze Image Enhancement based on Dark Channel Prior Algorithm in Machine Vision**

Dan Li , Jinping Sun, Hongdong Wang, Hanqin Shi, Weiwei Liu, and Likai Wang  
Research Article (12 pages), Article ID 3887426, Volume 2022 (2022)

**[Retracted] The Effects of Exercise Interventions on Mental Health in Chinese Older Adults**

Lijun Wang , Shuwei Li , Lin Wei, Bo Ren , and Meng Zhao   
Research Article (11 pages), Article ID 7265718, Volume 2022 (2022)

**[Retracted] Ecological Landscape Design and Evaluation in Public Charging Facilities for Electric Vehicles**

Yang Yu   
Research Article (14 pages), Article ID 3010851, Volume 2022 (2022)

**[Retracted] Consumption Pattern and Mental Health of Employees Based on Big Data Analysis**

Teng Su   
Research Article (7 pages), Article ID 6894141, Volume 2022 (2022)


**[Retracted] The Construction of National Image of China by English World Media in Public Health Emergencies**

Dian Zhang   
Research Article (8 pages), Article ID 9669941, Volume 2022 (2022)



## Contents

**[Retracted] Improved CEEMDAN, GA, and SVR Model for Oil Price Forecasting**

Yichun Lu, Junyin Luo , Yiwen Cui, Zhengbin He, and Fengchun Xia

Research Article (11 pages), Article ID 3741370, Volume 2022 (2022)

**[Retracted] Construction of Teaching Supervision System of Applied Undergraduate Colleges and Universities under the Perspective of “Internet+”**

Songfeng Zhang  and Fucha Zhao


Research Article (10 pages), Article ID 9277583, Volume 2022 (2022)

**[Retracted] A Study on Parents’ Attitudes towards Middle School Students’ Online Learning Based on Statistical Analysis**

Guomin Chen , Shihui Zheng , Jianwu He , and Xiaowei Wang 





Research Article (17 pages), Article ID 4848738, Volume 2022 (2022)

**[Retracted] Analysis of the Relationship between Employee Health Level and Building Office Space and Environment**

Shiyu Ma 


Research Article (12 pages), Article ID 7779922, Volume 2022 (2022)

**[Retracted] Innovating a Practical Teaching Base of Landscape Architecture Major Based on the Campus Environment: A Case Study of Xuzhou University of Technology (China)**

Xuehong Tan , Pin Liu , Nan Nan , and Yunle Peng 


Research Article (7 pages), Article ID 6209454, Volume 2022 (2022)

**[Retracted] Protection and Inheritance of Traditional Culture in Urbanization Construction Based on Genetic Algorithm under the Concept of Environmental Protection**

Lin Guo 

Research Article (10 pages), Article ID 5844732, Volume 2022 (2022)

**[Retracted] Multiple Influences of Intelligent Technology on Network Behavior of College Students in the Metaverse Age**

Jiajia Ge 


Research Article (7 pages), Article ID 2750712, Volume 2022 (2022)

**[Retracted] Benefit Modeling and Analysis of Wind Power Generation under Social Energy Economy and Public Health**

Ying Liu , Zulkefly Abdul Karim , Norlin Khalid , and Fathin Faizah Said 

Research Article (9 pages), Article ID 5635853, Volume 2022 (2022)

**[Retracted] Ant Colony Algorithm-Based Audit Supervision to Promote the Optimization of New Infrastructure Investment Environment**

Feng Yuan 

Research Article (7 pages), Article ID 7454982, Volume 2022 (2022)

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Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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## Retraction

# Retracted: Consumption Pattern and Mental Health of Employees Based on Big Data Analysis

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
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## Retraction

# Retracted: Benefit Modeling and Analysis of Wind Power Generation under Social Energy Economy and Public Health

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## Retraction

# Retracted: The Effects of Exercise Interventions on Mental Health in Chinese Older Adults

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## Retraction

# Retracted: Research on Haze Image Enhancement based on Dark Channel Prior Algorithm in Machine Vision

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## Research Article

# Research on Haze Image Enhancement based on Dark Channel Prior Algorithm in Machine Vision

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According to the characteristics of foggy images, such as high noise, low resolution, and uneven illumination, an improved foggy image enhancement method based on dark channel priority is proposed. First, the new algorithm refines the transmittance and optimizes the atmospheric light value and converts the restored image to HSV space. Second, the brightness  $V$  component is enhanced by MSRRCR algorithm improved by bilateral filtering, and the saturation  $S$  is improved by adaptive stretching algorithm. Finally, the image is converted from HSV space to RGB space to complete image enhancement. The new method solves the problems of that the color of large area is uneven and the overall color of the image is dark when the traditional dark channel prior method is used to remove fog. The experimental results show that from subjective evaluation and quantitative analysis the new algorithm overcomes the shortcomings of noise amplification and edge blur when the conventional enhancement algorithm enhances the image. It can improve image darkening and avoid image distortion in JPEG, BMP, GIF, PNG, PSD, and TIFF formats. By comparing with other image enhancement algorithms, the improved algorithm performs better than DCP, SSR, MSR, MSRRCR, and CLAHE algorithm in PSNR, SSIM, and IE evaluation indexes. It has a good effect on preserving the edge information and has good adaptability and stability for heavily polluted haze image enhancement.

## 1. Introduction

With the gradual aggravation of environmental pollution, more and more cities frequently appear haze. Due to the low contrast and saturation of the image collected in foggy days, the color is prone to offset and distortion, which has a bad impact on the computer vision system relying on image information. Therefore, how to improve the image quality through a simple and effective image defogging method is a hot topic.

The commonly used image defogging methods mainly include image enhancement and image restoration. However, the former does not consider the image degradation caused by fog, and directly uses some image enhancement algorithm to remove fog. It is mainly divided into global image enhancement and local image enhancement. Global image enhancement methods include global histogram equalization algorithm, wavelet, and multiscale analysis

method, Retinex algorithm based on color constancy principle. Local image enhancement methods include local histogram equalization algorithm, local contrast enhancement algorithm, and local variance enhancement algorithm. Image enhancement realizes defogging by high-lighting the details of the image, ignoring the essence. Based on the physical model of atmosphere, the image restoration method can get the parameters by applying prior conditions to remove fog. The model is used to estimate the model parameters and then restore the image. The restoration of fog image based on physical model mainly includes partial differential equation based, depth relationship based and prior information. In recent years, some experts have put forward more and more defogging methods based on the above ideas, and have made some achievements.

In order to solve the problem of blocking effect in the restored image of large uniform regions such as sky, Tufail et al. [1] proposed a single image defogging technique based

on dark channel to estimate the atmospheric light, and reconstruct the fog free image using atmospheric light and transmission image. According to the density of fog, the transmission image is adaptively selected to reconstruct the image, and the transmission image is refined by the combination of Laplacian filter and pilot filter. Salazar-Colores et al. [2] proposed a image restoration algorithm based on morphological reconstruction to solve the problem of haze, smoke and fog caused by suspended particles (such as dust, carbon, and water droplets) in the air which will lead to image degradation. The experimental results were evaluated qualitatively. Chen et al. [3] proposed an improved blind image deblurring algorithm and solved the ringing effect caused by incorrect fuzzy kernel estimation. High-pass filter improved the image quality. The method of combining super Laplacian priori and dark channel priori is used to estimate the potential clear image. The accurate blur kernel is estimated by alternating iteration from coarse to fine. A deconvolution method based on Laplacian prior and regularization prior is used to restore the clear image. Raikwar and Tapaswi [4] proposed that the accuracy and effectiveness of single image deblurring depends on the accuracy of transmitted light and atmospheric light. The problem of transmission estimation is transformed into the estimation of minimum color channel difference between blurred image and nonblurred image, and a nonlinear model is proposed to estimate the bound function, so as to realize the accurate estimation of transmission. Anan et al. [5] proposed a framework based on the segmentation of sky and nonsky regions to restore the sky and nonsky parts, respectively. The sky part is restored by contrast limited adaptive histogram equalization (CLAHE) method, and the nonsky part is restored by improved DCP method and fused to get the final image. Wang et al. [6] proposed an image-defogging algorithm based on different color wavelength compensation. It can restore the haze free image and reduce the color distortion of the bright area. Zou et al. [7] proposed a new defogging algorithm for blurred images. First, the logarithmic pilot filter was used to estimate the ambient light, which retained the characteristics of the image in the bright light source region and improved the fuzziness of the dark light source region. Second, aiming at the disadvantage that the brightness of dark channel prior and bright channel prior is too high, the multichannel prior method is introduced. Finally, an adaptive transmission value calculation method based on multiple priors is proposed.

In recent years, image-defogging algorithm based on neural network has made rapid development. Li et al. [8] combined transmittance and atmospheric light into one variable and proposed a multiscale network structure (AOD-et). The network results eliminate the error of separate training of atmospheric light and transmittance and achieve better restoration effect. But the result of the algorithm is dark. Liu et al. [9] proposed a residual network structure, combined with the foggy image and its hypothesis or prior information, to estimate the transmittance, and then get the restoration results. However, this method takes the composite image as the training set, so the stability of the restoration effect is poor, and the applicability for real

outdoor foggy images is low. Chen et al. [10] proposes a hybrid-learning algorithm DehazeNet based on patch graph, which combines the two strategies by using a hybrid learning technology including patch graph and dual attention generation antagonism network. Sharma et al. [11] studies the main problems of the image processing technology based on physical model, decomposes the existing deep learning methods into three categories: convolution neural network, recurrent neural network and generation confrontation network, and compares their advantages and disadvantages. However, it does not consider the nature of image degradation, resulting in the trained model is full of uncertainty for fog image restoration in real environment.

Therefore, based on the single image dark channel prior defogging algorithm, this paper analyzes the degradation process of foggy image, and improves the method based on dark channel prior algorithm according to the image haze distribution characteristics. In view of the uneven thickness of cloud and fog in the original image, a linear attenuation model based on the fog concentration distribution is established to modify the atmospheric light value and transmittance. By refining the atmospheric transmittance, the atmospheric light value estimation is optimized to improve the clarity of the output image. In view of the situation that the brightness of the restored image is reduced, the image is transferred to HSV space, the  $S$  component is stretched linearly, and the brightness  $V$  component is processed by MSRCR algorithm. The restored image is enhanced twice. Finally, the image is transformed back to RGB space to realize the defogging enhancement.

## 2. A Priori Method of Dark Channel

*2.1. Atmospheric Scattering Model.* When the light meets the suspended particles in the atmosphere, part of the incident light will be scattered by the particles, so that the light intensity will be weakened [12–14]. Therefore, each suspended particle in the gas can be regarded as a separate scatterer. Generally speaking, the scattering intensity does not affect each other [15, 16]. According to the study of atmospheric scattering mechanism, Mie scattering mechanism can be used to analyze the scattering effect of dust, mist, fog, dense fog, and other adverse weather conditions [17, 18]. The atmospheric scattering model is expressed as follows:

$$I(x) = J(x)t(x) + A(1 - t(x)). \quad (1)$$

In the above formula,  $x$  is the position coordinate of the current pixel,  $I(x)$  is the illumination intensity at  $x$  obtained at the observation point,  $t(x)$  is the transmittance from  $x$  to the observation point, which reflects the ability of light to penetrate the medium.  $A$  is the global atmospheric light value, and  $J(x)$  is the intensity of the reflected incident light of the target in the detection scene.  $A(1 - t(x))$  is the atmospheric light component, that is, the light intensity of ambient light scattered by haze and other media to the observation point.  $J(x)t(x)$  is called direct attenuation, indicating the attenuation

degree of reflected light at  $x$  in the atmosphere. The above formula can also be written as follows:

$$J(x) = \frac{I(x) - A(1 - t(x))}{t(x)}. \quad (2)$$

The key to solve the problem of clear and fog free image  $J(x)$  is how to estimate the global atmospheric light value  $A$  and transmittance  $t(x)$ .  $t(x)$  can be expressed as follows:

$$t(x) = e^{-\beta d(x)}. \quad (3)$$

The above formula indicates that the contrast of the scene decreases exponentially with the increase of the depth of field,  $\beta$  represents the scattering coefficient caused by light scattering and absorption by atmospheric particles. It is considered to be constant.  $d$  is the depth of field of the image.

**2.2. Dark Channel Prior Theory.** Image enhancement algorithm only takes into account the numerical level of operation [19–22], although it improves the image tone and contrast to a certain extent, but it does not go deep into the essence of defogging, so it is not enough to only use image enhancement algorithm, image enhancement based on image restoration can achieve good results [23–25]. Based on the physical model, the dark channel prior theory deduces the unknown parameters of the model with reasonable assumptions to re-store the fog free image.

In the dark channel prior method, when the foreground part of the sky region is removed from the image, there will always be a certain color channel of at least one pixel with a very low intensity value, which is called dark primary color. For any input image, the dark primary color points can be solved by formula:

$$J^{\text{dark}}(x) = \min_{c \in \{r, g, b\}} \left( \min_{y \in \Omega(x)} (J^c(y)) \right). \quad (4)$$

Among formula (4)  $J^{\text{dark}}(x)$  represents the dark channel image of the image, and for the fog free image of the nonsky region, the dark channel of  $J^{\text{dark}}(x)$  tends to 0,  $\Omega(x)$  represents a square sliding window centered on pixel  $x$ , and  $J^c$  refers to one of several channels of color image. In the haze image, because the particles make the atmosphere scatter, the brightness of the image is increased, and the contrast is decreased, so that the corresponding dark channel value no longer tends to 0. For haze image processing, it is assumed that the atmospheric light value  $A$  is given. Suppose a window centered on pixels  $x$ , the transmissivity in  $\Omega(x)$  is constant, denoted as  $\tilde{t}(x)$ . The physical model of fog map is simulated, and the size of local area is set as  $\Omega(x)$ . As shown in formula.

$$\min_{y \in \Omega(x)} (I^c(x)) = \tilde{t}(x) \min_{y \in \Omega(x)} (J^c(x) + A^c(1 - \tilde{t}(x))). \quad (5)$$

The atmospheric light value  $A$  is not 0, and divide both sides of formula (5) by  $A^c$ , the minimum value filtering is made on three channels.

$$\begin{aligned} & \min_c \left( \min_{y \in \Omega(x)} \left( \frac{I^c(x)}{A^c} \right) \right) \\ &= \tilde{t}(x) \min_c \left( \min_{y \in \Omega(x)} \left( \frac{J^c(x)}{A^c} \right) \right) + (1 - \tilde{t}(x)). \end{aligned} \quad (6)$$

According to the prior principle of dark channel, the dark primary color value of clear fog free image  $J^c(x)$  tends to 0, and the transmittance  $\tilde{t}(x)$  is as follows:

$$\tilde{t}(x) = 1 - \min_c \left( \min_{y \in \Omega(x)} \left( \frac{I^c(x)}{A^c} \right) \right). \quad (7)$$

So far, the estimated value of transmittance  $t(x)$  is generally correct, but directly used for image defogging will produce halo in some cases. We can use the filter to estimate more precise transmittance, filter out halo, and obtain better defogging effect. Because there are some particles in the clear sky in real life, we can still feel the fog when watching distant objects, so we can keep a certain degree of fog when removing the fog. A constant  $\omega$  ( $0 < \omega \leq 1$ ) is introduced into formula (8), set up  $\omega = 85$ .

$$\tilde{t}(x) = 1 - \omega \min_{y \in \Omega(x)} \left( \min_{c \in \{r, g, b\}} \frac{I^c(y)}{A^c} \right) (\omega \in (0, 1]). \quad (8)$$

In the dark primary color image of haze image, the lower the transmittance is, the thicker the fog is and the brighter the image is. That is to say, when the transmittance tends to 0, the brightness value of the point with the densest fog is the atmospheric light value. Therefore, the first 0.1% of the highest brightness value in the dark channel image is selected as the point with the highest fog. In the original fog map, the highest value of each channel corresponding to these points is selected as the atmospheric light value  $A$ . Combined with the estimated transmittance  $\tilde{t}(x)$  and atmospheric light value  $A$ , the restored fog free image is obtained.

$$J(x) = \frac{I(x) - A}{\tilde{t}(x)} + A. \quad (9)$$

Although the defogging method based on the principle of dark primary color can restore fog free image more realistically, it has some limitations. When processing the image with sky area or high brightness area, the depth of field is wide, the light of vehicle, large sky area and white object will affect the estimation of atmospheric light value  $A$ , resulting in poor defogging effect and color block effect in the sky area. The results show that the defogging image has obvious white edge effect, which is caused by the rough transmittance. In addition, the defogging images are generally dark. Aiming at the color block effect of dark channel defogging, this paper solves it by reasonably estimating the transmittance and atmospheric light value, and solves the problem of dark tone by MSRRCR algorithm enhancement.

### 3. New Image Defogging Algorithm

In view of the above problems in fog image enhancement, this paper calculates the dark primary color image based on the dark channel principle [26–29], optimizes the calculation process of transmittance  $t(x)$  and the estimation of atmospheric light value  $A$ , and then restores the image to HSV space. In RGB color space, the relationship between the values of the three-color components and the generated colors is not intuitive. In HSV color space, it is easier to track objects of a certain color than RGB. It is often used to segment objects of a specified color. The  $V$  component is enhanced by MSRCR algorithm, and the  $S$  component is linearly stretched, which can improve the image clarity and effectively alleviate the phenomenon of object edge blur and halo, avoid image darkening, maintain the original color of the image, and enhance the brightness and contrast details of the image. The algorithm flow is shown in Figure 1 below.

**3.1. Improvement of Atmospheric Light Value.** In the above inference, the atmospheric light  $A$  should be estimated before the transmission rate  $\tilde{t}(x)$  estimation, and its estimation accuracy greatly affects the final image restoration. He and Sun [30] extracted the first 0.1% pixels in the dark channel according to the brightness size, and then took the maximum value of the original image corresponding to the pixel as the value of  $A$ . However, this method may make the  $A$  value of each channel close to the maximum pixel value 255, resulting in the color deviation, the brightness distortion or a large number of color spots in the processed image. In order to better estimate the value of atmospheric light  $A$ , this paper proposes an optimization method of atmospheric light based on the fog concentration distribution.

First, the sky and nonsky regions are segmented by OTSU image segmentation method [31–34], and the average intensity value of the sky region of the original image after segmentation is taken as the estimated value of  $A$ . Since the depth of field of the sky region can be regarded as infinite, that is  $d(x) \rightarrow +\infty$ , we can know  $t(x) \approx 0$ , taking it into equation (3), It can be seen that:

$$I(x) \approx A. \quad (10)$$

In the above formula,  $A$  is the brightness value of the maximum fog area, so it is reasonable to take the average intensity of the sky area as the value of atmospheric light  $A$ . That is,

$$A^c = \text{mean}_{c \in \{r,g,b\}} I_s^c(y), \quad (11)$$

Where  $I_s^c$  represents a color channel in the sky, and  $\text{mean}_{c \in \{r,g,b\}}$  is the average filter, the final transmissivity is obtained by introducing the above equation (8):

$$\tilde{t}(x) = 1 - \omega \min_{y \in \Omega(x)} \left( \min_{c \in \{r,g,b\}} \frac{I^c(y)}{\text{mean}_{c \in \{r,g,b\}} I_s^c(y)} \right). \quad (12)$$

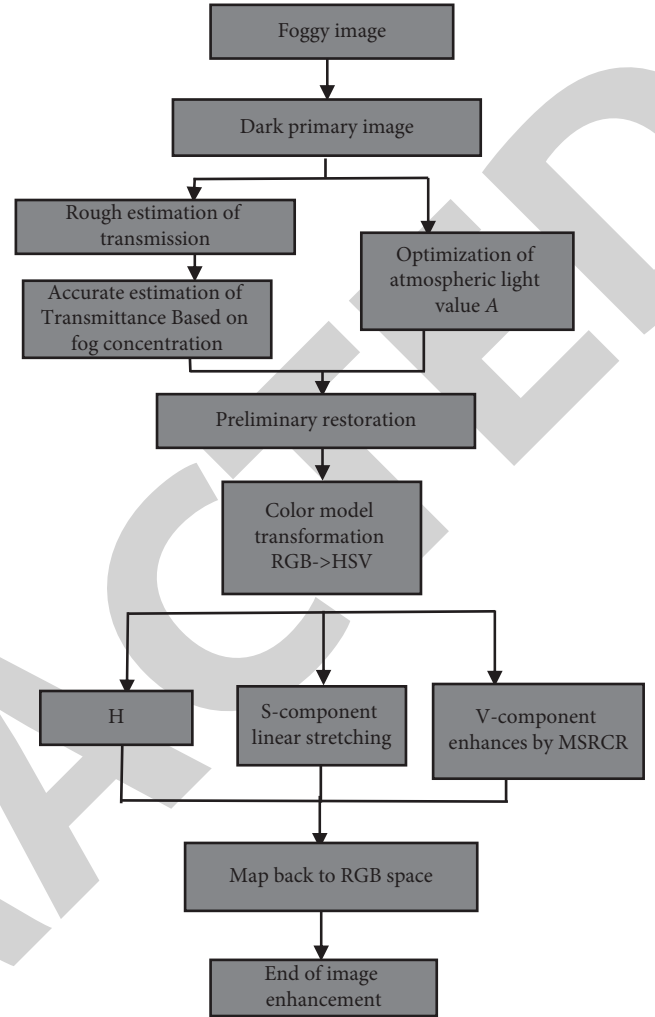


FIGURE 1: Algorithm flow.

**3.2. Transmittance Estimation Based on Fog Concentration.** In the process of atmospheric imaging, atmospheric light  $A$  foggy image  $I(x)$  and clear image  $J(x)$  are coplanar, and the mode length decreases in turn. Obtaining  $J_{\min}^c(x)$  is the key to estimate the transmission. There is a certain attenuation relationship between foggy image and clear image. Wang et al. [35] proposed a linear attenuation model based on minimum channel, as shown in equation.

$$J_{\min}^c(x) = \frac{I_{\min}^c(x) - \text{Min}}{\text{Max} - \text{Min}} I_{\min}^c(x), \quad (13)$$

Where  $\text{Max}$  is the maximum of  $I_{\min}^c(x)$  and  $\text{Min}$  is the minimum of  $I_{\min}^c(x)$ . Under the condition of uniform distribution of fog concentration, this attenuation can reflect the relationship between the minimum channel of foggy image and clear image, but under natural conditions, the fog concentration of foggy image changes with the depth of field, so the above attenuation cannot accurately reflect the mapping relationship between the minimum channel.

It is found that, the fog concentration increases with the increase of depth of field. It can be considered that for a clear image, when affected by fog, the influence is different in the

close range and depth of field. For the depth of field region, the degradation is more serious due to the influence of dense fog, that is, in the dense fog region, the attenuation from foggy image to clear image is more severe. Inspired by the linear attenuation model, a linear attenuation model based on fog concentration distribution is proposed in this paper. The expression is as follows:

$$J_{\min}^c(x) = [\gamma + W'(x)] \times I_{\min}^c(x), \quad (14)$$

Where  $\gamma$  is the attenuation constant and  $W'(x)W'(x)$  is the adaptive fog concentration attenuation function. In order to accurately reflect the different attenuation speed in different fog concentration regions, the adaptive fog concentration attenuation function is defined as follows:

$$W'(x) = \frac{W_{\max}(x) - W_{\min}(x)}{2}. \quad (15)$$

It can be seen from equation (15), in the region with high-fog concentration,  $W'(x)$  has a larger value, which makes  $J_{\min}^c(x)$  have a stronger pixel value in the dense fog region. In the close range area, if  $W'(x)W'(x)$  is small, the intensity of  $J_{\min}^c(x)$  is low, even close to 0. This is in line with the theory that dark channels tend to zero proposed by He and Sun [30]. In order to further reflect the attenuation difference between the dense fog and the close range area, the attenuation constant is introduced to compensate for the attenuation. In this paper, the value is the gray mean value of the fog concentration, that is:

$$\gamma = \text{mean}(W(x)). \quad (16)$$

In conclusion, the transmittance can be expressed as follows:

$$t(x) = \frac{A - I_{\min}^c(x)}{A - [\gamma + W'(x)] \times I_{\min}^c(x)}. \quad (17)$$

In order to eliminate texture, the transmission rate can be smoothed by bilateral filtering, and then the transmittance is obtained.

**3.3. Combining Retinex Algorithm.** The image after dark primary color processing is generally dark in visual effect, which can be improved by fusing Retinex algorithm [36, 37] after restoration. However, in practical application, Retinex algorithm is easy to produce halo at the edge when processing the edge part with large brightness difference in order to take into account the change of light in the image [38, 39]. When it enhances RGB model, it will ignore the relationship of three channels and may appear distortion. Therefore, the original restored image is transformed from RGB model to HSV model, and MSRCR image is enhanced and S component is stretched in HSV color space.

Retinex theory holds that the image formed in human eyes is formed by the object reflecting the light [40]. The color of the object itself has nothing to do with the external factors. What actually plays a role is the reflection ability of the object to various types of light sources. Therefore, the model consists of two parts, one is illumination component,

the other is reflection component. The model expression of Retinex theory is as follows:

$$I(x, y) = R(x, y) \times L(x, y). \quad (18)$$

$I(x, y)$  is the final received image information;  $R(x, y)$  is the reflection component of the object, which usually has a lot of high-frequency information. It represents the reflection ability of the object itself to light, and has nothing to do with the light itself;  $L(x, y)$  is the illuminance component of light, usually a low frequency signal. It can be seen that the information of the object itself can be obtained by removing the illumination component from the final received image, so that the effect of image enhancement can be achieved. Based on this, the SSR algorithm [41, 42] transforms equation (18) into logarithmic domain, which is expressed as follows. Where  $I_i(x, y)$  is the  $i$ -th color component of the input image,  $R_i(x, y)$  is the output of the  $i$ -th color component, and the illumination component is convoluted with the image obtained by  $F(x, y)$ :

$$R_i(x, y) = \log I_i(x, y) - \log[F(x, y) * I_i(x, y)]. \quad (19)$$

The expression of Gaussian function is as follows:

$$F(x, y) = K e^{-(x^2+y^2)/\sigma^2}. \quad (20)$$

$\sigma$  is the scale parameter used to adjust the dynamic compression range and color balance.  $K$  is the normalized constant and satisfies the equation  $\iint F(x, y) dx dy = 1$ .

Since SSR cannot satisfy both dynamic range compression and color fidelity, a multiscale Retinex (MSR) [43, 44] is proposed, whose expression is

$$R_i(x, y) = \sum_{n=1}^N W_n \{ \log[I_i(x, y)] - \log[I_i(x, y) * F_n(x, y)] \}, \quad (21)$$

Where  $W_n$  is the weight factor of the  $n$ th scale, and satisfies  $\sum_{n=1}^N W_n = 1$  and  $N$  represents the number of scales. By adjusting the weight factor and scale parameters, dynamic compression and tone reproduction can be achieved. The fog image enhancement algorithm based on MSR not only makes the details of the image clearer, the color fidelity higher, and the global contrast higher but also removes the large-scale convolution operation, suppresses the halo effect of the image, improves the operation efficiency of the algorithm, and can avoid the problem of uneven image enhancement of the traditional algorithm. Because the processing results will have color distortion, this paper introduces the MSRCR method [45, 46] of color recovery factor, and introduces the color recovery factor  $C$  on the basis of MSR. MSRCR algorithm has good color reproducibility, brightness constancy, and dynamic range compression. It has better image enhancement effect and more realistic color than MSR. The local contrast of the image processed by MSRCR algorithm is improved, and its brightness is similar to the real scene, so the image is more realistic under visual perception. The expression is as follows:

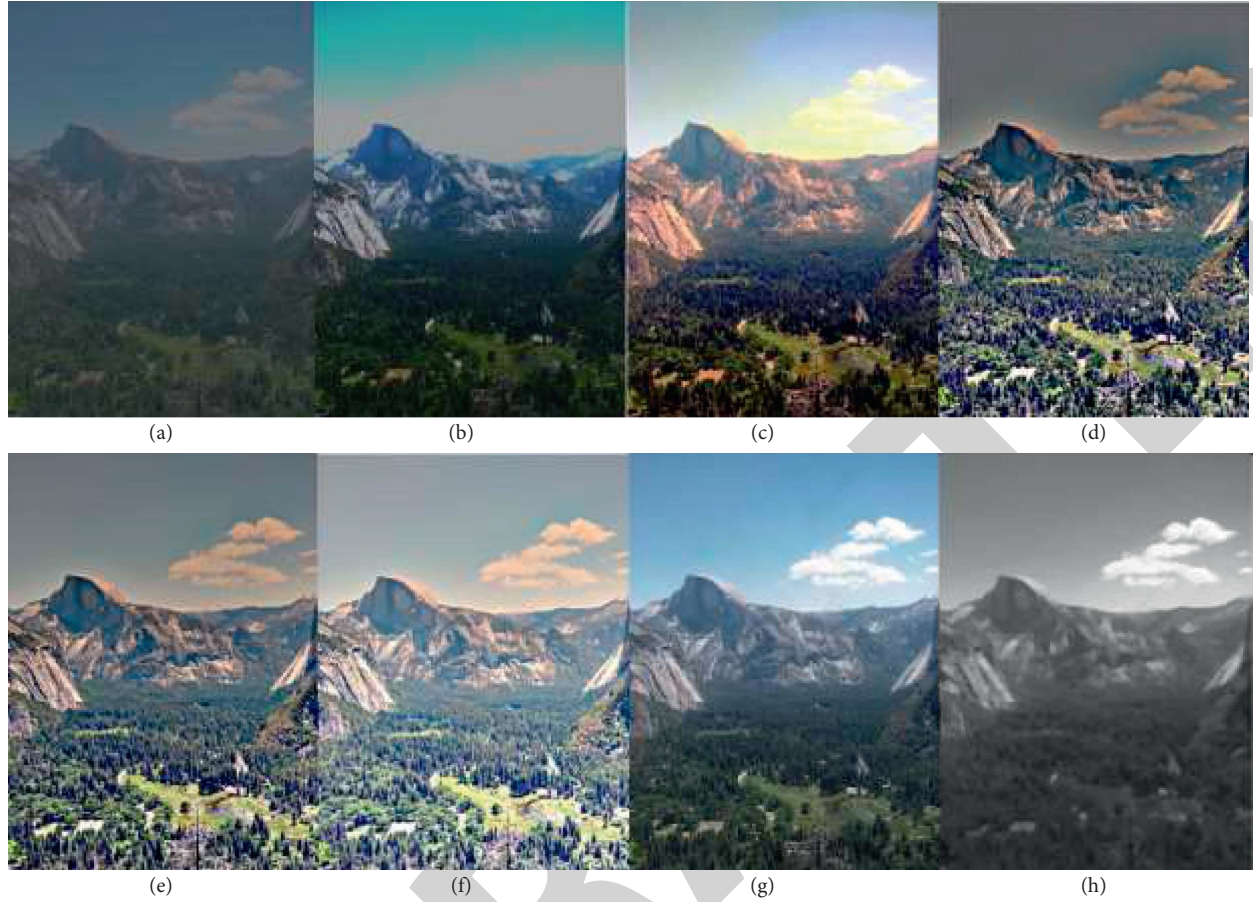


FIGURE 2: Algorithms comparison of mountain. (a) Original image, (b) DCP, (c) SSR, (d) MSR, (e) MSRCR, (f) CLAHE, (g) the paper, and (h) dark channel.

$$\text{RMSRCR}_i = C_i(x, y)\text{RMSR}_i(x, y),$$

$$C_i(x, y) = \frac{\beta \{\ln(\alpha I_i(x, y))\}}{\sum_{n=1}^N I_i(x, y)}, \quad (22)$$

where  $\beta$  is the gain adjustment coefficient and  $\alpha$  is the nonlinear adjustment coefficient. MSRCR can get color fidelity and remove the color offset of the image.

After the luminance  $V$  component is enhanced, the saturation will also change accordingly, so the saturation component  $S$  should be corrected. In order to balance the saturation of the whole image and optimize the saturation of images with different illuminances, an adaptive stretch algorithm is adopted for saturation  $S$ . The saturation after stretching is obtained as follows:

$$\tilde{S}(x, y) = 1 + \left( \frac{M_V}{M + m + 1} \right) \times S(x, y). \quad (23)$$

$M_V$  represents the average image saturation,  $M$  represents the maximum image saturation, and  $m$  represents the minimum image saturation. The drawing of formula (23) makes the images of different brightness enhanced. After the brightness of the image is enhanced, and the saturation is corrected in HSV space, the image can be enhanced by converting the image from HSV space to RGB space.

#### 4. Experimental Verification and Result Analysis

In order to illustrate the feasibility and effectiveness of the algorithm, several haze images of different scenes are selected for enhancement processing, which will be verified and evaluated from subjective evaluation and quantitative analysis. The experimental environment includes Windows 10 operating system, 8G memory, 3.6 GHZ CPU, and MATLAB 2018. The image data used in this paper are all from the public data set and the data collected in the laboratory.

The subjective aspect is mainly based on human vision as the evaluation standard. In order to illustrate the applicability of the algorithm, different scene images with different haze concentrations in the research group image data set under natural conditions are selected for comparison of different algorithms. According to Figures 2–5, it can be seen that the defogging algorithm based on dark channel prior (DCP) has a certain degree of defogging after dark channel defogging, but the overall color is dark and has a certain distortion. The image enhanced by SSR, MSR, and MSRCR algorithms is prone to halo, edge blur and other phenomena on the edge of the image. With the deepening of the fog concentration, the defogging effect is getting worse and

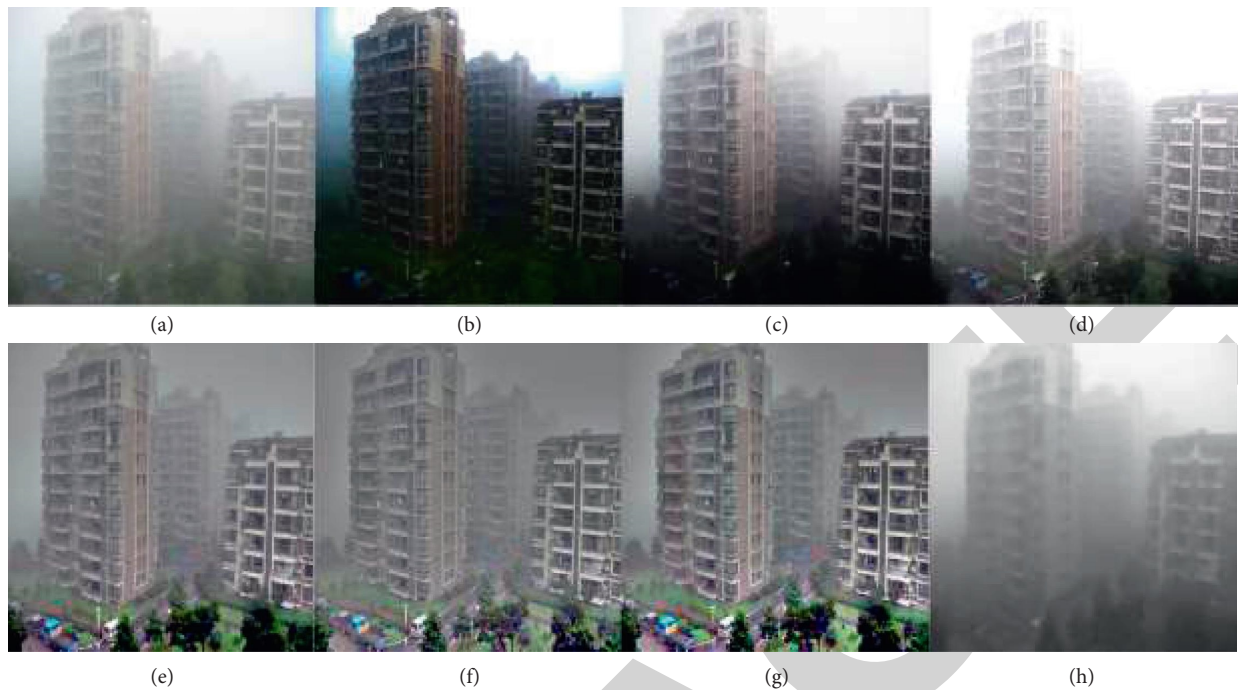


FIGURE 3: Algorithms comparison of buildings. (a) Original image, (b) DCP, (c) SSR, (d) MSR, (e) MSRCR, (f) CLAHE, (g) the paper, and (h) dark channel.

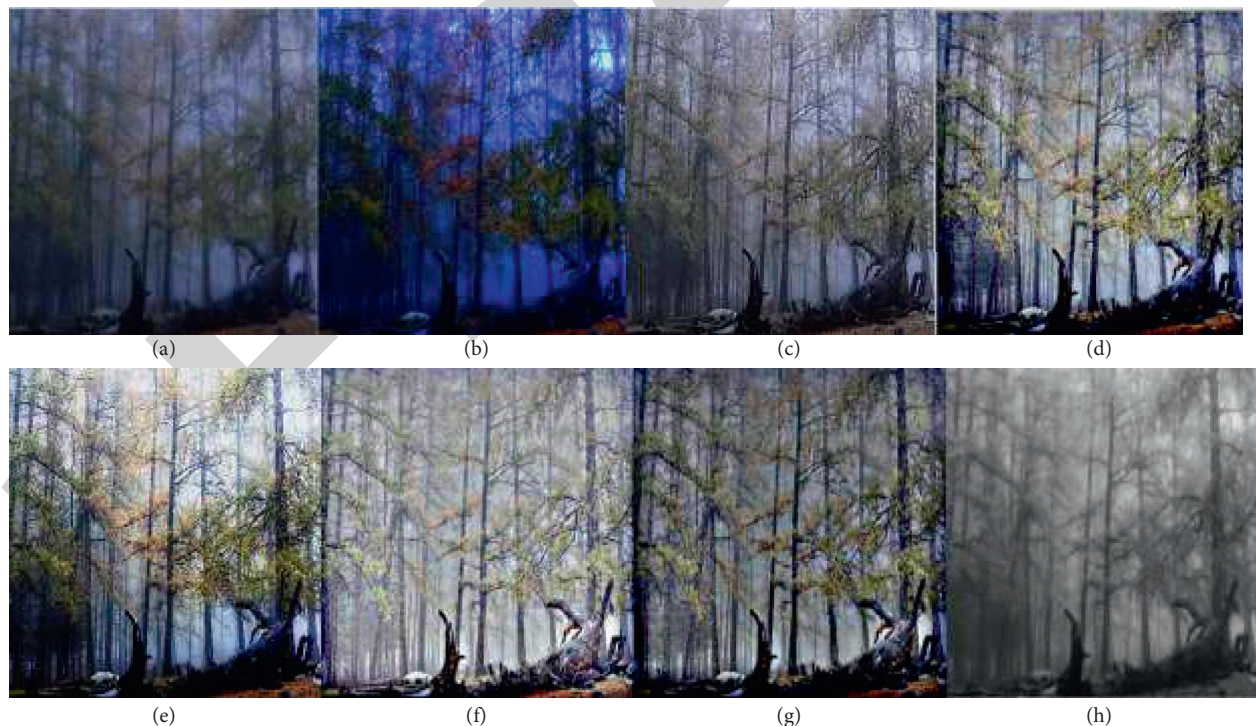


FIGURE 4: Algorithms comparison of woods. (a) Original image, (b) DCP, (c) SSR, (d) MSR, (e) MSRCR, (f) CLAHE, (g) the paper, and (h) dark channel.

worse, the image quality is not clear, and the edge and other details of the sign are not obvious. Limited adaptive histogram equalization (CLAHE) can improve the contrast. Compared with DCP, CLAHE uses contrast limited

processing in each neighborhood. CLAHE algorithm mainly enhances the local contrast to enhance the image details. The key of CLAHE algorithm is to restrict the contrast by clipping the histogram before calculating the conversion

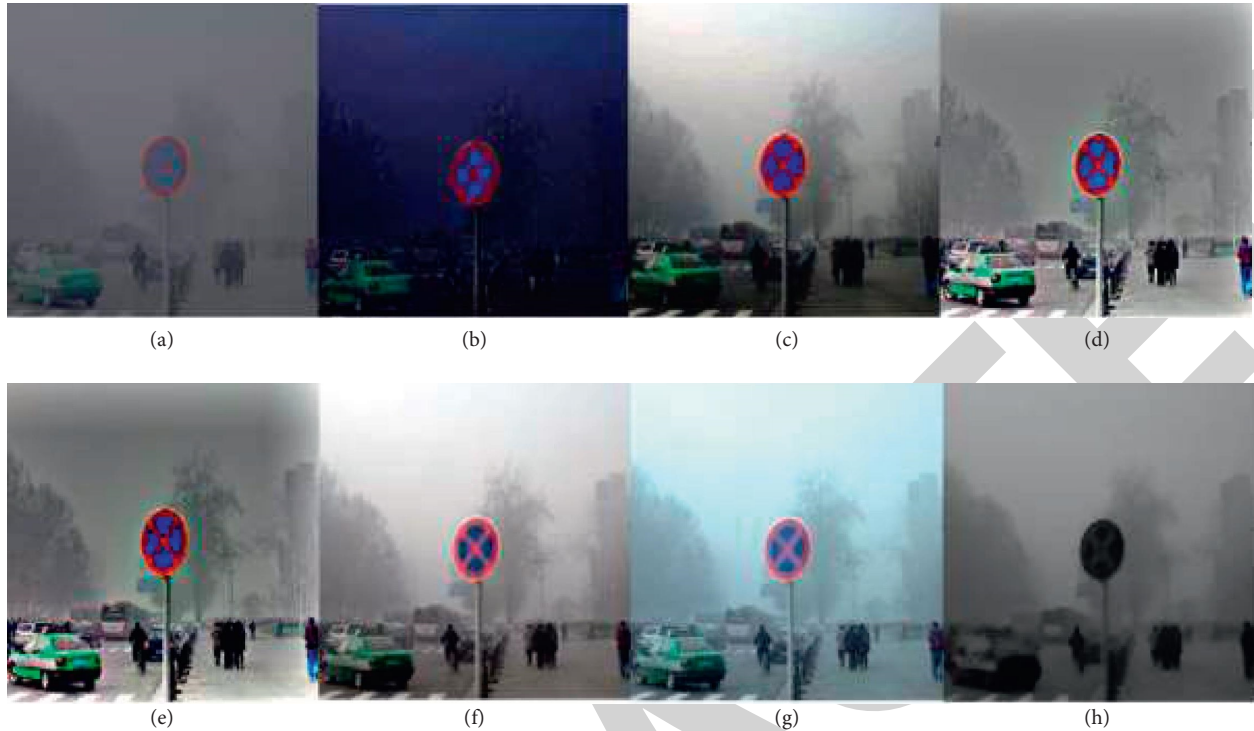


FIGURE 5: Algorithms comparison of traffic. (a) Original image, (b) DCP, (c) SSR, (d) MSR, (e) MSRCR, (f) CLAHE, (g) the paper, and (h) dark channel.

TABLE 1: Performance comparison of image enhancement algorithms.

Evaluation criteria	Algorithms	Mountain	Buildings	Woods	Traffic
PSNR	DCP	17.131	20.651	21.745	18.356
	SSR	18.952	21.542	23.462	20.532
	MSR	20.349	23.747	25.854	22.646
	MSRCR	22.642	28.484	27.245	24.894
	CLAHE	24.958	26.102	26.457	25.461
	The paper	27.593	30.452	31.532	28.127
SSIM	DCP	0.067	0.075	0.082	0.071
	SSR	0.091	0.135	0.177	0.186
	MSR	0.206	0.228	0.332	0.316
	MSRCR	0.478	0.582	0.596	0.517
	CLAHE	0.513	0.682	0.641	0.701
	The paper	0.709	0.831	0.847	0.734
IE	DCP	10.542	11.245	12.935	11.523
	SSR	12.854	13.087	14.515	13.723
	MSR	15.778	15.961	16.274	14.852
	MSRCR	16.345	16.095	19.025	17.037
	CLAHE	17.154	17.549	19.574	17.562
	The paper	18.675	19.534	21.452	18.048

function: first, the original image is divided into several small blocks, then the histogram of each small block is calculated, and finally the histogram is redistributed by restricting the contrast of each small block. Although it improves the overall brightness, it enlarges the noise. The improved method of image enhancement has some improvement in color and edge. The new algorithm can effectively defog the high brightness areas such as the sky, and the contrast brightness of the whole image has been improved very well. The color of the image after defogging is more real, the details and certain

scene depth are preserved, and the images are more natural. Figure 6 is the gray histogram after image enhancement of this paper and Figure 7 is the comparison of running time of different algorithms.

Objective verification objective evaluation uses peak signal to noise ratio (PSNR), structural similarity index measurement (SSIM), and information entropy (IE) as the evaluation criteria between image enhancement algorithms.

The peak signal-to-noise ratio (PSNR) is an objective criterion used to evaluate the fidelity of an image. It is



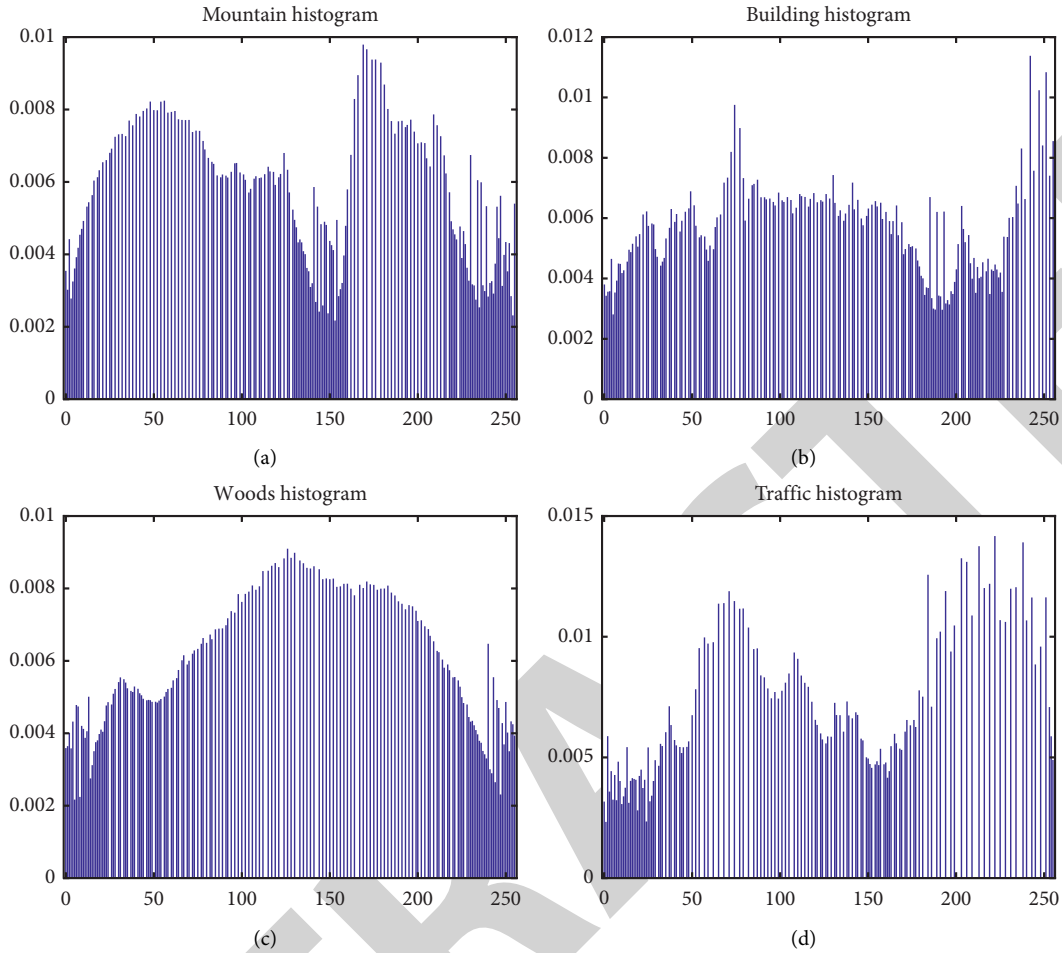


FIGURE 6: Gray histogram after image enhancement. (a) Gray histogram of mountain image, (b) gray histogram of building image, (c) gray histogram of woods image, and (d) gray histogram of traffic image.

defined by the mean square error (MSE). If the PSNR is larger, the distortion of the image is smaller. The calculation process of peak signal-to-noise ratio is as follows: where  $L$  is the maximum gray value of the image.

$$\text{PSNR} = 10 \log_{10} \left( \frac{L^2}{\text{MSE}} \right). \quad (24)$$

The structure similarity is a measure of the similarity between the defogging image and the original image, and the value range is  $[0, 1]$ . The larger the value is, the more complete the structure information of the original image is preserved, and the stronger the restoration ability of the defogging algorithm is. The calculation process of structural similarity is shown in formula (25), where  $l$ ,  $c$  and  $s$  are the contrast functions of brightness, contrast and structure, and  $\alpha$ ,  $\beta$  and  $\gamma$  are the weights of the three functions, which are all positive numbers:

$$\text{SSIM} = l^\alpha c^\beta s^\gamma. \quad (25)$$

Information entropy reflects the amount of information an image has. If the information entropy is larger, it means

that the image has more information. The calculation process of information entropy is as follows:  $M$  is the total number of gray levels of the image,  $P_i$  is the probability of the pixel of the  $i$ -th gray level in the total pixel:

$$\text{IE} = - \sum_{i=0}^{M-1} P_i \log P_i. \quad (26)$$

It can be seen from Table 1 and Figure 8 that the data through objective verification show that the improved algorithm is better than DCP, SSR, MSR, MSRCR, and CLAHE algorithm in PSNR, SSIM, and IE evaluation indexes in the case of haze, low illumination, and other interference factors. The image enhanced by the new algorithm has obvious improvement in brightness, contrast enhancement, noise removal, and anti-distortion. The experimental results show that the new algorithm can improve the image darkening, avoid image distortion, and has a good effect on preserving image edge information. It has good adaptability and stability, and is more suitable for fog image enhancement. The algorithm in this paper has good processing results in the haze world of low-quality road traffic images, the edge details of the enhanced results are more

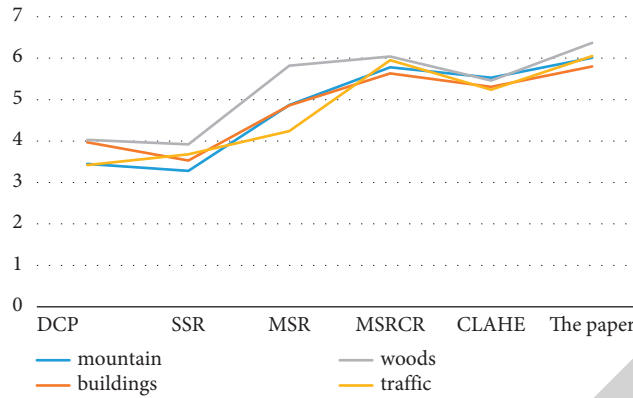


FIGURE 7: Comparison of running time of different algorithms.

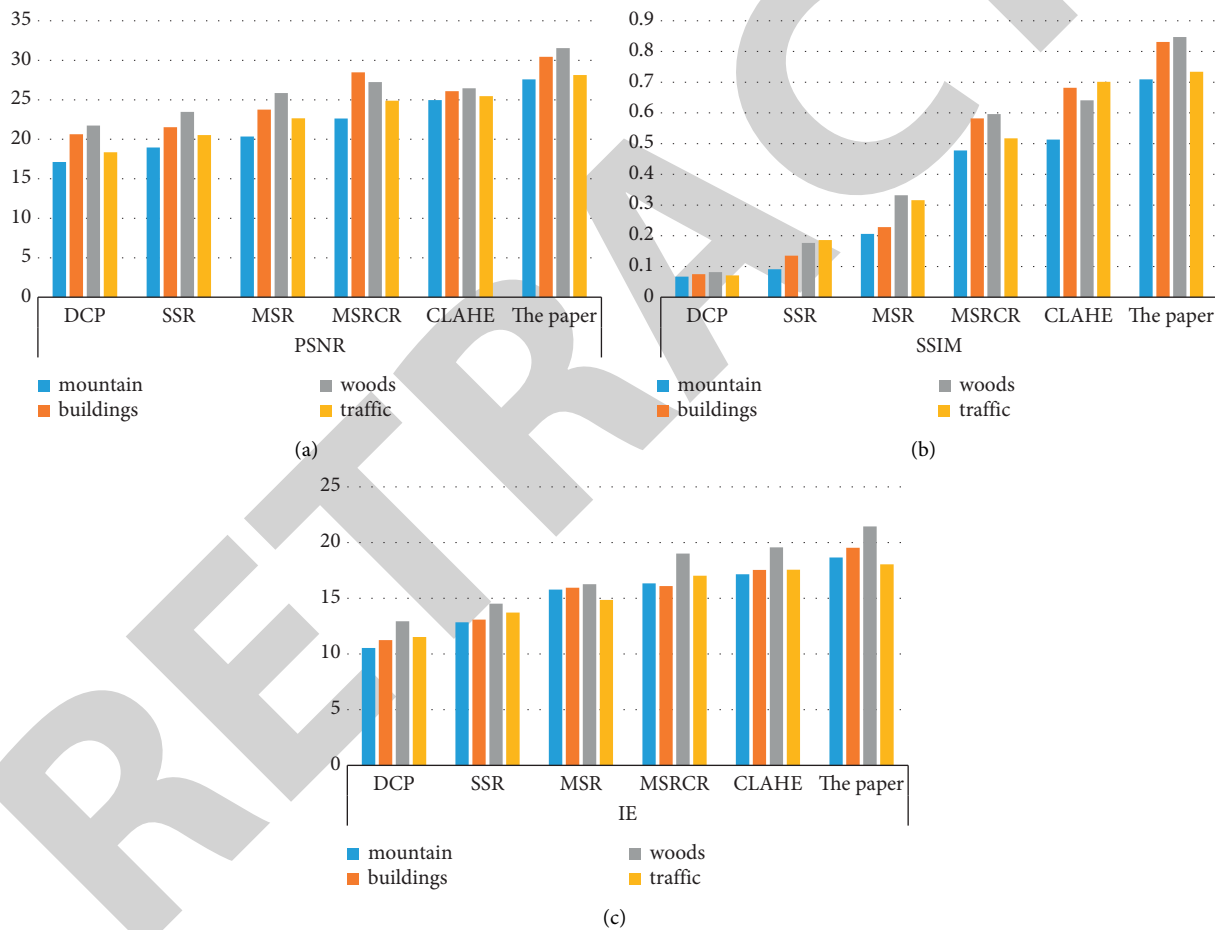


FIGURE 8: Comparison of image quality evaluation indexes.

prominent, the reconstructed image has no color distortion and deviation, the image clarity and contrast have also been improved, the image noise has been weakened, and the prospective area has also been restored clearly, although the complete information of the image in sunny weather cannot be completely restored, but it can help restore image information and overall contour.

### 5. Conclusion

We breathe all the time. A person has to breathe more than 20,000 times a day and exchange at least 10,000 liters of gas with the environment every day. Haze weather will directly affect people’s quality of life and health. In haze weather, there are a large number of particles, dust, pollutants,

viruses, heavy metals, and other harmful substances floating in the air. When the human body inhales the haze through breathing, the toxic and harmful substances will invade the human respiratory tract and lungs. It will cause respiratory disease, cardiovascular disease, heart disease, and other diseases. Aiming at the problem that haze affects the image quality, an improved haze image enhancement method based on dark channel priority was proposed.

The new algorithm solved the problem that the dark channel prior method leads to the image color darkening, refines the transmittance, and optimizes the atmospheric light value. After restoration, the image was converted from RGB space to HSV space for secondary enhancement. In the process of enhancement, the  $V$  component was enhanced by MSRCR algorithm, and the saturation  $S$  was improved by adaptive stretching algorithm. Finally, the image was restored to RGB space, the haze image was defogged and enhanced. Objective image quality evaluation method is used to carry out quantitative evaluation. Information entropy, image gradient, and image variance are used as three indexes of image quality to evaluate the optimization effect of the algorithm. In the complex environment, the new method can significantly improve the brightness and contrast of the image, effectively remove the noise, suppress the image halo phenomenon, better enhance the color and clarity of the image, and improve the imaging effect. However, due to the low real-time performance of the algorithm in this paper, it cannot be applied to the system with high real-time requirements. Therefore, it is planned to further improve the real-time performance of the algorithm and expand the application scope of the system. In the follow-up research process, it should also consider the impact of image depth on the enhancement algorithm, use different enhancement coefficients for local areas with different depths, and consider its enhancement mechanism from many aspects. Therefore, we should make more in-depth research and improve it in the future.

### Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflicts of Interest

The authors declare that they have no conflicts of interest.

### Acknowledgments

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## Retraction

# Retracted: The Effects of Exercise Interventions on Mental Health in Chinese Older Adults

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] L. Wang, S. Li, L. Wei, B. Ren, and M. Zhao, "The Effects of Exercise Interventions on Mental Health in Chinese Older Adults," *Journal of Environmental and Public Health*, vol. 2022, Article ID 7265718, 11 pages, 2022.

## Research Article

# The Effects of Exercise Interventions on Mental Health in Chinese Older Adults

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**Objectives.** The aim of this meta-analysis was to comprehensively evaluate the effects of exercise interventions on mental health in Chinese older adults, according to the effects of intervention methods, intervention duration, intervention frequency, intervention time, measurement tools, and subject types. **Methods.** We searched CNKI, Wanfang and Technology Journal Database for randomized control trials, 15 original studies were extracted, reporting on 1509 Chinese older adults (Age: 55–79 years old). We used CMA2.0 software. After heterogeneity test, suitable random effect model was selected. **Results.** Physical exercise had a positive effect on mental health in Chinese older adults, combined effect [SMD = -1.25, 95% CI (-1.66, -0.84),  $P \leq 0.001$ ], anxiety combined effect size [SMD = -1.45, 95% CI (-2.08, -0.83),  $P \leq 0.001$ ], depression combined effect size [SMD = -1.02, 95% CI (-1.56, -0.48),  $P \leq 0.001$ ]. Significant differences in the intervention types, intervention duration, intervention frequency, intervention time, and measurement tools were found. **Conclusion.** Physical exercise had positive intervention effect on the mental health of the Chinese older adults, which was applicable to all older adults. Exercise rehabilitation was the more effective, and the best intervention effect on the older hypertension. Due to the high heterogeneity of this study and the limited number of included literature, more high-quality needed to be included in the subsequent studies.

## 1. Introduction

In October 2016, the Central Committee of the Communist Party of China and The State Council issued the outline of the “Healthy China 2030” plan, which mentioned “strengthening the popularization of psychological health and improving mental health literacy,” and promoting mental health into a major strategy of national development. With the advance of population aging, the health problems of the older adults are becoming increasingly prominent. As a part of healthy aging [1], mental health has become an indicator to evaluate the health status of the older adults. Mental health is a manifestation of people’s good psychological quality and an important part of people’s overall

health [2]. Previous studies have found that physical exercise, as a means to improve the physical health of the older adults, affects the development of their mental health [3]. And developed a one-year physical exercise strategy for 180 elderly people, and found that their mental health score was significantly higher than the control group, and their anxiety and depression indicators were significantly lower [4]. Fu obtained the same result. They investigated the elderly with more than 12 years of swimming experience, and found that the mental health of the older adults with long-term exercise was significantly higher than that of their peers, anxiety and depression indicators were significantly lower, and the effect of exercise intervention was more obvious in the female older adults [5]. Meta-analysis confirmed that physical

exercise also has positive effects on mental health of college students and drug addicts [6,7]. However, Zhang found that the two kinds of qigong exercises did not significantly improve the depressed mood of the older adults [8].

The high inconsistencies of these results suggest the need for systematic evaluation of existing studies based on quality control. Previous studies in English languages have discussed the mental health problems of middle-aged and older adults [9], but they only involve physical and mental exercise, without specific analysis of Chinese older adults groups. Taking part in physical exercise in the Chinese older adults, the project of obvious aboriginality, at the same time, China's elderly will help their children to look after the next generation after retirement, also stressed that "to elderly with love," and in the countryside will also exist "left-behind elderly," this is obviously different from life in the elderly is abroad, which has differences of pressure, and that affects mental health. Therefore, it is necessary to explore the effect of physical exercise on the mental health of the Chinese older adults. So, what is the effect of physical exercise on the mental health intervention of the Chinese older adults? What are the moderating factors? These are all to be resolved.

In this study, a sample of Chinese older adults was included in a randomized controlled experimental study, which in the way of intervention, intervention in a single time, the frequency of intervention, intervention, measuring tools, and the participants of the type on the adjustment variable, in mental health and anxiety, depression for results variables, using the meta-analysis to explore the effect of physical exercise of mental health for the Chinese older adults. In order to obtain more comprehensive and objective results, but also can integrate the research design, improve the application value of physical exercise projects.

## 2. Materials and Methods

This systematic review was conducted according to the Preferred Reporting Item for Systematic Review and Meta-Analyses (PRIMA) guidelines [10].

**2.1. Search Strategy.** We searched CNKI, Wanfang and Technology Journal Database, and the key words were mental health, mental state, psychological symptoms etc. Anxiety, anxiety symptoms, depression symptoms, and other outcome indicators; physical exercise, physical activity, exercise, and other intervention words; paired combinations of words performed by older adults subjects. In order to prevent omissions, we also search the references which obtain literature and review. The deadline is October 31, 2021.

**2.2. Selection Criteria.** The selection criteria were based on the PICOS criteria in order to define the characteristics of the included studies. Population: studies including Chinese older adults participants over 55 for age were included; Intervention: studies evaluating the effect of physical exercise were included; Comparator: studies comparing other

exercise or no exercise were included; Outcomes: studies assessing mental health were included; Studies design: studies with experimental studies and any type of design (i.e., within-subject and between-subject designs) were included. One reviewer initially performed the article search, after which one reviewer screened the titles and abstracts of studies identified for potential selection by the search. Any disagreements were discussed with each other, until a consensus was achieved.

**2.3. Methodological Quality Assessment.** Studies included in the meta-analysis were further assessed using the PEDro scale. This instrument evaluates both internal and external validity, gives a score out of 10, and is a reliable scale of the methodological quality of randomized control trials. Each article was scored independently by two reviewers, and divergent scores were settled by discussion.

**2.4. Data Extraction.** Information on study details (i.e., author, year, sample size, average, standard deviation, intervention type, intervention duration, intervention frequency, intervention time, measurement tools, subject older adults types, and outcome variables) were extracted from all the included studies. If there was any missing or vague information, we contacted the original author to obtain the corresponding information. Data from included studies extracted independently by two of the reviewers and any discrepancies were solved by discussed with each other.

**2.5. Data Analysis.** Statics were calculated using CMA2.0 and IBM SPSS Statistics 21. The sample size and mean post-pre intervention score with standard deviation (SD) from intervention as well as control groups were used to calculate the standardized mean differences (SMD). To assess the heterogeneity  $I^2$  was considered, and 25%, 50%, and 75% were taken as the boundary values of low heterogeneity, medium heterogeneity, and high heterogeneity [11]. The publication bias test was performed using the Funnel Plot and Rosenthal's Classic Fail-safe N test.

## 3. Results

**3.1. Search Results.** A total of 1004 articles for potential inclusion were initially retrieved through the search. After removing duplicates, 481 articles remained for further screening of titles and abstracts. Afterward, 190 full-text articles were assessed for examination of their eligibility. Finally, 15 articles were included in the systematic review. The specific criteria for the screening process are shown in Figure 1.

**3.2. Quality of Studies.** According to the PEDro scale, the quality of the 15 included articles was evaluated. The score ranged from 5 to 8. The results are shown in Table 1. The quality of the included studies was above medium level, and the overall research quality was relatively good.

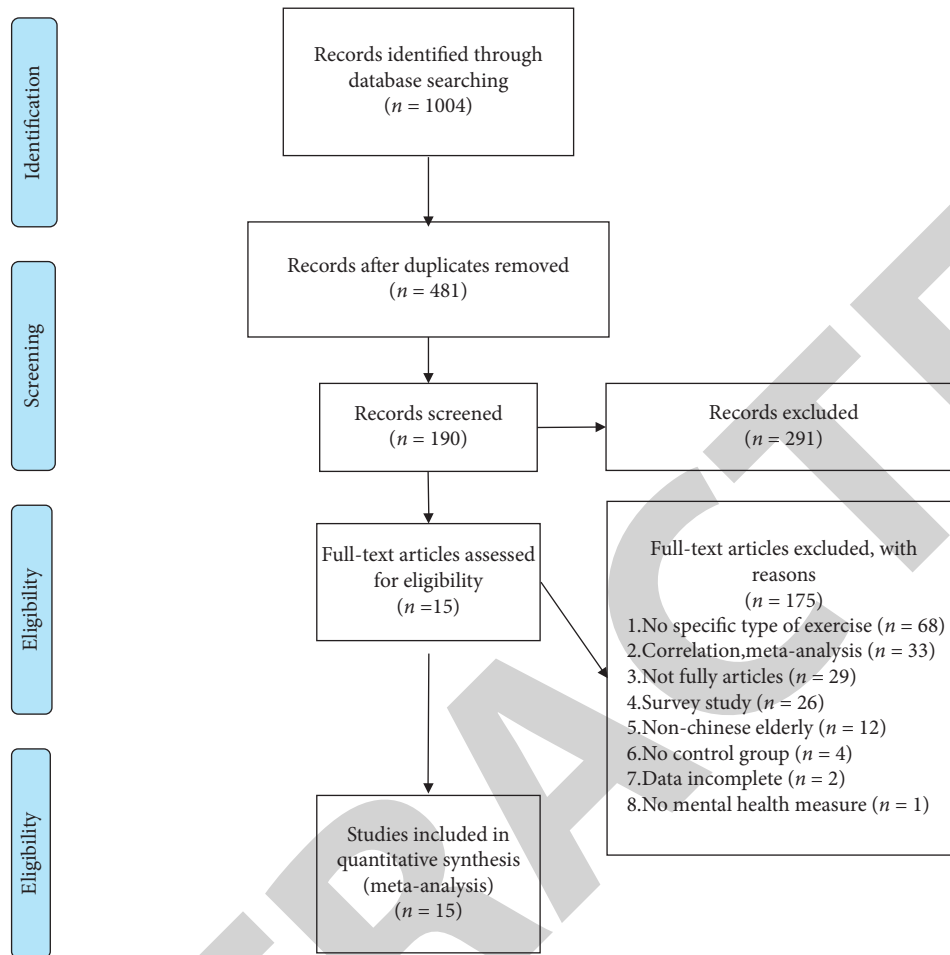


FIGURE 1: Article selection process.

TABLE 1: PEDro scores of the included studies.

Study	Evaluation criterion											Scores
	1	2	3	4	5	6	7	8	9	10	11	
Xu [12]	1	1	1	1	0	0	0	1	1	1	0	6
Chen et al. [13]	1	1	1	1	0	0	1	1	1	1	0	7
Luo et al. [14]	1	1	1	0	0	0	0	1	1	1	0	5
Shen [15]	1	1	1	1	0	0	0	1	1	1	0	6
Sun and wang [16]	1	1	1	1	0	0	0	1	1	1	0	6
Zhang and Ma [8]	1	1	1	1	0	0	0	1	1	1	0	6
Zhao [17]	1	1	1	1	1	1	0	0	1	1	0	7
Zhao and Xu [18]	1	1	1	1	0	0	0	1	1	0	0	5
Ma et al. [19]	1	1	1	1	0	0	0	1	1	1	0	6
Gao [20]	1	1	1	1	1	1	0	1	1	1	0	8
Hou [21]	1	1	1	1	0	0	0	1	1	1	0	6
Ou [22]	1	1	1	1	0	0	0	1	1	1	0	6
Guan [23]	1	1	0	1	0	0	0	1	1	1	0	5
Sun [24]	1	1	1	1	0	0	0	1	1	1	0	6
Fan [25]	1	1	1	1	0	0	0	1	1	1	0	6

Note: 1. Eligibility criteria; 2. Randomization; 3. Allocation hidden; 4. Similar group baseline; 5. Blinding of all subjects; 6. Blinding of all therapists; 7. Blinding of all assessors; 8. Drops out <15%; 9. Intention to treat method; 10. Statistical between group; 11. print measures and measures of variability.

**3.3. Study Characteristics.** The study characteristics included the author (year), intervention types, intervention duration, intervention frequency, intervention time, measurement

tools, subject older adults types, and outcome variable (Tables 2 and 3). According to the different types of intervention methods included in the original study,

TABLE 2: Characteristics of studies included in the meta-analysis.

Author (year)	Intervention types	Intervention duration (min)	Intervention frequency (time)	Intervention time (week)	Measurement tools	Subject older adults types	Outcome variable
Xu [12]	Tai Chi	60	7	12	STAI	Healthy	Anxiety
Xu [12]	Dance	60	7	12	STAI	Healthy	Anxiety
Chen et al. [13]	Walk	20–30	5	16	SAS	Hypertension	Anxiety
Luo [14]	24-Form tai chi	60	3	24	SCL-90	Female	Anxiety, depression
Shen [15]	Square dance	60	4	12	SCL-90	Healthy	Anxiety, depression
Sun and wang [16]	Square dance	60	3	12	BFS	Healthy	Depression
Zhang and Ma [8]	Artery-relaxed scripture	45	7	8	SAS	Healthy	Anxiety
Zhao [17]	Fitness dance	90	3	12	GDS, SAS	Healthy	Anxiety, depression
Zhao and Xu [18]	Fitness dance	90	3	12	GDS	Healthy	Depression
Ma et al. [19]	Fitness walk	120	4–6	16	SCL-90	Empty nesters in rural areas	Anxiety, depression
Gao [20]	Qigong	60	5	24	SAS, SDS	Healthy	Anxiety, depression
Hou [21]	Tai Chi	30	7	24	SCL-90	Healthy	Anxiety, depression
Ou [22]	Tai Chi	60	3	24	SCL-90	Female	Anxiety, depression
Guan [23]	Square dance	50	3–4	12	SCL-90	Healthy	Anxiety, depression
Guan [23]	Five-animal exercises	50	3–4	12	SCL-90	Healthy	Anxiety, depression
Sun [24]	Exercise rehabilitation	30	7	48	SAS, SDS	Healthy	Anxiety, depression
Fan [25]	Exercise rehabilitation	20–30	3	48	SCL-90	Healthy	Anxiety, depression

intervention types were divided as follows: traditional exercise (7: referring to the number of literature included in this meta-analysis), walk (2), dance (6), and exercise rehabilitation (2). The duration of a single intervention was divided as follows: less than 30 minutes (2), 30–60 minutes (including 30 and 60 minutes, 12), and more than 60 minutes (3). As regular exercise (more than three times per week) was used in the included literature, intervention frequency was divided as follows: 3–6 times per week (12) and 7 times per week (5). Intervention periods were divided as follows: less than 12 weeks (1), 12–16 weeks (10), and more than 16 weeks (6).

Each article was coded independently by two reviewers, and divergent conditions were settled by discussion. The coding consistency was 93.67%.

Square dance: a rhythmic dance performed spontaneously by Chinese residents in open spaces, such as squares and courtyards, for the purpose of fitness usually accompanied by loud rhythmic music. Artery-relaxed scripture: an exercise method in fitness qigong to strengthen the body and strength, its main feature is the combination of movement and stillness, internal stillness to collect the heart and breath, external movement to strengthen the muscles and bones. Fitness dance: a dance used for bodybuilding and slimming,

through the movement of the whole body muscles to achieve the effect of trimming the body, beautiful lines. Five-animal exercises: a gymnastic exercise created by Hua Tuo that imitates the activities of animals (tigers, deer, bears, apes, and birds (cranes)) and has a good exercise effect on the body and the five organs. Exercise rehabilitation: the exercise method mainly includes aerobic training, resistance training, and flexibility and balance training, all of which are based on the physical condition of the elderly and adhere to the principle of gradual progress.

**3.4. Publication Bias Assessment.** The effect value of physical exercise on the mental health intervention effect of the older adults was concentrated on both sides of the total effect value (Figures 2–4). From the subjective funnel plot, it can be seen that there is no serious publication bias in the research on the effect of physical exercise on the mental health of the Chinese older adults, but it still needs to be further tested.

Physical exercise on the intervention effects of mental health, anxiety, and depression, which loss of safety factor is, respectively, 1502, 1268, and 606 (Table 4), namely, the corresponding amount of literature is needed to deny the current judgment of the effect of physical exercise on mental



TABLE 3: Studies included in the analyses.

Author (year)	Outcome variable	Intervention groups		Control groups	
		X1 ± SD1	n1	X2 ± SD2	n2
Xu (2005) [12]	Anxiety	21.75 ± 1.61	20	35.05 ± 5.27	14
Xu (2005) [12]	Anxiety	21.55 ± 5.96	18	35.05 ± 5.27	14
Chen et al. (2017) [13]	Anxiety	21.55 ± 5.96	18	35.05 ± 5.27	14
Luo (2008) [14]	Anxiety	23.02 ± 2.09	80	38.07 ± 3.74	80
Luo (2008) [14]	Depression	0.28 ± 0.31	40	0.45 ± 0.40	40
Shen (2016) [15]	Anxiety	0.22 ± 0.24	40	0.38 ± 0.41	40
Shen (2016) [15]	Depression	1.44 ± 0.44	20	1.67 ± 0.46	10
Sun and wang (2020) [16]	Depression	1.58 ± 0.38	20	1.79 ± 0.54	10
Zhang and Ma (2011) [8]	Anxiety	9.27 ± 3.22	40	13.24 ± 3.28	40
Zhao (2015) [17]	Anxiety	32.64 ± 8.84	21	44.62 ± 7.98	52
Zhao (2015) [17]	Depression	7.63 ± 2.81	30	10.77 ± 2.30	30
Zhao and Xu (2015) [18]	Depression	39.29 ± 4.29	30	46.54 ± 5.24	30
Ma et al. (2012) [19]	Anxiety	9.23 ± 2.62	30	10.00 ± 2.41	30
Ma et al. (2012) [19]	Depression	1.45 ± 0.59	60	1.52 ± 0.58	60
Gao (2016) [20]	Anxiety	1.37 ± 0.56	60	1.45 ± 0.61	60
Gao (2016) [20]	Depression	33.05 ± 6.49	149	36.73 ± 7.021	37
Hou (2011) [21]	Anxiety	33.91 ± 6.21	149	36.99 ± 8.48	37
Hou (2011) [21]	Depression	0.23 ± 0.28	100	0.43 ± 0.44	100
Ou (2010) [22]	Anxiety	0.23 ± 0.27	100	0.35 ± 0.39	100
Ou (2010) [22]	Depression	0.28 ± 0.31	40	0.45 ± 0.40	40
Guan (2017) [23]	Anxiety	0.22 ± 0.24	40	0.38 ± 0.41	40
Guan (2017) [23]	Depression	1.33 ± 0.43	16	1.43 ± 0.47	16
Guan (2017) [23]	Anxiety	1.26 ± 0.24	16	1.36 ± 0.24	16
Guan (2017) [23]	Depression	1.20 ± 0.39	16	1.43 ± 0.47	16
Sun (2019) [24]	Anxiety	1.21 ± 0.27	16	1.36 ± 0.24	16
Sun (2019) [24]	Depression	46.01 ± 2.59	45	56.58 ± 3.15	45
Fan (2019) [25]	Anxiety	45.18 ± 2.37	45	56.35 ± 2.15	45
Fan (2019) [25]	Depression	12.64 ± 3.85	80	19.25 ± 4.34	80

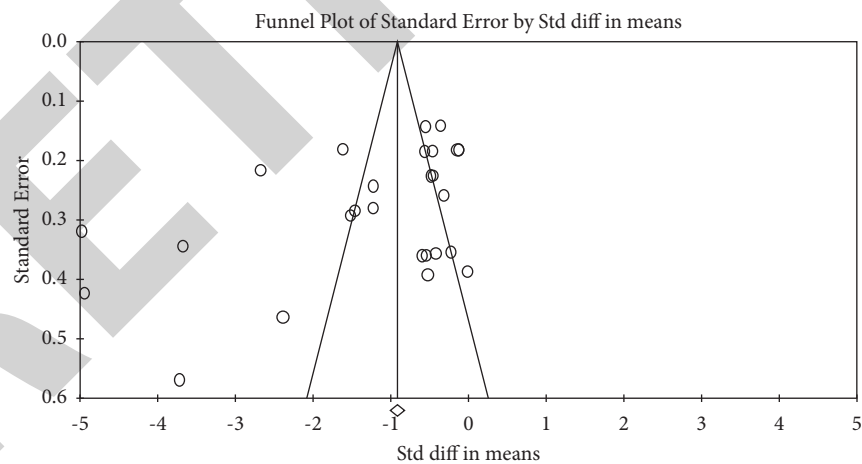


FIGURE 2: Funnel Plot of effect of physical exercise on mental health of the older adults.

health in the older adults, it shows that the current outcomes are no publication bias.

Heterogeneity test ( $I^2 = 95.03$ ) (Table 4) and I-Squared  $>75\%$  indicated high heterogeneity. It also indicated that 95.03% variation of the indicators of the effect of physical exercise on the mental health of the older adults was caused by the real difference in the effect value, and the study was also affected by intergroup errors. Therefore, the random

effect model was used in this study to further explore the source of heterogeneity.

**3.5. The Effect of Physical Exercise on Mental Health of Chinese Older Adults.** A comprehensive analysis of the effect of physical exercise on the mental health of the older adults shows the combined effect of mental health [SMD =  $-1.25$ ,

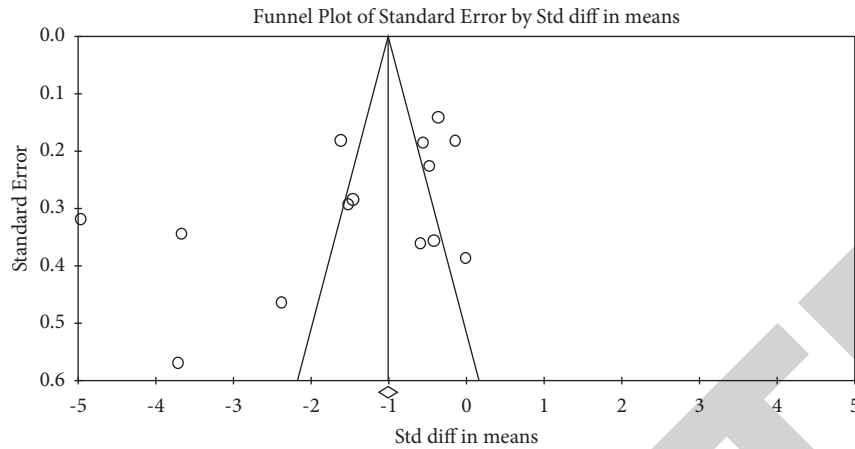


FIGURE 3: Funnel Plot of effect of physical exercise on anxiety of the older adults.

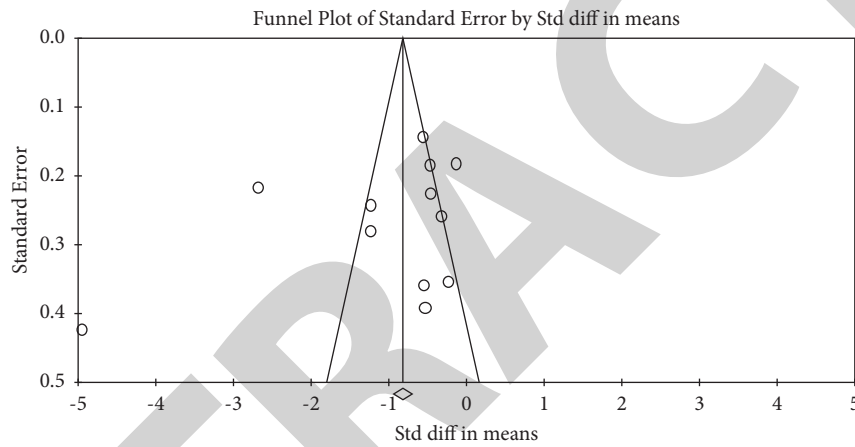


FIGURE 4: Funnel Plot of effect of physical exercise on depression of the older adults.

TABLE 4: Publication bias and heterogeneity test.

Outcome variable	Number	Publication bias		Heterogeneity test	
		Fail safe N	Q	I <sup>2</sup>	Tau-squared
Mental health	28	3656	339.72	95.03	1.12
Anxiety	15	1268	331.86	95.78	1.42
Depression	13	606	206.60	94.19	0.91

95% CI (-1.66, -0.84),  $P = 0.000 < 0.001$ ], the combined effect of anxiety [SMD = -1.45, 95% CI (-2.08, -0.83),  $P = 0.000 < 0.001$ ], and the combined effect of depression [SMD = -1.02, 95% CI (-1.56, -0.48),  $P = 0.000 < 0.001$ ] (Table 5). The results show that the total effect of physical exercise on the mental health of the older adults which intervention group is better than the control group, indicating that as long as the exercise, it will improve the mental health, anxiety, and depression of the older adults.

3.6. Results of Subgroup Analysis of Effect Sizes. Heterogeneity tests showed that there was high heterogeneity among studies, which may indicate a significant moderating effect. Subgroup analysis is one of the common

methods to explore the source of heterogeneity. Therefore, this study further explores the source of heterogeneity and its regulatory effect by subgroup analysis. This study explored intervention types (traditional exercise, walk, dance, and exercise rehabilitation), intervention duration (less than 30 minutes, 30–60 minutes, more than 60 minutes), intervention frequency (3–6 times/week, 7 times/week), intervention time (less than 12 weeks, 12–16 weeks, more than 16 weeks), measurement tools (GDS, SAS, SCL-90, SDS, STAI, and BFS) and the subjects older adults types (healthy, female, hypertension, and rural empty nesters in rural areas)

The effect of physical exercise types on mental health ( $P < 0.001$ ), anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) of the older adults had a positive effect. Among them,

TABLE 5: The effect of physical exercise on mental health of Chinese older adults.

Outcome variable	Number	SMD	LL	UL	Q	P
Mental health	28	-1.25	-1.66	-0.84	542.970	0.00
Anxiety	15	-1.45	-2.08	-0.83	331.86	0.00
Depression	13	-1.02	-1.56	-0.48	206.60	0.00

exercise rehabilitation had the greatest effect on mental health ( $d = -2.50$ ), anxiety ( $d = -2.62$ ), and depression ( $d = -3.77$ ) (Table 6).

The intervention time of physical exercise on mental health ( $P < 0.001$ ), anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) of the older adults had a positive effect. Among them, the intervention time of 12 to 16 weeks had the greatest effect on mental health ( $d = -1.46$ ) and anxiety ( $d = -1.70$ ), and the intervention time of more than 16 weeks had the greatest effect on depression ( $d = -1.54$ ) (Table 9).

The physical exercise on the measurement tools of mental health of the older adults ( $P < 0.001$ ), anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) had a positive effect. Among them, the intervention effect of physical exercise measured by STAI on mental health of the older adults ( $d = -2.91$ ), anxiety ( $d = -3.01$ ) was relatively high, measured by SDS on depression of the older adults ( $d = -2.68$ ) is relatively high (Table 10).

The physical exercise on the older adults types of mental health ( $P < 0.001$ ), anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) had a positive effect. Among them, the effect of physical exercise on mental health ( $d = -4.97$ ) and anxiety ( $d = 4.97$ ) of hypertension was higher than that of healthy older adults, female older adults, and rural empty nesters, and the effect of physical exercise on depression of healthy older adults was higher than that of female elderly and rural empty nesters (Table 11).

## 4. Discussion

**4.1. The Effect of Physical Exercise on Mental Health of Chinese Older Adults.** Through meta-analysis, this study conducted a comprehensive quantitative analysis of 15 Chinese literature on the effect of physical exercise on the mental health of the Chinese older adults. GDS, SAS, SDS, SCL-90, STAI, and BFS scales were selected to evaluate mental health, including three indicators of mental health, anxiety, and depression.

It was showed that physical exercise had a positive impact on the mental health of the Chinese older adults, that is, physical exercise could help improve the mental health level of the Chinese older adults. Compared with depression, physical exercise had the greatest effect on anxiety. Previous studies had suggested that the greatest benefits of exercise lie in the psychological domain, not in the physical domain [26]. Meta-analysis of Ma and Chen showed that the physical exercise can effectively improve the mental health of college students [27], and other studies had shown similar results, confirming that the physical exercise is a method to reduce the anxiety and depression [28–32]. This was consistent with the results of this study on the Chinese older adults. Therefore, we should pay attention to the effect of physical

exercise on the mental health of the older adults, especially their anxiety. Physical exercise could improve the anxiety and depression of the older adults and then improve the individual mental health level.

**4.2. Subgroup Analysis of Effect Sizes.** Due to non-homogeneity, subgroup analysis was conducted to explore the effect of physical exercise on the mental health of the older adults, and conducted on the intervention types, intervention duration, intervention frequency, intervention time, measurement tools, and subject older adults types.

**4.2.1. Intervention Types.** It was showed that the effect of physical exercise intervention types on mental health of the older adults had a positive effect. At present, the exercise intervention for the mental health of the older adults is still based on traditional exercise, which was related to the local exercise mode in China, it had a long history, and had been handed down to the present [32,33]. The effect of exercise rehabilitation was better than walk, dance, and traditional exercise. First of all, because of their walk's intensity was appropriate and mild, it could relieve the emotional tension caused by physical reasons in the older adults to a certain extent. Secondly, dance could increase the communication between the older adults and their peers, had more opportunities to obtain social support, and make each other find a sense of belonging and community, thus improving their mental health status [34]. Thirdly, traditional exercises, including Tai chi and qigong, could improve the emotional conditions of the older adults. For example, Tai chi can effectively regulate the emotional conditions of the older adults. The exercise program focused on "mental concentration," focused the mind and eliminating distractions. In addition, abdominal breathing could also help regulate emotions and relieve stress [35], which was confirmed by the meta-analysis results of [36]. And Yijinjing, qigong also had the effect of pleasure. Finally, exercise rehabilitation could improve some physical conditions in a more targeted way, thus improving the mental health level of individuals and achieving antianxiety and depression effects [37]. In the future, physical exercise programs that are more suitable for the physical and mental conditions of the subjects can be developed.

**4.2.2. Intervention Duration, Frequency, and Time.** It was showed that the duration of a single intervention of physical exercise had a positive effect on the mental health of Chinese older adults. Most studies had used intervention time of more than 30 minutes, interestingly, but the intervention

TABLE 6: The moderating effects of intervention methods on mental health of the older adults.

Outcome variable	Intervention methods	Number	SMD	LL	UL	I <sup>2</sup>	Q	P
Mental health	Traditional exercise	12	-0.56	-0.68	-0.44	74.77	542.97	0.00
	Walk	3	-0.81	-1.04	0.57	99.99		
	Dance	9	-0.87	-1.08	-0.66	76.83		
Anxiety	Exercise rehabilitation	4	-2.50	-2.74	-2.26	95.64	331.86	0.00
	Traditional exercise	7	-0.92	-1.39	-0.44	85.86		
	Walk	2	-2.55	-7.28	2.19	99.42		
Depression	Dance	4	-1.06	-2.02	0.10	85.79	206.60	0.00
	Exercise rehabilitation	2	-2.62	-4.63	-0.61	96.39		
	Traditional exercise	5	-0.49	-0.67	-0.32	0.00		
	Walk	1	-0.12	-0.48	0.24	0.00		
	Dance	5	-0.73	-1.18	-0.27	66.74		
	Exercise rehabilitation	2	-3.77	-6.00	-1.55	95.60		

The effect of physical exercise duration on mental health, anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) of the older adults ( $P < 0.001$ ) had a positive effect. Among them, the intervention effect on mental health ( $d = -2.51$ ) and depression ( $d = -2.67$ ) of the older adults when the single exercise duration less than 30 minutes is the largest, and the intervention effect on anxiety of the older adults was the largest when the exercise duration is 30–60 minutes ( $d = -1.21$ ) (Table 7).

TABLE 7: The moderating effects of intervention duration on mental health of the older adults.

Outcome variable	Intervention duration	Number	SMD	LL	UL	I <sup>2</sup>	Q	P
Mental health	<30 min	3	-2.51	-2.76	-2.26	97.62	542.97	0.00
	30–60 min	20	-0.75	-0.86	-0.64	92.26		
	>60 min	5	-0.46	-0.66	-2.26	97.62		
Anxiety	<30 min	2	-0.81	-2.16	0.54	98.80	331.86	0.00
	30–60 min	11	-1.21	-1.80	0.63	92.49		
	>60 min	2	-0.81	-2.16	0.54	93.72		
Depression	<30 min	1	-2.67	-3.09	-2.24	0.00	206.60	0.00
	30–60 min	9	-0.99	-1.60	-0.39	94.19		
	>60 min	3	-0.53	-1.16	0.11	81.88		

TABLE 8: The moderating effects of intervention frequency on mental health of the older adults.

Outcome variable	Intervention duration	Number	SMD	LL	UL	I <sup>2</sup>	Q	P
Mental health	3–6	21	-0.85	-0.95	-0.74	93.91	542.97	0.00
	7	7	-1.08	-1.25	-0.91	97.14		
Anxiety	3–6	10	-1.07	-1.82	-0.32	95.86	331.86	0.00
	7	5	-2.28	-3.71	-0.85	96.44		
Depression	3–6	11	-0.75	-1.23	-0.27	90.74	206.60	0.00
	7	2	-2.72	-7.03	1.59	98.96		

The frequency of physical exercise on mental health, anxiety ( $P < 0.001$ ), and depression ( $P < 0.001$ ) of the older adults ( $P < 0.001$ ) had a positive effect. Among them, the frequency of exercise 7 times a week on mental health ( $d = -1.08$ ), anxiety ( $d = -2.28$ ), and depression ( $d = -2.72$ ) of the older adults which intervention effect was higher than 3–6 times a week (Table 8).

TABLE 9: The moderating effects of intervention time on mental health of the older adults.

Outcome variable	Intervention periods	Number	SMD	LL	UL	I <sup>2</sup>	Q	P
Mental health	<12	1	-1.46	-2.01	-0.90	0.00	542.97	0.00
	12–16	15	-0.87	-1.01	-0.72	94.58		
	>16	12	-0.91	-1.03	-0.80	96.08		
Anxiety	<12	1	-1.46	-2.01	-0.90	0.00	331.86	0.00
	12–16	8	-1.70	-2.98	-0.43	96.77		
	>16	6	-1.15	-1.89	-0.42	95.19		
Depression	12–16	7	-0.59	-0.98	-0.21	70.90	206.60	0.00
	>16	6	-1.54	-2.54	-0.53	97.15		

effect of less than 30 minutes of exercise is higher than 30–60 minutes and more than 60 minutes. The frequency of physical exercise intervention had a positive effect on the

mental health of Chinese older adults. The intervention effect of daily physical exercise was higher than 3 to 6 times a week. The intervention time of physical exercise had a

TABLE 10: The moderating effects of physical exercise on the effect of measurement tools of mental health in the older adults.

Outcome variable	Measurement tools	Number	SMD	LL	UL	$I^2$	Q	P
Mental health	GDS	2	-0.73	-1.10	0.35	82.57	542.97	0.00
	SAS	5	-1.84	-2.08	-1.61	97.71		
	SCL-90	16	-0.63	-0.74	-0.53	89.48		
	SDS	2	-1.18	-1.51	-0.84	98.93		
	STAI	2	-2.91	-3.62	-2.21	69.66		
	BFS	1	-1.22	-1.70	-0.74	0.00		
Anxiety	SAS	5	-2.42	-4.02	-0.83	97.71	331.86	0.00
	SCL-90	8	-0.53	-0.93	-0.13	83.81		
	STAI	2	-3.01	-4.31	-1.70	69.66		
Depression	GDS	2	-0.76	-1.66	0.14	82.57	206.60	0.00
	SCL-90	8	-0.70	-1.30	-0.09	92.84		
	SDS	2	-2.68	-7.07	1.71	98.93		
	STAI	1	-2.38	-3.29	-1.47	0.00		

TABLE 11: The moderating effects of physical exercise on the mental health of subject older adults types.

Outcome variable	Subject elderly types	Number	SMD	LL	UL	$I^2$	Q	P
Mental health	Healthy	21	-1.03	-1.14	-0.93	93.84	542.97	0.00
	Female	4	-0.46	-0.69	-0.24	0.00		
	Hypertension	1	-4.97	-5.59	-4.34	0.00		
	Empty nesters in rural areas	2	-0.13	-0.38	0.13	0.00		
Anxiety	Healthy	11	-1.43	-2.03	-0.82	93.07	331.86	0.00
	Female	2	-0.48	-0.79	-0.16	0.00		
	Hypertension	1	-4.97	-5.59	-4.34	0.00		
	Empty nesters in rural areas	1	-0.14	-0.50	0.22	0.00		
Depression	Healthy	10	-1.24	-1.94	-0.54	95.00	206.60	0.00
	Female	2	-0.45	-0.77	-0.14	0.00		
	Empty nesters in rural areas	1	-0.12	-0.48	0.24	0.00		

positive effect on the mental health of the Chinese older adults. The intervention effect of 12 to 16 weeks of exercise was higher than that of less than 12 weeks and more than 16 weeks. They might be because of exercise in small amounts, several times a week, and in moderation is more suitable for older people, neither making them feel physically tired nor reducing their psychological benefits. Prof Ji believed that exercisers regularly exercise for 20–60 minutes each time, which was conducive to improving mood and forming a good emotional state [38]. The results of intervention dose suggest that the study of mental health intervention for the older adults was cost-effective, and the intervention time was not the longer the better. Physical activity for less than 30 minutes a day and 12 to 16 weeks had the best results for older adults, helping individuals improve their mental health.

**4.2.3. Measurement Tools.** It was showed that physical exercise had a positive impact on the measurement tools of mental health in the Chinese older adults. The possible reasons for this result are as follows: first, the measurement dimensions were inconsistent between scales. Some scales only measure fixed variables, such as SAS and STAI, which measure anxiety. GDS and SDS, which measure depression, while SCL-90 and BFS measure somatization, fear, agitation, calmness, and other dimensions in addition to anxiety and depression. Second, the objects used in the scale were

different. GDS was only applicable to the older adults, while other scales were applicable to the general person. The measurement dimensions between scales were inconsistent with the applicable objects, which might lead to some differences in the results of measurement tools. These results suggested that in the future, when choosing measurement tools, we should try to select scales developed for the older adults that fit the research needs. Compared with the other measurement tools, SCL-90 scale was the most widely used in mental health.

**4.2.4. Subject Older Adults Types.** It was showed that physical exercise had a positive effect on the mental health of the subjects' older adults types. Different from other subjects, the older adults with hypertension suffer from both physical and psychological pressures, which jointly affect their mental health level. The main motivation for the older adults to participate in physical exercise is to enhance their physical health [39]. In the process of physical exercise, the older adults with hypertension will also bring this expectation into it, thus affecting the effect of physical exercise. This result is in line with the view of Maslow's hierarchy of needs theory. After the basic physiological needs were satisfied, the older adults with hypertension pursue higher levels of needs [40], and physical exercise just relieves the dual pressure of body and mind, achieving twice the result with half the effort.

**4.3. Limitations.** Due to the database limitations, the co-cited research was not analyzed. So, high-quality Chinese articles that have made important contributions in this field cannot be sorted out and cannot be compared with the articles in English. In the future, relevant research can further expand the scope of literature retrieval, research group, research content, and analyze current research hotspots and trends more comprehensively.

## 5. Conclusion

In this study, a meta-analysis was conducted to explore the effect of physical exercise on the mental health of the Chinese older adults. The results showed that: (1) physical exercise could improve the mental health, anxiety, and depression of the older adults to a certain extent; (2) The intervention effect of physical exercise on the mental health of older adults was significantly moderated in the intervention types, intervention duration, intervention frequency, intervention time, measurement tools, and subject older adults types. Physical exercise had a positive effect on the mental health of the older adults, which was applicable to all older adults groups, but exercise rehabilitation was the most effective, and physical exercise had the best intervention effect on the older adults with hypertension. In order to achieve the intervention effect of improving mental health, it was recommended that the older adults do exercise a small number of times every day, 30 to 60 minutes each time, for 12 to 16 weeks to achieve the effect. In terms of measurement tools, future research should try to select scales developed for the older adults that fit the research needs.

## Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

## Authors' Contributions

LJW and SWL contributed to conception and design of the study. LW organized the database. SWL and MZ performed the statistical analysis. LJW wrote the first draft of the manuscript. SWL, LW, and MZ wrote the sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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## Retraction

# Retracted: Ecological Landscape Design and Evaluation in Public Charging Facilities for Electric Vehicles

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] Y. Yu, "Ecological Landscape Design and Evaluation in Public Charging Facilities for Electric Vehicles," *Journal of Environmental and Public Health*, vol. 2022, Article ID 3010851, 14 pages, 2022.

## Research Article

# Ecological Landscape Design and Evaluation in Public Charging Facilities for Electric Vehicles

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The deterioration of the environment in the 21st century has made environmental issues one of the most severe tests for modern society. With this comes a change in energy structure from high-carbon to low-carbon direction, and electric vehicles are gradually developing into the darling of a city with low-carbon transportation and safe travel. This paper carries out a systematic analysis of landscape design and environmental protection in the development of new energy electric vehicle charging facilities in urban habitat. By categorizing the content and provisions of published domestic and international standards, new requirements for standardization are obtained, including barrier-free design, electromagnetic radiation, child safety protection, and urban landscape integration. Among them, ecological landscape public charging facilities can enhance the overall quality of urban environment. This paper analyzes the necessity of landscape design in charging facilities, explores the ecological concepts extended by macroscopic landscape design principles and the problems of public charging facilities, and proposes a design and evaluation method of ecologically landscaped public charging facilities based on hierarchical analysis and neural networks. The hierarchical analysis method is introduced to establish a landscape design assessment index system, and then a neural network is introduced to describe the characteristics of electric vehicle charging, and the landscape design assessment learning samples are trained to establish a landscape design assessment model. Finally, a comparison experiment is conducted with other landscape design assessment methods using specific examples, and the results show that the proposed method has more obvious advantages in ecological landscape public charging facility design assessment with high accuracy, faster landscape design assessment, charging efficiency, and environmental protection.

## 1. Introduction

The landscape compatibility problem in public charging facilities foreign studies mainly focuses on the number of charging facilities' fixed capacity and site selection, without considering its function as a building and the building itself into the landscape mechanism and other aspects. As a kind of public service facility with high sustainability and energy ratio, most of the studies on charging facilities focus on functional characteristics, grid mechanism, and operation management, but there is a lack of studies on the characteristic expression of landscape design in charging facilities. Background and trend of landscape reference in public charging facilities: Under the current environmental problems, the use and exploration of sustainable energy has become one of the ways to solve the problems, and charging

facilities are expanding under the call of new energy [1–3]. New energy charging facility landscape architecture is a new energy charging facility architecture integrated with aesthetic and artistic design, which can meet people's dual demand for low-energy consumption and architectural aesthetics of the building. In recent years, the development rate of new energy charging facility landscape architecture has been increasing, the design research of new energy charging facility landscape architecture has become a hot spot, and landmark new energy charging facility landscape architecture is emerging. Therefore, it is necessary to review the development background and research history of new energy charging facility landscape architecture, summarize the development of new energy charging facility landscape, and propose the method of new energy charging facility landscape architecture. The existing public charging space



has a single set of supporting facilities, grid technology restrictions, and spatial landscape problems, while at this stage the exploration of functionality is much more than the exploration of landscape. In terms of form, the base station extends outside the space in the form of rows of trees with a canopy, providing a resting space and creating a quiet environment. Functionally, while satisfying the demand for fast charging, the space is also designed with landscape references to achieve a harmonious coexistence between man and nature. The superfast charging station superimposes landscape performance based on meeting the needs of functional use, as a type of landscape architecture. From the development trend, the future use of landscape design for charging facilities has become a general trend. The Vinci diagram of the new demand analysis path for standardization of charging facilities in ecological landscapes is shown in Figure 1.

In Figure 1, we analyze the new demand for standardization of charging facilities in ecological landscapes, which mainly includes three aspects: (1) Content of charging facility standards. To meet the latest development trend of electric vehicles, charging facilities need to be designed according to the latest standards. (2) New demands of ecological protection. (3) New demands of landscape design of charging facilities. The popularity of electric vehicles to enhance the ecological protection of society, set point facilities are also an important component of the electric vehicle industry chain and need to further enhance ecological protection. New energy vehicle charging device can be divided into fast and slow charging. Slow charging is the use of AC charging device to input single-phase AC power, the output of the car AC power, but not directly used in the new energy vehicle storage device, and the use of charging devices to achieve the purpose of charging for new energy vehicles. Slow-charging devices can also be combined with the specific use of each type, to be divided into public charging and home charging, where home charging is generally a small-output power, power is usually within 2.8 kW, so the charging time is relatively long, but the cost design is small, so many residents are favored, but the public charging power is relatively high, but the highest power must be within 7.5 kW. The charging time is shorter than that of home charging [4–6]. In addition, in the design and construction of equipment, the construction of JIATO charging equipment is relatively easy and less costly, so it can be well used in construction. Fast charging is a generally used DC mode to charge, which belongs to the battery charging type; there are many manufacturers of this mode charging device; there will be differences between the maximum output power, basically must be suitable to control between 22 kW and 220 kW. In addition, priority should be given to DC equipment of good-quality brand, which can well bear the output voltage and current at the same time, and because of its relatively large variation within the interval, it can generally be used in various models of new energy vehicles so as to achieve the actual needs of various types of new energy vehicle charging, and the installation method of new energy vehicle fast charging device basically adopts the floor type [5].

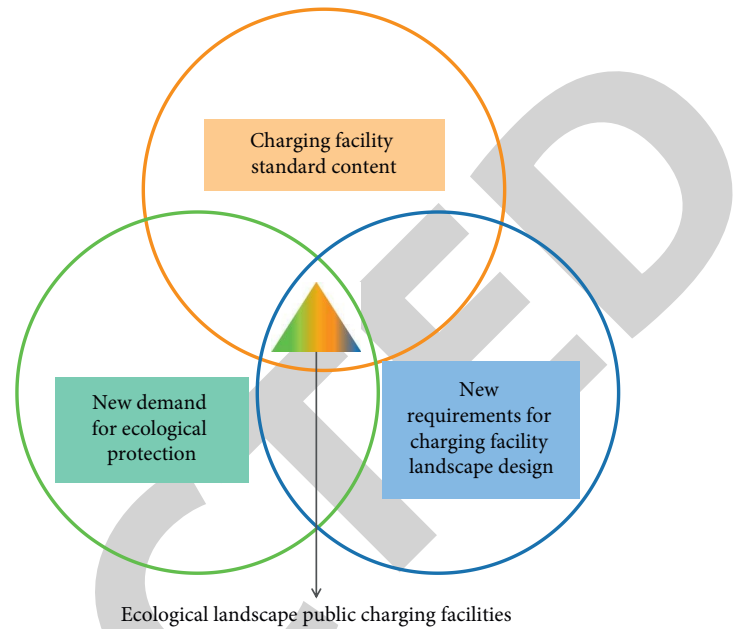


FIGURE 1: Diagram of the new demand analysis path for standardization of charging facilities in ecological landscapes.

The existing charging facilities lack reasonable expression of landscape design factors and are not given much attention in this field. The use of urban fragmented space while relying on the urban road network reflects the ecological concept, and the landscape architecture is reasonably planned according to the geographical location, materials, and grid structure. First, for geographical location, the materials of the ultra-fast charging station are collected from its nearby forest park, utilizing the sustainability of the building materials, and the ecological concept is reflected everywhere in the future maintenance of the base station with zero waste and docking of the materials, and the main building materials are considered for future maintenance, while the complexity of the surrounding road network extension from the route also determines its embodiment in functional applications [6]. The location of the base station makes use of the urban debris space, forming a transition space between the city and nature. More importantly, the use of debris space creates a prerequisite space for the harmonious development of man and nature in an urbanized city. Architecture in ecology becomes a carrier of human activities and landscape environment. Second, for the use of materials, the sustainability of wood is constantly reflected in the landscape architecture, fitting the ecological concept and rational planning of sustainability and the fixed capacity of facilities. The main body of local materials highlights the ecological concept of landscape design embodied in the building itself, while the use of materials is also the basis for the charging facilities reflecting the principles of landscape design [7]. The main contributions of this paper include the following: (1) analyzing the existing charging facilities' lack of reasonable expression of landscape design factors, which are not paid attention to in this field. (2) To obtain ideal landscape design and environmental protection effect and

evaluation results of electric vehicle public charging facilities, this paper designs hierarchical analysis method and neural network landscape design effect assessment method, which has the advantages of hierarchical analysis method and neural network and overcomes their disadvantages. (3) The results of simulation experiments show that the method in this paper obtains ideal results for the evaluation of the design effect of ecological landscape public charging facilities, and the efficiency of landscape design effect evaluation is also obvious. Moreover, the efficiency of landscape design effect assessment is significantly better than the landscape design effect assessment methods of hierarchical analysis method and neural network.

## 2. Related Work

### 2.1. Ecological Landscape Public Charging Facilities

*Landscape Design Environmental Protection Electric Vehicles.* With the development of clean energy and the promotion of the concept of sustainable development, electric vehicles have gradually become the mainstream transportation. The large number of electric vehicles put into use has reduced environmental pollution and saved energy, but it also brings its charging problem. Charging piles, as an important charging place for electric vehicles, seriously affect the development of electric vehicle industry and the convenience of car owners with their cars [8].

Therefore, it is necessary to plan the site selection, construction capacity, and charging network of charging piles. Power battery performance such as mass specific energy, volume specific energy, charging multiplier, and so on has an important impact on the development of EV charging facilities. Specific energy determines the range of electric vehicles (the driving range of one charge) and charging multiplier determines the charging time. In this paper, we believe that the promotion of electric vehicles can be divided into 3 stages: demonstration, public welfare, and commercial operation. The characteristics of charging facilities planning are different in different stages. In the demonstration stage, the electric vehicle technology is not yet fully mature, and the market mechanism to promote the development of electric vehicles in a sustainable way has not yet been formed. The charging facility planning in the demonstration stage can be regarded as the recent planning. At this stage, EV technology is developing rapidly, but it is still at a low level and there are hidden bottlenecks, such as safety factors; the total number and proportion of EVs at this stage are still relatively low and the economy is not high. The development mode is to rely on government subsidies and lead the propaganda of acceptable charging EVs, which can be expanded to electric buses, public vehicles of large enterprises and institutions, and a few social vehicles. This stage of charging facilities planning can be regarded as medium-term planning. At this stage, the technology of electric vehicles is basically mature, and the total amount of electric vehicles has reached a certain scale and the variety of electric vehicles is relatively rich. At this stage, the economy of electric vehicles is equal to or even surpasses that of fuel

vehicles, and the development mode is mainly market driven. The planning of electric vehicle charging facilities at this stage can be regarded as long-term planning.

The basic framework of the habitat standardization system for electric vehicle charging facilities is shown in Figure 2. In this paper, a systematic analysis of the current situation and demand for common standardization of new energy electric vehicle charging facilities in urban habitat is carried out. Firstly, two research methods, content analysis and semistructured questionnaire research, were identified, and the logical analysis path was “induction-deduction” [9–11]. Then, two independent coders categorized the contents and clauses of published domestic and international standards by content analysis, summarized eight types of standardization needs, and compared the missing contents of domestic standards from international standards. Finally, a semistructured questionnaire survey was used to collect the factors that the public thinks need to be included in the consideration of the habitat environment in addition to the existing contents of the standards. The results of the standard code comparison and questionnaire survey show that the current domestic standard system for electric vehicle charging facilities already covers (1) site planning, (2) installation arrangement, (3) environmental requirements, (4) fire safety, (5) energy saving and environmental protection, (6) lighting requirements, (7) noise impact, (8) signs and markings, and other eight aspects of the habitat environment. The four new requirements not yet covered are (9) barrier-free design, (10) electromagnetic radiation, (11) child safety protection, and (12) urban landscape integration. The results of the standard code comparison and questionnaire survey show that the current domestic standard system for electric vehicle charging facilities already covers (1) site planning, (2) installation arrangement, (3) environmental requirements, (4) fire safety, (5) energy saving and environmental protection, (6) lighting requirements, (7) noise impact, (8) signs and markings, and other eight aspects of the habitat environment [12–14].

Public charging facilities at home and abroad account for the background status public charging facilities; that is, public charging stations are a sustainable energy supply facility derived from the current energy structure transformation. New energy vehicles tend to improve the development of energy utilization as the main means, and their charging facilities should be on the same level of hard functionality. In terms of architecture, the open building structure is supposed to be an extension of the space division. Taking the fast-charging station as an example, the basis of functional embodiment extends to the public landscape, and the addition of landscape elements to a certain extent complements the industry, focusing on the symbiosis of architecture and environment and the co-topology of the environmental planning industry chain. Second, the principle of scientific nature of landscape design materials. The choice of materials should also fit the characteristics of sustainable development of charging facilities, the reality of the environment in the material of the facility site has not considered the ecological concept, or even the facility site is under the open air. In terms of materials, the

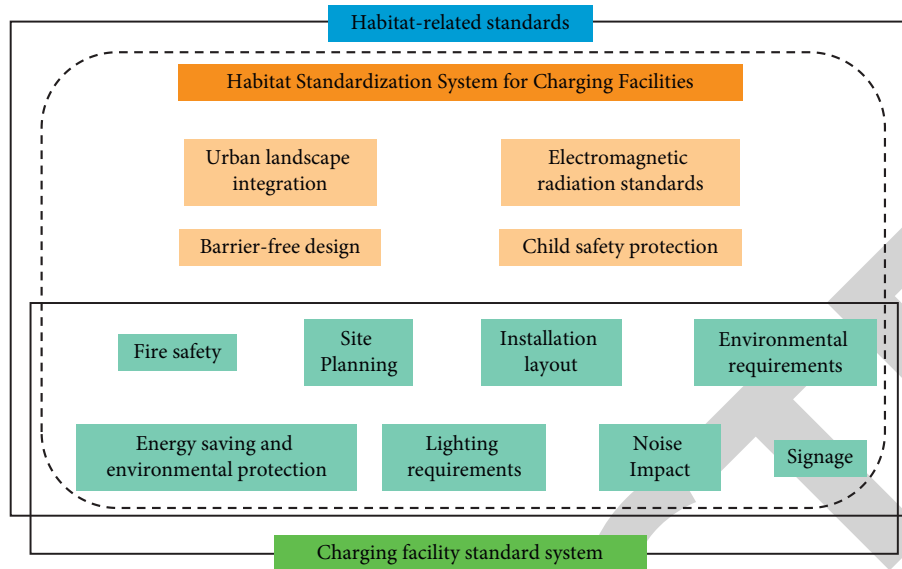


FIGURE 2: The basic framework of habitat standardization system for electric vehicle charging facilities.

materials age and fall off due to the long-term environment in the open air, which shortens the service life of the materials. Therefore, the choice of materials should consider the influence of external factors, and at the same time, the choice of materials should pay attention to echoing the environment of the facility place. The material selection of the facility space should be combined with the material qualities, environment, and other external objective factors, based on the ecological concept, scientific selection of materials, reasonable protection of landscape architecture, and the principle of scientific should be used to configure landscape materials [15–17]. In the design, the charging station is shown in the form of anthropomorphic trees, and the modular construction method makes the charging station scalable and can perform a “forest” according to the needs. In the use of materials, to reflect the form of the base station, trees selected by the Nature Conservancy were used, and the toughness of the wood meets the requirements to a certain extent, while the attachment of solar panels is ensured [18, 19].

**2.2. Artificial Intelligence and Landscape Design.** With the continuous development and improvement of China’s economy, people’s living standards are constantly improving, families and public places have carried out some landscape design, landscape design can bring people a more comfortable feeling, and each person has different requirements for landscape design, so the landscape design effect needs to be accurately assessed to better provide people with the best living, working and leisure environment, therefore, landscape design effect assessment has been the focus of people’s attention. For landscape design effect assessment, domestic and foreign research institutions have conducted in-depth research, and there are many effective landscape design effect assessment methods. The current landscape design effect assessment method is divided into

two kinds of qualitative analysis and quantitative analysis, among which the most representative qualitative analysis method is the hierarchical analysis method, which is based on the landscape design effect assessment indexes; according to the weights of various indicators to the landscape design effect assessment results, the method is relatively simple and belongs to the linear modeling method, while the landscape design effect and evaluation indexes are a nonlinear mapping relationship, resulting in the deviation of landscape design effect assessment is relatively large, and the practical application value is low; the most representative quantitative analysis method is artificial neural network, such as RBF neural network, BP neural network, limit learning machine network, and so on. The artificial neural network has strong nonlinear modeling ability and gets better landscape design effect assessment results. Since landscape design effect assessment is very complex, single hierarchical analysis method and neural network both have their own shortcomings and cannot describe landscape design effect comprehensively and accurately, so landscape design effect assessment faces great challenges [20].

With the concept of developing clean energy and promoting sustainable development, electric vehicles have gradually become the mainstream transportation. Although the large number of electric vehicles put into use has reduced environmental pollution and saved energy, it also brings its charging problem. Charging piles, as an important charging place for electric vehicles, seriously affect the development of electric vehicle industry and the convenience of car owners with their cars. Therefore, it is necessary to plan the site selection, construction capacity, and charging network of charging piles. Landscape scheme design and quality evaluation is divided into subevaluation and overall evaluation where subevaluation is more rational and tends to focus on whether the specific functions of the landscape scheme are reasonable or not, but overall evaluation is also important; it is often a comprehensive evaluation of the landscape scheme

by experts based on their own experience. In the past, we often encountered the following situation: every indicator of the landscape scheme is at a medium level, but the total score is low; while some schemes only have a few indicators but score high and other indicators score average, but the total score is high. This fully illustrates that there is a nonlinear relationship between the overall quality of the landscape and the evaluation factors. In this paper, a BP neural network model is used to explain the nonlinear relationship between the quality of natural ecological river landscape schemes and their evaluation factors [20, 21].

Landscape ecological planning is the practical activity of using the principles of landscape ecology to solve ecological problems at the landscape level, which concentrates the application value of landscape ecology, and it is especially significant to apply it to the urban fringe areas with fragile ecology and complex landscape pattern changes. Landscape ecological planning can be understood as follows: based on regional natural, social, and economic information, from a macro, overall, and comprehensive perspective on the regional landscape pattern to make dynamic planning, in order to optimize the structure, protect the ecological balance, and promote the sustainable development of the region. The landscape pattern can be reflected by a set of landscape indices, so the landscape ecological planning process is essentially a nonlinear mapping process, that is, a nonlinear mapping relationship between various topographic factors and various disturbance effects (especially the role of human) and a set of landscape indices. The artificial neural network method that has emerged at home and abroad in recent years can perform large-scale parallel processing of information, is good at association, generalization, analogy, and reasoning, and can extract regular knowledge from a large amount of raw or statistical data, which is very suitable for quantitative research of landscape ecological planning. With the development of artificial neural network technology, researchers have designed a variety of neural network models, which describe and simulate the biological neural system at different levels from different perspectives and are applied in various fields, of which 80%–90% of the artificial neural network models use BP networks or its variant forms, reflecting the best part of artificial neural networks [22, 23].

*The Embodiment of Landscape Design Principles in Facilities.* First, the extension of landscape design in space is tackled. In the existing charging facilities, the landscape of the facility and the building space are separated, and the landscape environment design mostly exists in the external environment [24]. The comfort given by the landscape cannot be extended to the facility body, and the functionality of the space monolith and the landscape environment are out of place. At the same time, in the limited facility space, the planning of landscape design has limitations, and the landscape guided by the principle of natural environment compatibility is extended in the facility. This time, we need to reflect the principle of extension of landscape design, not only in the space inside and outside the environment, but also in the landscape design of plants, visual angle, and

landscape carrier extension [25]. In short, the audience's visual angle and sensory experience in the public charging facilities will not have a greater sense of difference when they are extended outside the facilities. Take the high-speed tram charging station as an example; the open space design extends the landscape from internal to external natural space, and the use of pavilion structure extends the tree canopy from the top of the charging station, truly integrating the facility with the landscape, and thus extending the internal environment of the base station to the external environment [26]. Meanwhile, in terms of vegetation, the surrounding plants are mainly local greenery species that can be selected in cooperation with natural resources conservation, and the plant configuration is also an extension from nature to architecture. As mentioned above, the material of the base station is collected from the nearby forest park, which extends from the environment to the facility so that the audience can feel the public charging facility and the environment in the space without any difference. In contrast, the current charging base stations do not consider the extension of landscape design in the space, and the internal and external environments often fail to achieve harmony, and the peripheral environment is only used as green decoration, and the use of the site is more a reflection of function [27].

### 3. Methods

*3.1. Ecological Landscape Charging Facility Site Selection Model.* The overall model structure is shown in Figure 3. To make more reasonable and full use of electric energy resources, optimize charging station area configuration and maximize people's charging demand for electric vehicles, a maximum cut-off model for electric vehicle charging stations is constructed to maximize the service range and charging efficiency of charging stations.

(1) Model assumptions: It is assumed that electric vehicle trips are mainly distributed on the shortest route between the origin and destination. In a transportation network, suppose there are  $n$  nodes; then there are  $n^*(n-1)$  shortest routes. The set of shortest routes between two places is  $C = \{C_1, C_2, \dots, C_{n^*(n-1)}\}$ , the length of the shortest route is  $D_c$ , and  $N_c$  is the set of nodes on the  $c$ th shortest route. Assume that the traffic flow on each route can be determined. That is, the traffic route network is deterministic, and the road traffic flow on each route is stable without considering the effect of individual road construction or building. Assume that the traffic route network is a network system, where the set of nodes is  $N = \{n_1, n_2, \dots, n_n\}$ , the set of edges is  $A = \{a_1, a_2, \dots, a_n\}$ ,  $Q$  is the number of charging stations set up, and  $R_i$  is the flow of electric vehicles on  $a_i$ .  $H_{\max}$  is the maximum distance between stations. Define two 0–1 variables, located on the path of  $a_i$  to set charging stations; then  $x = 1$ , otherwise 0; located on the shortest route to plan at least one charging station,  $y = 1$ , otherwise 0. Assume that there is an upper limit to the number of charging posts in a single charging station. One charging station may not be able to meet the charging demand of all users. Let the charging station have charging piles  $f$  units,

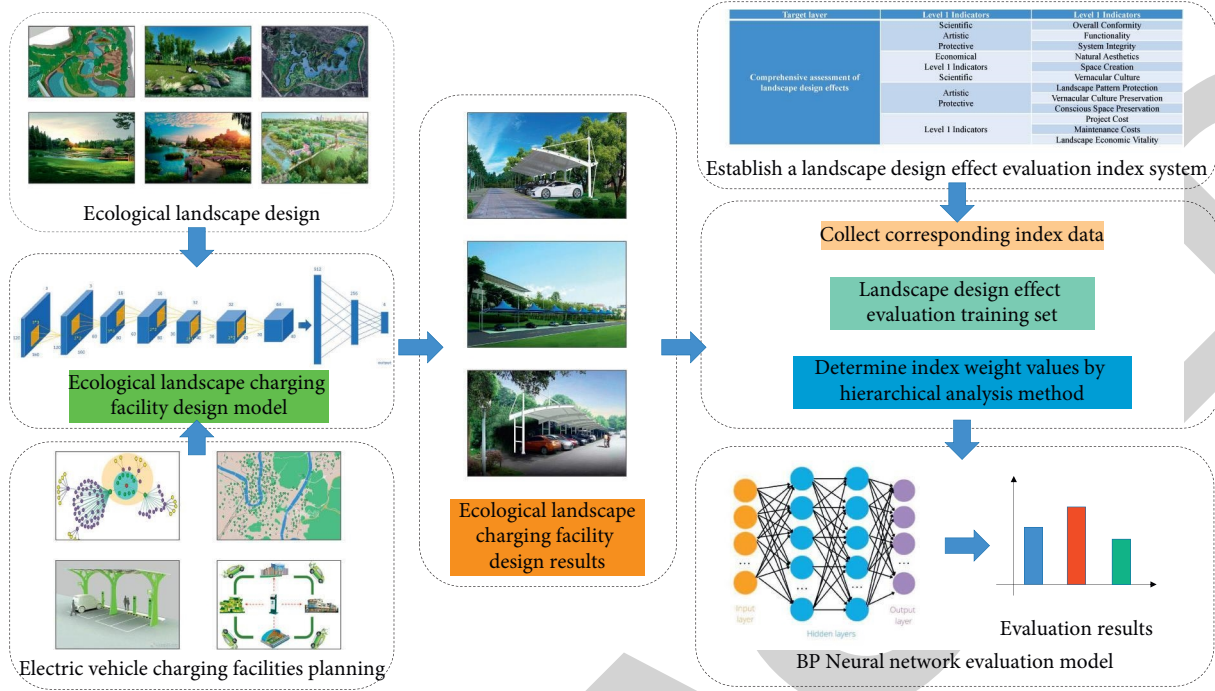


FIGURE 3: Overall model structure.

and  $f$  denotes the number of charging piles installed in charging station  $i$ .

(2) Modeling:

$$\text{Max} \sum_{a_i \in A_c} R_i x_i, \quad (1)$$

$$\sum_{i=1}^n x_i = n, \quad (2)$$

$$\sum_{c \in C} f_c x_i \leq S, \quad (2)$$

$$D_c \times (1 - y_c) \leq H_{\max}, \quad (3)$$

$$y_c, x_j \in \{0, 1\}. \quad (3)$$

The objective function is the maximum traffic flow intercepted; the constraint is the total number of  $n$  charging facilities installed; the constraint is the maximum capacity of charging facilities not exceeding  $S$ ; the constraint indicates that the user can still charge the electric vehicle during the remaining trips. The constraint indicates that the decision variable takes the value of 0 or 1.

(3) Algorithm solving: Ant colony algorithm refers to an optimization algorithm that simulates the foraging behavior of ants to find the optimal path. By identifying a series of solutions to be optimized as the solution space of feasible solutions, the ant colony algorithm is driven by the pheromone and iterates in a continuous loop to find the optimal path under the influence of positive feedback mechanism and then obtains the optimal solution of the problem. The algorithm is mainly applied to the assignment problem, traveler problem, network routing, and other optimization combination problems. Related scholars at home and abroad

improve the ant colony algorithm; the most classical one is the maximum-minimum ant colony system (MMAS), which mainly improves three aspects, such as initializing the amount of information  $\tau_{it}(0) = \tau_{\max}$ , to find the ant releasing pheromone of the shortest path after one cycle and limiting  $\tau_{it}(0)$  between  $[Tmin, Tmax]$ . The main parameters are chosen as follows: information heuristic factor  $\alpha$ , expectation heuristic factor  $\beta$ , ant colony size  $m$ , and information volatility factor  $\rho$ .

$$\begin{aligned} \alpha &\in [0, 5], \\ \beta &\in [0, 5], \\ m &\in [10, 10000], \\ \rho &\in [0.1, 0.99]. \end{aligned} \quad (4)$$

*Calculation Method: Variable Initialization.* Determine the range of the study;  $n$  denotes the number of regions; that is, the range of the study is  $n$  regions. Create a matrix of weights for  $n$  regions, and the weights, namely, pheromones, are expressed in terms of EV traffic flow on each traffic path and specify the distance of each shortest path. Perform iterations. Specify the maximum number of iterations, and when the maximum number of iterations is reached, the iteration stops, and the best route and its distance are recorded. The probability of ants choosing a route is the probability that the charging station is set in a certain path, and the probability is calculated by the formula  $b_i = (\tau_{it} / \sum \tau_{it}) \times R_i$ . The preliminary station setting scheme is determined according to the probability size. According to the constraints in the model, if the conditions are met, the calculation continues to the next step, and if not, the probability is recalculated to determine the new station setting scheme. Select the path according to

TABLE 1: Landscape design effect comprehensive assessment index system.

Target layer	Level 1 indicators	Level 1 indicators
Comprehensive assessment of landscape design effects	Scientific	Overall conformity
	Artistic	Functionality
	Protective	System integrity
	Economical	Natural aesthetics
Comprehensive assessment of landscape design effects	Level 1 indicators	Space creation
	Scientific	Vernacular culture
	Artistic	Landscape pattern protection
	Protective	Vernacular culture preservation
Comprehensive assessment of landscape design effects	Level 1 indicators	Conscious space preservation
	Scientific	Project cost
	Artistic	Maintenance costs
	Protective	Landscape economic vitality

the objective function. Bring the number of site settings that meet the conditions into the model objective function, take the maximum value, and record the best path and update the pheromone. Continue the drop generation until the number of drop generations reaches the maximum value and stop. Get the best station setting value.

### 3.2. Landscape Evaluation of Public Charging Facilities.

To evaluate the landscape design effect with high precision, an optimal landscape evaluation index system must be established. In this paper, a landscape evaluation index system is established based on the principles of representativeness, measurability, comparability, validity, and scientific, as shown in Table 1.

The quantitative operation of the landscape design effect is carried out in the form of a 100-point system, and they are described specifically as shown in Table 2.

We use the hierarchical analysis method to determine the weights of landscape design assessment indexes, and the specific process is as follows: (1) The landscape design effect assessment indexes are quantified and the judgment matrix of landscape design effect assessment indexes is established, as shown in the following equation:

$$\bar{A} = \begin{bmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,m} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,m} \\ \cdots & \cdots & \cdots & \cdots \\ a_{m,1} & a_{m,2} & \cdots & a_{m,m} \end{bmatrix}, \quad (5)$$

where  $a_{i,j}$  is the relative weight of indicator  $i$  relative to  $j$ . (2) Calculate the product of the elements of each row of equation (5); that is,

$$M_i = \prod_{j=1}^n a_{ij}. \quad (6)$$

(3) Calculate the  $n$ th root of  $M_i$ :

$$\bar{w}_i = \sqrt[n]{M_i}. \quad (7)$$

(4) Normalize  $w_i$  using the following equation to obtain the weight vector as  $\bar{w} = [w_1, w_2, \dots, w_n]^T$ .

$$w_i = \frac{\bar{w}_i}{\sum_{i=1}^n \bar{w}_i}. \quad (8)$$

TABLE 2: Scoring criteria for comprehensive assessment results of landscape design effects.

Landscape design effect assessment grade	Score
Excellent medium	90–100
Qualified	80–90
Unqualified	70–80
Landscape design effect assessment grade	60–70
Excellent medium	60

3.3. Design Algorithm of Public Charging Facilities in Ecological Landscape. The number of input, implicit, and output nodes of the BP neural network are  $N$ ,  $L$ , and  $M$ , respectively. The structure of the neural network is shown in Figure 4. The input vector is  $X = [x_0, x_1, \dots, x_{N-1}]$ ; the weights between the implicit layer point  $j$  and the input layer point  $i$  and the output layer node  $k$  are  $V_{ij}$  and  $W_{ik}$ , respectively, and the thresholds of the output and implicit layers are  $\phi_j$  and  $\theta_k$ . The outputs of the nodes in the implicit layer and the output layer are computed as

$$h_j = f(\beta_j) = f\left(\sum_{i=0}^{N-1} V_{ij}x_i - \phi_j\right), \quad (9)$$

$$y_k = f(a_k) = f\left(\sum_{i=0}^{L-1} W_{ik}h_i - \theta_k\right).$$

Calculate the deviation of  $y_k$  from the target output; that is,

$$\delta_k = (d_k - y_k)y_k(1 - y_k),$$

$$\delta_k^* = h_j(1 - h_j) \sum_{k=0}^{M-1} \delta_k W_{jk}. \quad (10)$$

The weight adjustment size is calculated as

$$\Delta W_{jk}(n) = \eta \delta_k h_j,$$

$$\Delta V_{ij}(n) = \eta \delta_j^* x_i. \quad (11)$$

The adjustment of weights is given as

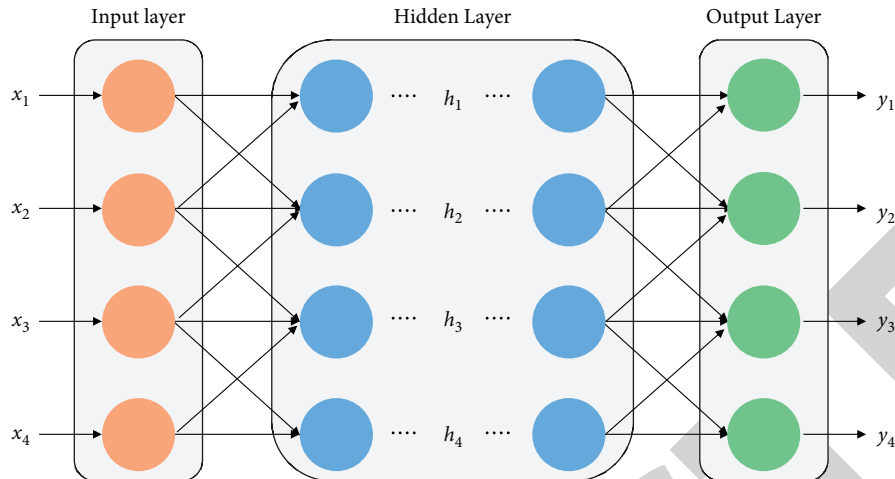


FIGURE 4: Neural network structure.

$$\begin{aligned}
 W_{jk}(n+1) &= W_{jk}(n) + \Delta W_{jk}(n) + \mu \Delta W_{jk}(n-1) V_{ij}(n+1) \\
 &= V_{ij}(n) + \Delta V_{ij}(n) + \mu \Delta V_{ij}(n-1).
 \end{aligned}
 \tag{12}$$

**Landscape Design and Evaluation Process.** (1) Establish the index system for landscape design evaluation. (2) Use hierarchical analysis to determine the weights of the indicators for landscape design assessment. (3) Collect sample data for landscape design assessment and use experts to score the effect of landscape design assessment, and form a sample set with its landscape design assessment indexes. (4) Adopt the number of landscape design assessment indicators to determine the number of input nodes of BP neural network, landscape design assessment effect as the output of BP neural network and determine the number of implied nodes of BP neural network according to certain formula so as to establish the topology of BP neural network. (5) Initialize the relevant parameters of the BP neural network. (6) Adopt the BP neural network to learn the training samples for landscape design evaluation and determine the optimal parameters with the landscape design evaluation accuracy as the training target. (7) Establish a landscape design assessment model according to the optimal parameters and test the model performance using the landscape design assessment test sample. The specific process of landscape design assessment by hierarchical analysis method and neural network is shown in Figure 5. The main steps include establishing the evaluation system and data collection, determining the BP neural network structure, and training the network. Finally, the performance of the model is tested using a landscape design evaluation test sample.

## 4. Experiments and Results

**4.1. Experimental Setup.** To test the performance of the hierarchical analysis method and neural network for the design and evaluation of ecological landscape public charging facilities, specific experiments were used to test

their performance, and their measurement environment is shown in Table 3. To make the landscape design evaluation results of hierarchical analysis method and neural network comparable, the landscape design evaluation of hierarchical analysis method and landscape design evaluation method of BP neural network are selected for comparison test, and the evaluation accuracy and evaluation time are selected as performance evaluation indexes. The method proposed in this paper performs 30 epochs on the training dataset. The specific training method is as follows: the initial vector is set to 0.0001; the Adam optimizer is used; and the batch size is set to 8 (the batch size is the size of a training sample selected and the limitation of the device GPU to choose the best optimization and speed according to the model). The training process performance improvement and loss convergence diagram is shown in Figures 6 and 7. Analysis by Figures 6 and 7 shows that a total of 30 epochs are trained, and the overall performance of the training process improves smoothly, and the model performance improves faster after 14 epochs, and the final accuracy converges to 99%.

**4.2. Test Objects.** For the effect of 50 ecological landscape public charging facility design solutions, multiple experts were used, and multiple peers scored according to the values of landscape design indicators as well as their own experience and knowledge, and the results of each landscape design scoring were counted, as shown in Figure 8.

From Figure 8, it can be found that the scoring results of different ecological landscape public charging facility design effects are different, indicating that the ecological landscape public charging facility design effects are characterized by certain randomness and nonlinear changes.

**4.3. Comparison of Evaluation Accuracy of Indicator Layer.** Ten ecologies landscape public charging facility design solutions were randomly selected as test samples and others as training samples, and five simulation tests were conducted for each method to reflect the fairness of the experimental

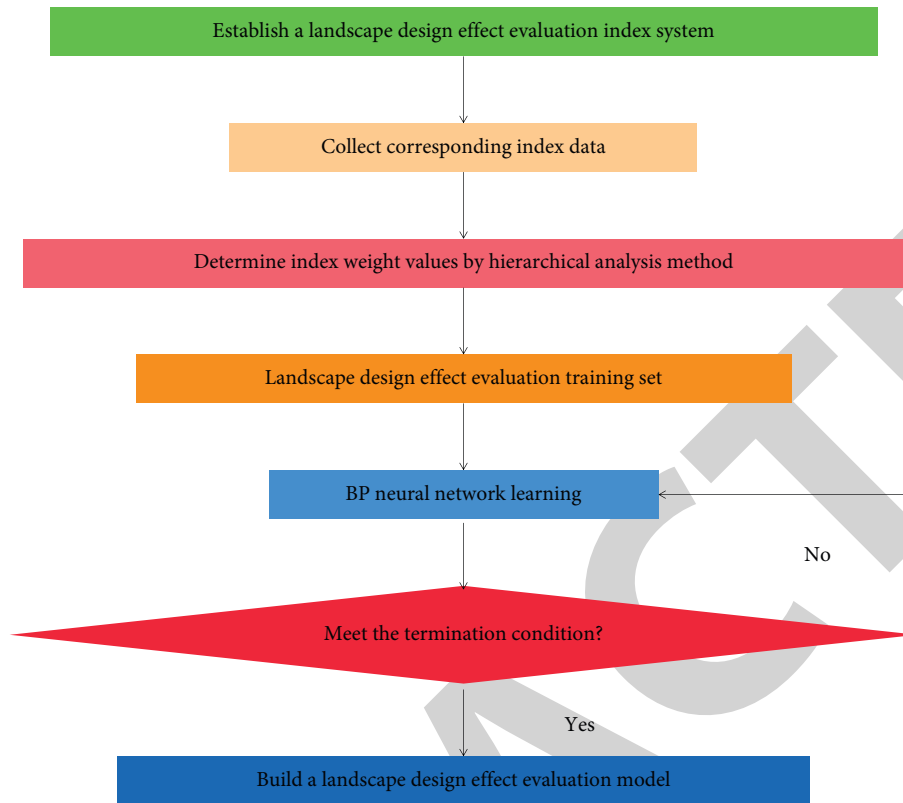


FIGURE 5: Landscape design evaluation process with hierarchical analysis and neural network.

TABLE 3: Test environment setup.

Parameter	Parameter values
CPU	AMD 3.0 GHz
RAM	16 GB
Hard disk	1000 GB SDD
Network card	1000M
Operating system	Win 10
Programming tool	VC6.0++

results, and the accuracy of landscape design effect assessment is shown in Figure 9.

Comparing the accuracy of ecological landscape public charging facility design with Figure 9, we know that the average accuracy of ecological landscape public charging facility design of this paper is 91.52%, that of hierarchical analysis is 84.20%, and that of BP neural network is 86.3%. Compared with the comparative methods, the error of the ecological landscape public charging facility design effect assessment of this paper decreases significantly, which is mainly because the method of this paper integrates the advantages of hierarchical analysis and neural network, solves the defects of the current landscape design effect assessment with large errors, and verifies the superiority of the landscape design effect assessment method of this paper.

**4.4. Ecological Landscape Charging Efficiency.** According to the queuing theory model and the determined parameters, the charging stations and the installed charging piles are coded to

generate the initial population, and then the dominant individuals are identified and entered the next generation of genetic operation based on the requirement of the least queuing time of the objective function. After a series of iterations, the final solution for selecting the location of charging stations and allocating the number of charging piles to make the objective function optimal is generated. According to the problem of charging station service efficiency, the number of populations, the length of individuals, the maximum number of iterations, the crossover rate, and the variation rate are 10, 9, 20, 0.8, and 0.01, respectively, when the number of charging stations is 120, 150, and 180, and the software is used for the programming operation of the ant colony algorithm. The basic process mainly includes the following steps: coding, creating the initial population, guiding the direction according to the fitness value after iteration, selection, crossover, variation, substitution to calculate the objective function value, and outputting the optimal solution. *Result Analysis.* When the number of charging posts is set to 120, the objective function value reaches the optimum at the 14th iteration and the least time is used (as shown in Figure 10). From the whole process of the change of the objective function value and the number of genetic iterations, the construction of the model and the selection of parameters are more scientific, and the objective value shows a continuous decline. Through simulation, it can be concluded that when 9 cells such as h1, h2, h3, h4, h5, h6, h7, h8, and h9 are selected to build stations, and the numbers of their charging posts are assigned as 16, 22, 15, 13, 5, 14, 11,



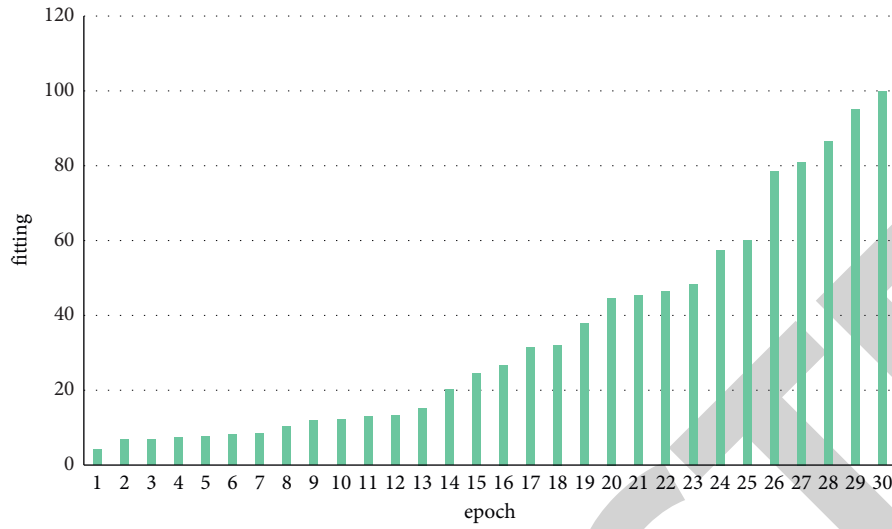


FIGURE 6: Training process performance improvement diagram.

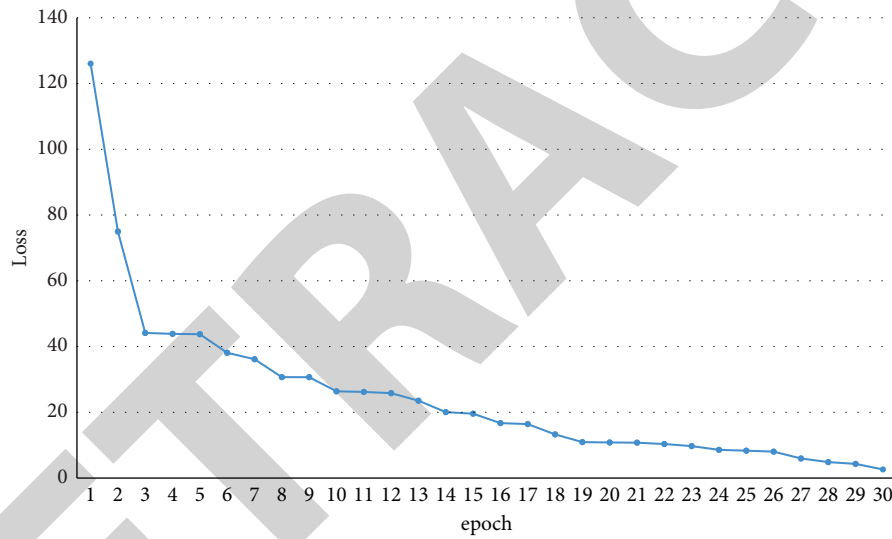


FIGURE 7: Training process loss convergence diagram.

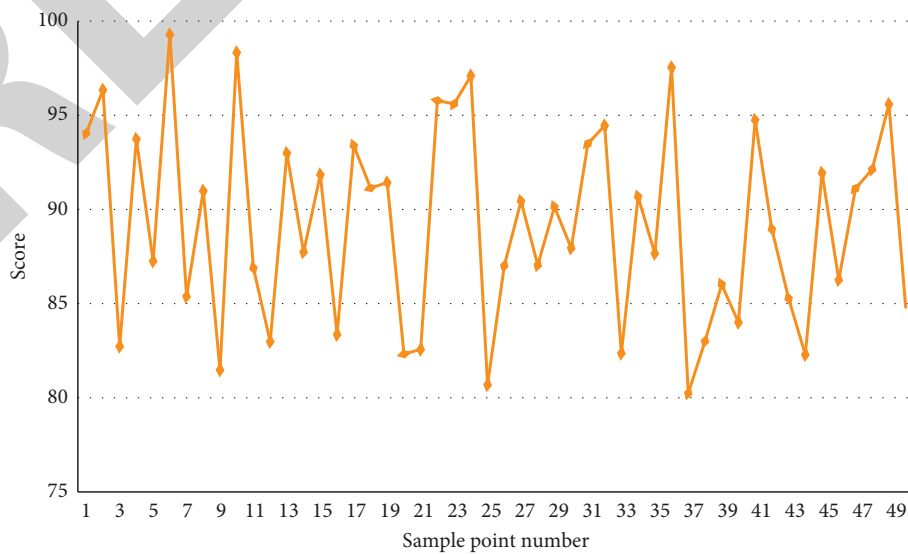


FIGURE 8: Scoring value of landscape design effect.

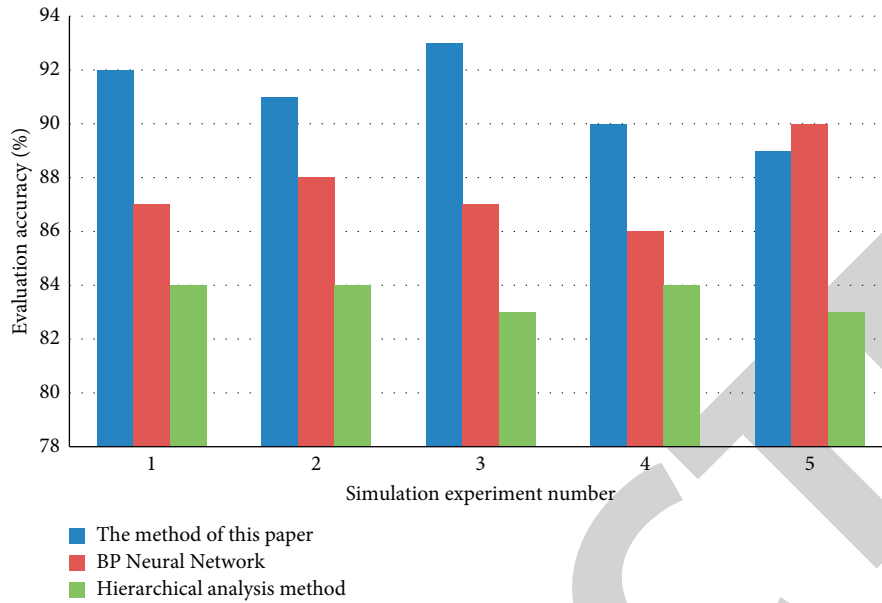


FIGURE 9: Comparison of the accuracy of landscape design effect assessment by different methods.

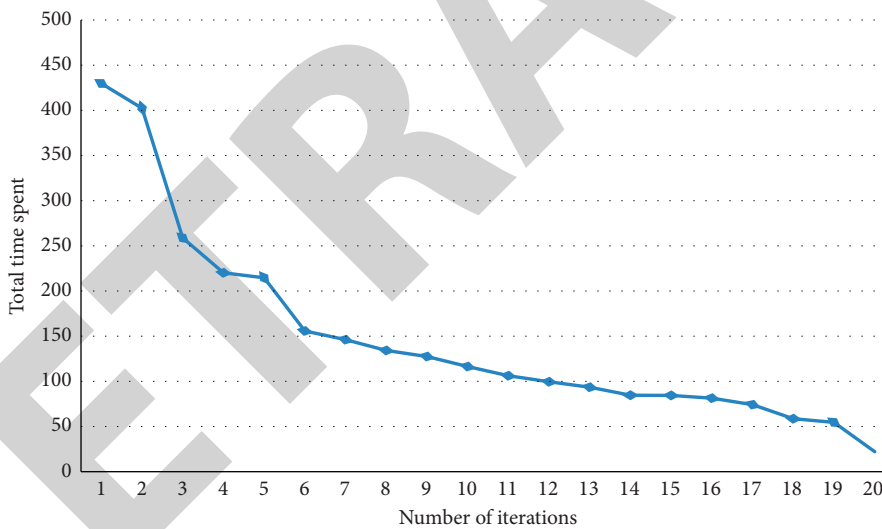


FIGURE 10: Charging pile output results graph.

9, and 15, respectively; the total time consumption that can be achieved is 226.83, as shown in Table 4.

From the above table, the selection of 9 traffic districts for setting charging stations makes the ecologies landscape public charging facilities more widely radiated to all areas.

The effect of neural network on the ecological landscape of charging facilities is shown in Figure 11. The decentralized layout of ecological landscape public charging facilities shortens the time consumed by users in the whole process of charging, makes it possible to get charging services nearby,

TABLE 4: Optimization results of charging facility site selection.

Charging station setup	Charging pile setup	Demand share (%)	Queuing time (h)	Detour time (h)	Total time consumption (h)
h1	(pcs)	13			
h2	16	18			
h3	22	12			
h4	15	11			
h5	13	4	50.61	176.22	226.83
h6	5	12			
h7	14	9			
h8	11	7			
h9	9	12			

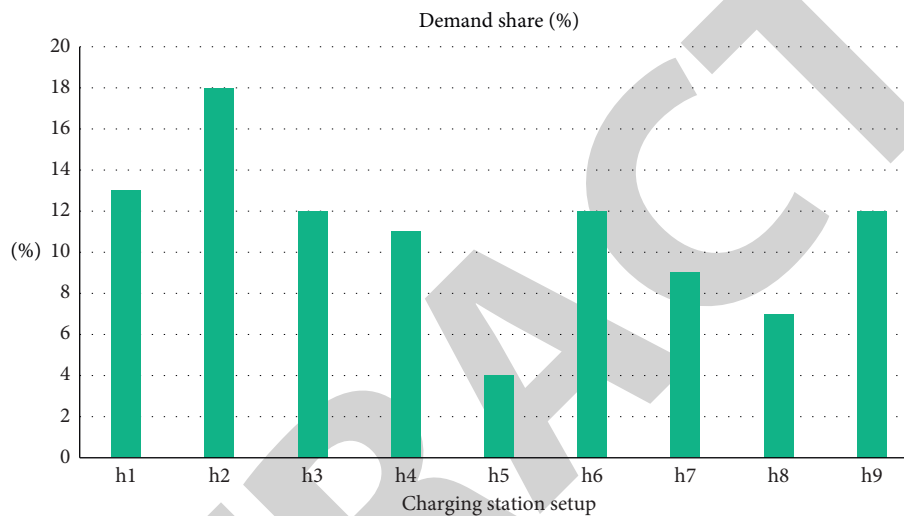


FIGURE 11: The effect of neural networks for ecological landscaping of charging facilities.

saves the time of detouring and queuing, optimizes the network system, and maximizes the utilization rate of charging facilities and user satisfaction.

## 5. Conclusion

Landscape design is an important part of public charging facilities, and the functionality of the facilities nowadays is much more than the landscape. The application of landscape design in public charging facilities has not been explored to coordinate the environment, the value carried by the landscape itself, and the application of landscape design in public charging facilities. The combination of landscape design and base station is the protection and improvement of the living environment so that the ecological concept is used in the space: "The intelligent person hears in silence, and the wise person sees in the unformed." The sustainable development of the charging station lies in the coprogression of the thinking of the times and environmental protection consciousness, reflecting the spirit of different places and social connotation in the ecological consciousness. In the present era of pursuing low carbon and environmental protection, public charging facilities in cities will certainly become an indispensable part. In addition to the main charging function, the principles and concepts of its landscape design have positive marketing to the urban living

environment and can play the role of embellishment. The human-oriented design concept should be applied to give it better convenience and functionality, better meet the public demand in the information age, realize greater value, create a more harmonious and beautiful urban environment, add fun, and facilitate people's daily life.

In response to the defects in the current evaluation process of ecological landscape public charging facility design, based on the theory of combinatorial optimization and using the respective advantages of hierarchical analysis and neural network, we propose a landscape design effect evaluation method of hierarchical analysis and neural network, using hierarchical analysis to establish a scientific and objective evaluation index system of ecological landscape public charging facility design and using the nonlinear fitting ability of neural network. Tracking the changing characteristics of landscape design, they overcome the defects of single hierarchical analysis method and neural network. The main steps of the proposed method are as follows: (1) establish the evaluation system and data collection; (2) determine the BP neural network structure; (3) initialize the neural network and train the network; and (4) build the landscape design evaluation model according to the optimal parameters and test the performance of the model using the landscape design evaluation test samples. The final test results show that this paper's method is a high-precision and

fast landscape design effect assessment method, and the assessment results can provide valuable reference opinions for the design staff of ecological landscape public charging facilities, which has a very wide application prospect. In the future, we plan to conduct research on public charging facilities for electric vehicles based on knowledge mapping and recurrent neural networks that integrate landscape design and environmental protection.

## Data Availability

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

## Conflicts of Interest

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

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## Retraction

# Retracted: Consumption Pattern and Mental Health of Employees Based on Big Data Analysis

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] T. Su, "Consumption Pattern and Mental Health of Employees Based on Big Data Analysis," *Journal of Environmental and Public Health*, vol. 2022, Article ID 6894141, 7 pages, 2022.

## Research Article

# Consumption Pattern and Mental Health of Employees Based on Big Data Analysis

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With the development of big data concept and technology, big data has an important impact on human development. This paper studies the relationship between the consumption pattern and mental health of enterprise employees under the normalization of epidemic prevention and control. Starting from the consumption structure and behavior of enterprise employees, it defines the meaning of enterprise employees' consumption and the connotation of enterprise employees' health psychology and analyzes the relationship between consumption behavior and consumption psychology and the elements of enterprise employees' health psychology. Based on the change of employees' income structure and consumption patterns, this paper speculates the relationship between employees' consumption patterns and mental health, analyzes the correlation between employees' consumption patterns and mental health through a questionnaire survey, and calculates the Correlation Clustering statistical results. It plays an important role in building a good enterprise staff consumption culture under the normalization of epidemic prevention and control and effectively realizes the significance of purifying the social consumption environment.

## 1. Introduction

During the epidemic period, not only the economic situation changed but also the behavior and attitude of global consumers had changed dramatically. The purpose of studying consumer psychology also includes meeting the psychological and physiological requirements of consumers, developing appropriate strategies for consumer services, and providing strong support for the protection of consumer interests. In daily life, in addition to learning, work, and entertainment, satisfying the desire of consumption leads to pleasure and happiness. The study of consumers' psychology and behavior mode can better meet the consumption pleasure of consumers. In consumer psychology, the study of consumers' subjective feelings, experience, and satisfaction is a necessary prerequisite for formulating service strategies. How to protect the employees at the grassroots level, what changes have taken place in people's consumption mentality, and what is the difference between the consumer market and the past? These problems have become the focus of people's attention. Therefore, from the perspective of normalization of epidemic

prevention and control, this paper studies the correlation probability between employees' consumption patterns and mental health. In general, risk can be expressed as a function of the probability of events and their consequences [1–3], namely,

$$R = F(P, C), \quad (1)$$

where  $R$  is the epidemic risk degree;  $P$  is the probability of changes in consumption patterns of enterprise employees after the epidemic; and  $C$  is the consequences of changes in consumption patterns and mental health of corporate employees after the epidemic.

The occurrence probability of this kind of bad event is described by the epidemic risk degree in the above function, so the risk is always associated with the loss. Therefore, the loss is regarded as the starting point of the research on the correlation between the consumption style and mental health of enterprise employees, that is, the concept of dosage is used to specify the risk [4, 5]. The probability of loss refers to the probability or opportunity of loss in a certain period of

time. In a more popular sense, risk actually represents an uncertainty that is always associated with potential losses.

Mental health problems are the result of the comprehensive action of various factors. There are many reasons for the increase of employees' psychological problems, mainly including social environmental factors, enterprise environmental factors, family environmental factors, and employees' psychological factors. Employees' mental health problems will inevitably be reflected in daily work, study, life, social interaction, etc., and will have a negative impact on work efficiency, work stability, and even the harmonious development of the whole society. Enterprise managers and even the whole society should incorporate the adjustment and release of employees' psychological problems into their daily management work and strive to improve the mental health level of employees. The main countermeasures to solve the mental health problems of employees are paying close attention to their mental health, improving their social adaptability, striving to create a good environment conducive to the mental health of employees, and reducing stressors.

Therefore, in the research on the relationship between employees' consumption patterns and mental health, we can follow the idea of empirical research on definition behavior and psychological analysis. Then, the definition of a healthy personality of employees is given, and the constitution of the healthy personality is analyzed. Finally, using the change of employees' income structure and employees' consumption patterns, we speculate the relationship between employees' consumption patterns and mental health and calculate the Correlation Clustering statistical results. The flow chart of this paper is shown in Figure 1.

## 2. Materials and Methods

**2.1. Consumer Definition.** Consumption is a kind of economic relationship. In the case of consumption activities, employees' consumption includes work and production needs, transportation needs, living environment needs, and material needs. An earlier meaning of consumption is a process of spending money to meet one's own needs [6–9]. And, consumer behavior is a kind of external activity driven by consumer psychology, which may be practical or spiritual things and may include now paid music, paid TV programs, food, daily necessities, and so on.

In the process of social development, the study of consumer behavior is not limited to the field of psychology, but closer to the field of sociology.

This paper discusses the consumption pattern of enterprise employees under the normalization of epidemic prevention and control, discusses consumption level and consumption structure of enterprise employees before and after the epidemic, and analyzes the influence of enterprise employees' healthy psychological environment on consumption behavior, so as to make a comprehensive analysis of enterprise employees' daily life and social economy.

**2.2. Analysis of Consumption Behavior and Consumption Psychology of Enterprise Employees.** The consumption psychology of enterprise employees is a kind of inner

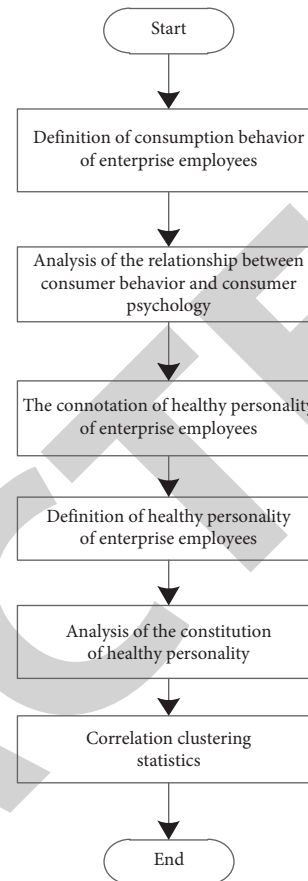


FIGURE 1: Flow chart of research ideas on the correlation between employees' consumption patterns and mental health.

emotional process of spending money and time to obtain various goods. What we call the desire to buy certain things and the psychological comfort after purchasing certain things all belong to the consumption psychology of enterprise employees [10–15]. At present, employees in enterprises generally have the following situations when they consume.

The first is task-based consumption behavior. When purchasing certain goods, it is because of the requirements of the leaders or the company, including but not limited to customizing the company's uniform clothing, raising funds for group construction, and requiring some office software or office equipment needed for work. In these cases, most employees are reluctant to consume.

Second, the consumption behavior of the company's employees is not the consumption behavior required by the company, but the consumption behavior caused by the comparison with colleagues. This includes, but is not limited to, buying clothes, accessories, lunches, and things better than what colleagues buy. In comparative psychology, most consumption is the spontaneous behavior of employees. Third, the employees of the company have a relatively pure consumption psychology, which is based on a real demand for goods. After consumption, the company's employees can get psychological comfort.

The abovementioned enterprise employees' consumption behavior is based on employees' consumption psychology, which is a predictable activity. In order to study the relationship between the consumption pattern and mental health of enterprise employees under the normalization of epidemic prevention and control, it is necessary to study the consumption psychology. The consumption behavior and consumption psychology of enterprise employees complement each other and are inseparable [16, 17].

Based on the observation and analysis of employees' consumption behavior, this paper uses the symbolic consumption theory, conspicuous consumption theory, and fashion consumption theory of consumption sociology to reveal the change trend of employees' consumption psychology.

**2.3. Consumerism.** How to evaluate the relationship between consumer behavior and mental health? Healthy consumption psychology can make the consumption behavior of enterprise employees more reasonable, and at the same time, healthy psychology can make the consumption behavior of enterprise employees more clear, can weaken the enterprise employees' desire of comparison and excessive shopping desire, also make the consumption behavior of enterprise employees more in line with China's national conditions, and advocate the consumption concept of diligence and thrift.

**2.4. Analysis on the Construction of Healthy Personality.** The mental health of the employees needs the assistance of healthy personality. Therefore, we need to clarify the connotation of the healthy personality of the employees. Healthy personality is a good character, which includes no aggressive personality, no violence, sincerity, and good treatment, which makes the employees of enterprises have a more ideal personality [18–21]. In order to analyze the mental health and consumption behavior of enterprise employees, it is necessary to analyze the definition of the healthy personality and the constitution of the healthy personality of the employees.

**2.5. The Definition of Healthy Personality of Enterprise Employees.** The healthy personality of enterprise employees is basically consistent with other personality, so it has not been clearly defined. For the convenience of this study, this paper can define the healthy personality of enterprise employees as a comprehensive ability that enterprise employees can adapt to the environment and solve problems when they encounter various challenges, difficulties, or major changes in the company or work [22–24]. Such capabilities include the following:

- (1) How to regulate personal emotions and not bring them into work?
- (2) How to improve the working environment and choose a favorable way to solve the difficulties?
- (3) How to mobilize the enthusiasm of individual employees when they are tired or repetitive?

This is a kind of continuous ability, or a kind of psychological adaptability. For enterprise employees, healthy personality can make employees have a strong ability to resist pressure, make them have a certain sense of security without needing others, make them release kindness to enterprise employees, make them strive to live their own life, help them do their own work well, make them observe the environment correctly and objectively, and adapt to the environment. This kind of personality can make enterprise employees less likely to panic when they encounter emergencies which leads to abnormal consumption behavior of enterprise employees.

Even people with a perfectly healthy personality can acquire mental health concerns, and it is crucial to understand how the concept of a healthy personality and the existence of mental health issues has been conceptualized. A person with a healthy personality, such as good working abilities and a high moral character, might yet suffer from mental health problems.

**2.6. The Constitution of Healthy Personality of Enterprise Employees.** This paper analyzes how to develop a healthy personality in enterprise employees on the basis of obtaining the consumption psychology and behavior of enterprise employees.

First of all, the most important thing for an enterprise is its employees' working ability. Frankly speaking, it can bring benefits to the company. Therefore, the most important thing for an enterprise employees' healthy personality is their working ability. Ability includes two aspects: one is self-ability and the other is the potential ability of enterprise employees, that is, learning to improve their own ability, which is the cornerstone of healthy personality of enterprise employees.

Secondly, the moral character of employees is also one of the important factors. In the process of work, enterprise employees need to follow their heart and be compassionate. Excellent enterprise employees should not only pay attention to current affairs, but also try their best to help others [25]. Therefore, excellent moral character plays an important role in the healthy personality of employees.

Therefore, good temperament cultivation is also an important part of the healthy personality of enterprise employees. The elements that constitute the healthy personality of enterprise employees are of multilevel, and there is an organic systematic connection between them. They have an inseparable nature in the complete personality structure. They are intertwined, interdependent, interrelated, and interactive, and together constitute the overall healthy personality of enterprise employees.

### **3. Analysis on the Relationship between Consumption Style and Mental Health of Enterprise Employees**

**3.1. Analysis on the Change of Enterprise Employees' Consumption Patterns under the Normalization of Epidemic Prevention and Control.** In order to verify the relationship between consumption patterns and mental health of



enterprise employees under the normalization of epidemic prevention and control, firstly the consumption patterns and sources of funds of enterprise employees are collected. This paper randomly selects 3000 employees from 10 enterprises in a city to analyze the sources of consumption funds of employees in different enterprises in 2018, and the results are shown in Table 1.

Analysis of Table 1 shows that due to the different family conditions, wages, consumption patterns, and consumption concepts of enterprise employees, the sources of consumption funds for enterprise employees are different. Among the 3000 employees, 986 used their wages for consumption, accounting for 32.87%, 523 used their credit cards for consumption, accounting for 17.43%, and 1062 used their flowers, Mayi Pay, which is a consumer credit product launched by Ant Financial, for consumption, accounting for 35.40%. The overall analysis of the above details shows that Huabei and credit card are the main ways of enterprise employees' capital consumption, which shows that with the development of network technology, people's living conditions and consumption ideas have changed.

However, the current outbreak has changed the consumption mode of enterprise employees again. Therefore, this paper makes a return visit to the 3000 employees in 2020 and analyzes the changes of consumption mode of enterprise employees under the normalization of epidemic prevention and control, and the results are shown in Table 2.

According to the analysis of Table 2, in 2020, 1868 employees of 3000 enterprises spent their wages for consumption, accounting for 62.23%, 298 employees used their credit cards for consumption, accounting for 9.93%, and 663 employees spent their money for consumption, accounting for 22.10%. 148 people spent through bank loans, accounting for 4.93%. 23 people consumed in other ways, accounting for only 0.07%. Comparing Tables 1 and 2, it can be seen that under the influence of the epidemic in 2020, the number of employees taking wages as the main source of consumption increased from 986 to 1868, accounting for 62.23% from 32.87%. At the same time, in 2020, the number of employees who used credit card and E-Payment as the main consumption mode was significantly reduced, indicating that the epidemic has affected the consumption psychology and mental health of enterprise employees.

*3.2. The Consumption Quota of Enterprise Employees under the Normalization of Epidemic Prevention and Control.* In order to further study the consumption situation of enterprise employees under the normalization of epidemic prevention and control, 3000 employees with different salaries were selected for consumption analysis and the consumption funds of employees of different enterprises in 2018 were obtained. The results are shown in Table 3.

By analyzing Table 3, we can see the consumption situation of employees in 2018. For the employees with a salary of 0–3000 yuan, one-tenth of them are paid in the range of 10000–15000 yuan and about 47% of them are paid in the range of 3000–10000 yuan. This shows that half of the employees' wages are below 10000 yuan before the outbreak

TABLE 1: Proportion of capital sources of employees' consumption in 2018.

The source of enterprise employees' consumption funds	Number/person	Proportion/%
Wages	986	32.87%
Credit card	523	17.43%
Flowers	1062	35.40%
Bank loans	426	14.20%
Other	3	0.01%
Total	3000	100%

TABLE 2: Proportion of capital sources of enterprise employees' consumption in 2020.

The source of enterprise employees' consumption funds	Number/person	Proportion/%
Wages	1868	62.23%
Credit card	298	9.93%
Flowers	663	22.10%
Bank loans	148	4.93%
Other	23	0.07%
Total	3000	100%

of the epidemic. According to the analysis of the way of consumption of their employees, 59% of the employees who earn less than 3000 yuan are paid by WeChat, Alipay, and other electronic payment methods. 31.2% of the employees spend their money through flower and credit cards, and only 9.8% of their employees are paid by cash. Of the employees earning 8000–10000 yuan, 56% were paid by WeChat, Alipay, and other electronic payment methods. 20% of the employees were paid using Huabei and credit cards, and 24% of the employees were paid by cash. Comparing the two kinds of employees, the higher the salary, the smaller the proportion of people who use overdue consumption such as Huabei and credit card. This is also true for employees with an income of 10000–15000 yuan or more.

In order to compare the consumption situation of enterprise employees under the normalization of epidemic prevention and control, the consumption situation and income situation of 3000 enterprise employees in 2020 were collected and the consumption funds of employees were obtained as shown in Table 4.

According to the analysis of Table 4, under the influence of the epidemic, the income of these 3000 employees has changed. The number of employees whose wages were 0–3000 yuan increased from 1000 to 1200, and the number of employees whose wages were 10000–15000 yuan or more decreased by 380. This shows that the epidemic environment has affected the wages of most enterprise employees and changed their living or working environment. Compared with 2018, 81.83% of the employees who earned 0–3000 yuan were more dependent on Alipay and WeChat's electronic payment methods and the number of people who used advanced consumption methods such as Huabei and credit cards decreased from 312 to 122, which indicated that the epidemic environment affected the consumption patterns of most employees. That is to say, the epidemic prevention and control has a certain impact on the consumption style and mental health of employees.

TABLE 3: Consumption analysis of employees in different enterprises in 2018.

Salary range (yuan)	Consumption pattern of enterprise employees			Total number
	Huabei, credit card	Cash	WeChat, Alipay	
0–3000	312	98	590	1000
3000–5000	385	215	160	760
5000–8000	58	94	88	240
8000–10000	100	120	280	500
10000–15000	50	155	95	300
Over 15000	15	87	98	200

TABLE 4: Consumption analysis of employees in different enterprises in 2020.

Salary range (yuan)	Consumption pattern of enterprise employees			Total number
	Huabei, credit card	Cash	WeChat, Alipay	
0–3000	122	96	982	1200
3000–5000	285	220	45	550
5000–8000	45	58	127	230
8000–10000	189	301	310	800
10000–15000	4	21	95	120
Over 15000	12	33	55	100

TABLE 5: Correlation between consumption patterns and mental health after cluster analysis.

Consumption level/month	Type I	Type II	Type III	F value
0–500	55.823 ± 1.66	43.935 ± 1.08	55.842 ± 7.16	63.554
500–1000	53.832 ± 1.88	23.845 ± 1.31	55.643 ± 2.62	231.543***
1000–2000	14.411 ± 2.16	53.653 ± 2.26	55.643 ± 4.51	164.553***
3000–5000	22.563 ± 6.43	76.753 ± 4.86	55.635 ± 1.99	431.542***
5000–8000	52.521 ± 3.11	23.532 ± 2.56	55.342 ± 1.97	643.231***
8000–15000	54.376 ± 4.32	53.643 ± 4.16	55.654 ± 1.76	743.321***
15000–20000	65.887 ± 3.13	35.326 ± 3.32	55.133 ± 1.54	234.664***
20000–50000	54.896 ± 4.21	64.642 ± 5.33	55.568 ± 1.64	243.431***
Over 50000	32.843 ± 2.16	66.532 ± 6.16	55.642 ± 1.31	532.321***
Class size	46.25%	24.21%	29.54%	—

3.3. *Cluster Statistical Analysis of the Correlation between Consumption Patterns and Mental Health.* The correlation between consumption patterns and mental health of enterprise employees under epidemic prevention and control can be obtained through cluster statistics. This paper selects the above experimental data to obtain the correlation.

In Table 5, when  $p < 0.001$ , it is indicated by “\*\*\*” which indicates that there is a statistically significant correlation between employees’ consumption style and mental health under the epidemic prevention and control. We have three ways of employee consumption: type I (electronic payment), type II (advanced consumption), and type III (cash). In this paper, consumption skills can be described as the ability of employees to spend money and time to get what they need. Consumption skills fundamentally determine whether consumers can get satisfaction from the consumption of products and services, that is, whether the purpose of consumption can be achieved. It can be seen from Table 5 that there is a certain correlation between employees’ consumption patterns and mental health under the epidemic prevention and control, and nearly half of the employees prefer electronic payment. Any kind of consumption activity includes both the psychological activity and the consumption behavior of consumers. Accurately grasping the psychological activities of consumers is the premise of

accurately understanding consumer behavior. Consumption behavior is the external expression of consumer psychology, which is more realistic than consumer psychology.

In the future, based on big data mining technology, an analysis system construction strategy for consumer characteristics can be proposed. Through the effective mining and analysis of massive data, the market prospect and consumer purchase behavior of products can be predicted, so as to support auxiliary enterprises to develop reasonable marketing strategies.

## 4. Conclusion

In the research on the relationship between employees’ consumption patterns and mental health, we can follow the idea of empirical research on definition behavior and psychological analysis. Then, the definition of a healthy personality of employees is given and the constitution of the healthy personality is analyzed. Finally, using the change of employees’ income structure and employees’ consumption patterns, we speculate the relationship between employees’ consumption patterns and mental health and calculate the Correlation Clustering statistical results.

In order to study the relationship between consumption patterns and mental health of enterprise employees under

the normalization of epidemic prevention and control, this paper analyzes the correlation between consumption patterns and mental health from three experiments: the income structure of enterprise employees, the correlation between income levels and consumption patterns of enterprise employees, and cluster statistics:

- (1) Under the influence of the epidemic, the number of enterprise employees who take wages as the main source of consumption increased by 882, accounting for 62.23%. At the same time, the number of enterprise employees using credit card and flower chant as the main consumption mode decreased significantly, indicating that the normalization of epidemic prevention and control has affected the consumption psychology and mental health of enterprise employees.
- (2) Compared with the preepidemic situation, 81.83% of the employees who were paid 0–3000 yuan in the enterprise were more dependent on Alipay and WeChat's electronic payment methods and the number of people using advanced consumption decreased by 190. The epidemic prevention and control had a certain impact on the way of consumption and mental health of employees.

## Data Availability

The datasets used and/or analyzed during the current study are available from the author on reasonable request.

## Conflicts of Interest

The author declares no conflicts of interest.

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## Retraction

# Retracted: The Construction of National Image of China by English World Media in Public Health Emergencies

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] D. Zhang, "The Construction of National Image of China by English World Media in Public Health Emergencies," *Journal of Environmental and Public Health*, vol. 2022, Article ID 9669941, 8 pages, 2022.

## Research Article

# The Construction of National Image of China by English World Media in Public Health Emergencies

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Based on the latest coronavirus corpus of the English corpus collection list (English-corpora), this paper aims to do the data mining of the China-related reports reported by the media of the United States, Canada, Britain, and Australia in public health emergencies. It tries to analyze how the English world media construct China's national image on the basis of the theory of evidentiality. It is found that the national media in the English world media report on China's national image show a dynamic process of "concern-worry-stigmatization-dumping." The western media made the construction of China's national image by subjective reports, objective but negative media discourse, and "double standards."

## 1. Introduction

For a long time, English-speaking media have made use of their status as the global mainstream media to guide public opinion, influence the international public's cognition and attitude towards the image of other countries, and form international relations and interaction behaviors conducive to their own interests [1]. Sudden global public health events provide a window to observe how English-speaking media construct the image of other countries. By the way, it provides enlightenment for the development of Chinese news media, that is, China-related media reports are reliable materials to study how English-speaking media construct China's national image by using their discourse power and the dominant power of public opinion.

Based on the COVID-19 news reports on China from the coronavirus corpus of the United States, the United Kingdom, Canada, and Australia from January 1 to June 14, 2020, This paper studies how the National image of China under the mirror image of the English-speaking world is constructed by western media in order to provide a reference for China to cope with the construction of the national image in international reports through data statistics, categorization, and analysis.

*1.1. The Process and Concrete Performance of the Construction of China's National Image by English-Speaking Media.* There are 360 million words capacity for the coronavirus corpus, and the news corpus is continuously updated at 4 million words per day until June 14, 2020. It covers news reports published in print and digital media in 20 countries, including the United States, the United Kingdom, Australia, and Canada since the outbreak of COVID-19. In the process of studying the data, it found the dynamic "stigmatization" of China in English-speaking media.

*1.1.1. The English-Speaking World's Media "Blame" and "Stigmatize" the Performance of China.* Based on the retrieval of the top 100 high-frequency words and their collocation verbs and nouns in Chinese-related news from English-speaking countries in the coronavirus corpus, it is found that the peak of global Chinese-related news occurred on February 1, 2020 (Table 1).

Table 1 confirms the collective "blame shifting" and "stigmatization" of China in the Western media. Among the top 100 high-frequency words matched with China, "virus" ranked first and second in the United States, the United Kingdom, Australia, and Canada. The collocation of these

TABLE 1: Time distribution of China-related news in English-speaking countries during the epidemic.

Section	All	20-01-01	20-02-01	20-02-11	20-02-21	20-03-01	20-03-11	20-03-21	20-04-01	20-04-11	20-04-21	20-05-01
Freq	102,199	12,485	12,242	6,836	8,401	10,506	8,120	12,176	8,293	8,749	7,753	6,638
Words (m)	237	7.3	4.8	4.0	5.7	17.6	26.8	55.5	38.4	35.8	33.8	31.3
Per mil	430.04	1,700.90	2,570.14	1,707.95	1,466.45	595.46	302.79	219.27	215.86	244.70	229.37	212.41

words with China indicated that the mainstream media of the four countries believed that the virus originated from China. The words “cover up,” “conceal,” and “biological weapon” are 490, 210, and 77 frequency, respectively, in the data, which were keywords used by Western countries to insult China (Table 2).

The peak of China-related news in the USA, the UK, Australia, and Canada on March 21 is because Trump used the word “Chinese virus” on Twitter for the first time around March 16, 2020 and mentioned coronavirus as “Chinese virus” in the Press Conference on March 19, as shown in Table 3. The frequency performance of “transparency” should be concerned. The topic only made the top 70 in the UK (Table 3).

Another manifestation of the Western media’s collective “blame shifting” and “stigmatization” of China is that they turned a blind eye to China’s positive response to the epidemic in the early stage. At the same time, when the epidemic broke out around the world, Western media rarely mentioned China’s timely assistance to countries in need and its active sharing of experience and contribution of solutions to other countries. In Table 3, the frequency of the collocation “help” in the United States, the United Kingdom, Australia, and Canada is not more than 2, and most of them praise the achievements made by other countries, such as Japan and South Korea, in the prevention and control of COVID-19 spreading around the world. The “China coronavirus” in the USA is 1,181 (m8.0), Canada at 7.0 (191), Australia at 220 (11), and the UK at 309 (9.8). It can be seen that there are many issues about the USA “stigmatizing” and “blaming” China, while those about the UK, Australia, and Canada “stigmatizing” China are concentrated. But “made in China” and “virus made in China” (US 141, UK 34, Canada 26, and Australia 19) are still the main ones who deliberately instigated the “demonization” of China. For example, the *Wall Street Journal* said in its report that “China is the real sick man of Asia” and used the epidemic to attack China with racist colors. The British media Henry Jackson published a report titled “Corona-virus Compensation? Assessing China’s Potential Culpability and Avenues of Legal Response.” It was an accurate calculation of how much China would have to pay.

## 2. The Way of Constructing China’s National Image by English-Speaking Media

As China has become the second-largest economy in the world, its international influence has been greatly enhanced. It is helpful for China to construct a good national image with the help of the media. It also made the Western media worried to crack down on China to a large extent. The

sudden outbreak of the epidemic has given some English-speaking countries an opportunity to deliberately defame, smear, discredit, and blame China and undermine the good national image of China.

*2.1. Western Media Stigmatize China by Subjectively Reporting the Epidemic.* Fairclough once proposed in his critical discourse analysis that language is subjective and reflects the speaker’s viewpoint and ideology [2]. Systemic functional linguistics is the mainstream of critical discourse analysis research. The analysis of modality, evidentiality, and discourse strategy is closely related to critical discourse analysis. The analysis of evidentiality not only makes language reflect reality but also explores different ideologies and different power relations. Franz Boas proposed evidentiality, a linguistic phenomenon that can indicate information source and degree of affirmation, to judge the objectivity of news report sources. The means to reflect the source of information is called “evidential,” which helps judge how news reporters cover up the truth of the facts by using language skills or intentionally misleading the audience. And how can we judge the “evidence”? We can get the answer from the language.

For example, we have the following:

- (i) It is *great*
- (ii) It is particularly *great*
- (iii) *I am not sure* if it is *great*
- (iv) *Probably*, it is *great*
- (v) *It should be great*

It can be noted that language forms such as “generally,” “not sure,” “probably,” “should,” and so on delivered the cognitive attitude of humans. Therefore, the forms of grammar are called evidentials [3]. Hu classified and integrated Chafe’s evidentiality models: verbal evidence, sensory evidence, hypothesis, belief, and reliability [4]. Systematic analysis of a country’s mainstream media based on linguistic theory is rare [5]. In English news discourse with strong political nature, we can fully discover how political groups convey implicit will and views under the cloak of objective language through news media so that readers can clearly understand how the state and media power affect readers through news discourse. Through the analysis of the news discourse of “evidentiality,” it is found that although western news reports purportedly emphasize the fair, objective, and true reflection of news events, in fact, the China-related reports of the epidemic are obviously marked by ideology and journalists’ personal views and attitudes. In news reports, evidentiality plays a very important role in evaluating meaning. It is often used to judge the reliability and source of

TABLE 2: A list of frequently used words with “China.”

Collocates	Freq	Pm	Country	Ranking	Peak
Coronavirus	1181	8.5	USA	1	20-1-1
Virus	1131	8.1	USA	2	20-1-1
Outbreak	809	5.8	USA	4	20-2-21
Health	780	5.6	USA	5	20-3-1
Help	93	0.7	USA	21	20-4-1
People	387	2.8	USA	8	20-3-21
Virus	274	10.1	Canada	1	20-2-1
Health	143	5.2	Canada	6	20-1-1
Coronavirus	191	7.0	Canada	4	20-1-1
Death	130	5.0	Canada	15	20-2-1
Help	17	0.6	Canada	41	20-3-21
Coronavirus	309	9.8	UK	1	20-2-11
Virus	143	4.5	UK	2	20-1-1
Effort	30	1	UK	32	20-4-1
Help	64	2.0	UK	3	20-4-1
Economy	121	3.8	UK	5	20-2-11
Transparency	19	0.6	UK	68	20-4-21
Coronavirus	220	11.0	AU	1	20-2-1
Virus	131	6.6	AU	4	20-2-21
Help	18	0.9	AU	6	20-4-1
Cover up	490	2.2	USA, UK, AU, Canada		20-2-1
Conceal	210	0.9	USA, UK, AU, Canada		20-1-1
Biological weapon	77	0.3	USA, UK, AU, Canada		20-2-11
Transparency	102	0.4	USA, UK, AU, Canada		20-4-21

TABLE 3: Time distribution of high-frequency words with “China.”

Section	All	20-01-01	20-02-01	20-02-11	20-02-21	20-03-01	20-03-11	20-03-21	20-04-01	20-04-11	20-04-21	20-05-01	20-05-11	20-05-21	20-06-01	20-06-11
Freq	666	37	15	4	3	17	60	301	87	79	38	25	0	0	0	0
Words(m)	237	7.3	4.8	4.0	5.7	17.6	26.8	55.5	38.4	35.8	33.8	31.3	30.5	36.1	29.3	16.2
Per mil	2.80	5.04	3.15	1.00	0.52	0.96	2.24	5.42	2.26	2.21	1.12	0.80	0.00	0.00	0.00	0.00

information. The sources of foreign media reports are unknown, and subjective: journalists often use language skills to cover up the truth of the facts or intentionally mislead the audience. The analysis of the national image in international public opinion under the evidentiality strategy provides a reference for improving China’s international communication power and establishing a good national image.

2.1.1.1. *The Analysis of Evidential Factors Found That Western Media Reports on China Are Subjective.* The USA media “Money Life” reports that “The major countries affected by COVID-19 are the United States, Spain, Italy, France, Germany, and the United Kingdom, with more than 1.64 million cases and an estimated 134,492 deaths. So who’s going to pay for it?” [6]. Several reasons are mentioned in the article, “The spread of COVID-19 could have been stopped. It goes without saying that China is also to blame very significantly for its lack of transparent sharing of information about COVID-19 (and its depth and spread within China), both to the WHO and the entire world during the period, from 1 December 2019 to 22 January 2020. Is it China? China, in my opinion, was neither forthcoming nor transparent about the outbreak (of COVID-19 in late 2019).” The article argues that China needs to take

heavy responsibility for not sharing transparent information about COVID-19 (and its depth and spread in China) with the WHO and the world. This article is highly subjective. When he expresses that “China is neither honest nor transparent about the OUTBREAK of COVID-19,” the distribution of data implies the subjective attitude of the speaker. The expressions such as “Could have been,” “in my opinion,” and “significantly” show evidence of direct sensory perception by the speaker. There are also obvious signs of authorial involvement in the news, such as “I think, I guess, I believe, I suppose, I notice, I report, in my opinion, etc.” It is hard to say that the author is objective with objective expressions such as “it is obvious that. . .,” “everyone admits. . .,” and so on. Nutyts (1998) believes that if the speaker has doubts about the evaluated thing, it means that the author needs enough space to prove the reliability of the information [7]. The objective degree of news report discourse depends on the degree of intervention of the speaker. Of course, if there is no evidence to prove the authenticity of the event, as long as he has an evaluation of the facts described, it proves that he has evidence to confirm the credibility of the information. Although the reporter tries to make the information seem objective and the facts he or she states more credible to help him or her avoid responsibility, these seemingly objective expressions tend to be

subjective. For example, hearsay, whether quoted directly or retold secondhand, is often used in news. Journalists are objective observers who report objectively and truthfully without personal evaluation. Newspapers succeed in influencing readers' ideologies while shirking their responsibility as sources of information. Through the analysis of evidentiality, it is found that verbal evidence and sensory evidence occupy the main position in the transitive system framework of news discourse. Reporters often unconsciously add their own subjective attitudes and evaluation and try to influence readers.

*2.1.2. According to the Analysis of the Sources of Information, It Is Found That Western Media's Reports on China Are Subjective.* Information sources of Chinese-related news commonly used the subjective expressions such as "I think," "I suppose," and "China's official news agency claims." For example, WA today mentioned how the coronavirus will strengthen the Belt and Road Initiative. "We are now only beginning to pick up weak signals of *Chinese ambitions* on the international stage," "We should not wait for them to be fully implemented to start thinking about policy options." It takes China to a hegemonic power with ambitions, but the source of its information is a former French defense ministry official, whose objectivity cannot be guaranteed. The *New York Times* (October 20, 2020) titled a passage "China Says Australia's Questions on Its COVID-19 Handling Groundless," and the Australian government has called for an international investigation into the origin and spread of the virus. "In Beijing, a Foreign Ministry spokesman said Payne's remarks were entirely without factual basis." A Foreign Ministry spokesman said the source of the information was unclear. "China say"? Source: China? Chinese government or official daily? Behind the seemingly objective is the transmission of subjective consciousness.

In order to reflect the objectivity of this study, after retrieving "China + [N\*]," the result is that the word frequency of *China Daily* is only 264, 1.1 million words. The word frequency of "China News" is 26, 0.1 million words. The word frequency of "China CDC" is 32. "A recent editorial in *China Daily*, a state-run newspaper, denied discrimination against foreigners, even as it said that "some foreigners choose to flout China's rules on containment." The source of the information is objectively stated as *China Daily*, but the appositive mark is not "a state-run newspaper," emphasizing that *China Daily* is a government-run media, and the implied meaning is self-evident. "The epidemic is raging outside China, and foreigners are being shunned, barred from public places and even deported," the report said. When it refers to "the expulsion of Africans," "*Africans in the city say* they have been evicted and forced into quarantine." According to the expression "*Africans in the city say*," it can speculate the source of the information is "*Africans*." It uses 2018 photos to tell readers that they have been evicted and quarantined. "An epidemiologist was quoted in the state-run paper *China Daily* as saying," "*China Daily = the state-run paper*." The article appears to be an objective statement of facts but later magnified the coronavirus death of Dr. Li Wenliang.

*2.2. Western Media Reports Convey the Will of Construction of the National Image.* We took "[V\*]" verb and "[N\*]" noun with China as the retrieval items and extracted high-frequency collocation verbs and content words in news reports of mainstream media in the United States, the United Kingdom, Canada, and Australia, as shown in Figure 1. The results show that mainstream media in English-speaking countries are generally subjectively "smearing," "stigmatizing," and "blaming" China. The United States, the United Kingdom, Australia, and Canada stayed on the sidelines during the first two months of 2020. The top 10 common high-frequency verbs are "visit, said, praised, surpass, overtook, says, hit, blame, left, and so on." In March 2020, some words including "targeting," "blaming," "accusing," "criticized," "bordering," "punish," "banned," "attack," and "China" appeared.

Statistics show that China's national image is "misinterpreted" by Western countries led by the United States, as shown in Figures 2 and 3. The proportion of high-frequency verbs in the news reports of China in the United States in Figure 2, and four countries in Figure 3 are similar and highly correlated, but the difference is relatively low, indicating the dominant position of the United States in the world public opinion. We classified the proportion of stigmatized verbs in China-related news reports of the USA, the UK, Australia, and Canada during the period of COVID-19, as shown in Figure 4, and found that the proportion of misreading of China's national image was lower than that of neutral classification. It is worth mentioning that when analyzing the data of the UK, "demonize China" (6 words frequency) appeared in the top 100 to demonize China.

There are nine elements that have an important impact on the selection and processing of news, such as time span, intensity, clarity, cultural proximity, consonance, unexpectedness, continuity, composition, and sociocultural values [8]. Both the intensity and unexpectedness make it more dramatic and more likely to be taken seriously by the media. Western English-speaking countries, led by the United States, are in a dominant position in new media communication, and China-related reports have been on a "rainy day" for a long time. By giving negative connotations to public health emergencies, it creates international attention and causes extensive adverse effects on the international communication of China's national image. In particular, the early outbreak in the Western media objective evaluation is given, such as the United States (83 words frequency), Canada (21 words frequency), Britain (23 words frequency), and other expressions, and all comments are just said by the WHO, while countries such as Britain and America are suspicious about WHO during the outbreak of epidemic prevention skeptical. They criticized the WHO's need to do the institutional reform and threatened to withdraw from the WHO.

As the *New York Times* said in an article titled "Japan and Thailand Confirm New Cases of Chinese Corona-virus" on January 18, World Health Organization officials have praised China's aggressive response to the virus by closing transportation, schools, and markets. The expression seems objective and fair, but the source of information is the WHO, not the official attitude of the media. When Canada's mainstream media CBC mentioned that the government had sent a chartered plane to repatriate Canadians trapped in the





FIGURE 1: Analysis of high-frequency word cloud in Chinese-related news reports in English-speaking countries during the epidemic.

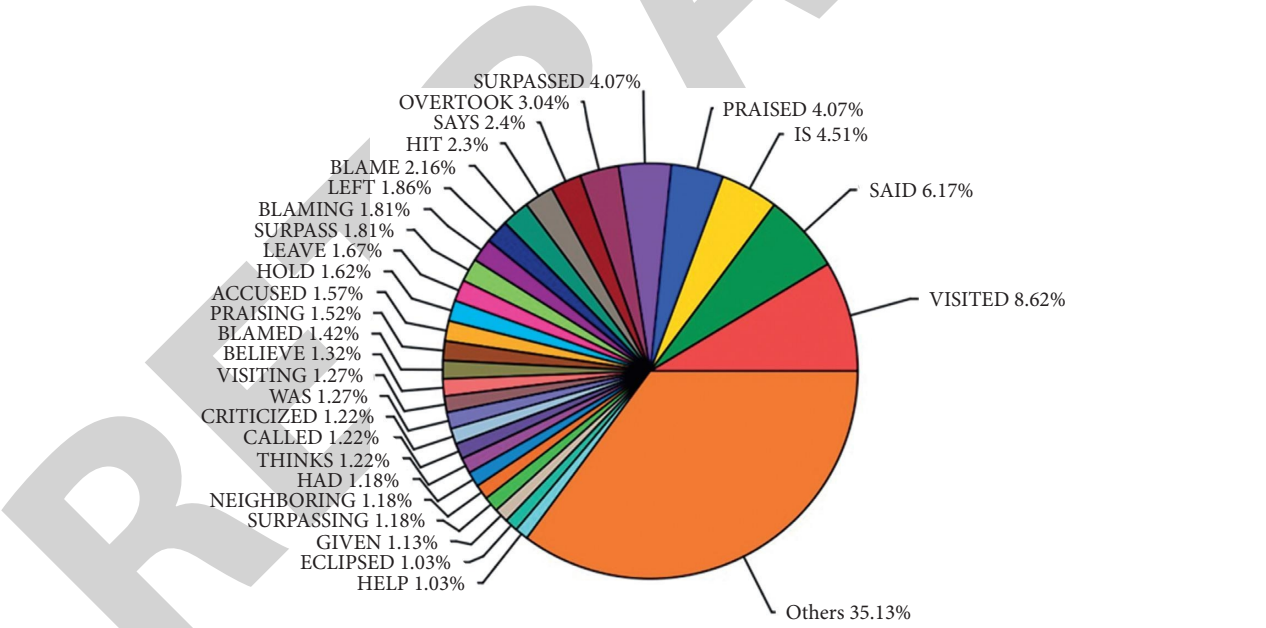


FIGURE 2: The proportion of high-frequency verbs in China-related news reports in the USA during the epidemic.

coronavirus zone, Foreign Ministry spokesperson Hua Chunying said that “most countries appreciate and support China’s efforts in combating Corona-virus.” The article is a paraphrasing of Hua’s remarks without making any comments. And Australian state media quoted Nader Rowland, a senior fellow at the Lowy Institute, as saying China is coming, faster, bigger, more decisive, and more powerful. However, the text “an implicit threat” holds a threatening attitude. Evidentials have made no secret of their attitude toward “stigmatizing” China. “China has invested a great deal of

energy in trying to prove itself as a savior through mask diplomacy,” the article said, quoting Robert Lemahieu, director of the Lowy Institute’s Asia Power Program. However, the real meaning of the article is that the global spread of the “Belt and Road Initiative” is an inevitable trend. Even though the epidemic has slowed down its spread, it still brings positive energy to the economic development of Australia.

It can be seen from the data analysis that media around the world make use of the power of public opinion to convey the implicit will under the cloak of seemingly objective

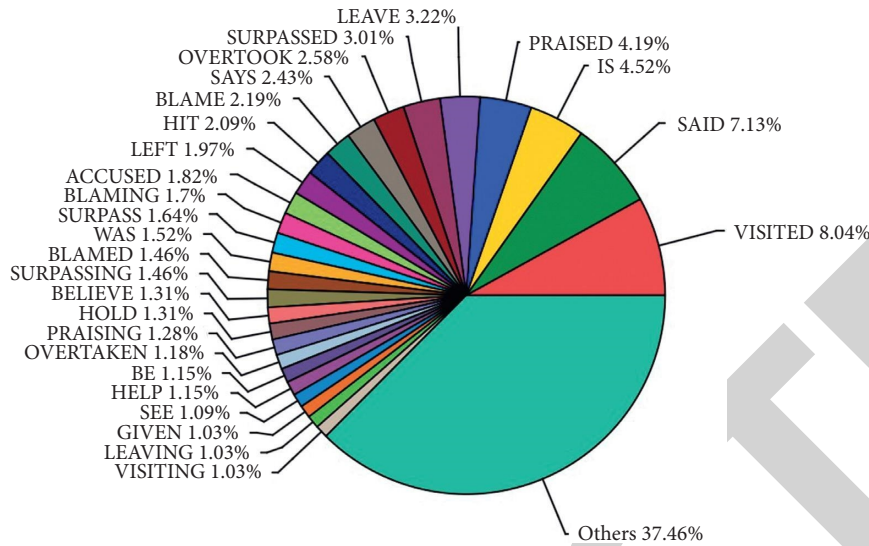


FIGURE 3: Proportion of high-frequency verbs in China-related news reports in the USA, Britain, Australia, and Canada during the epidemic period.

language under the monopoly and instigation of western mainstream media. Due to the strong influence of Western media in the field of international public opinion, such negative reports have affected the subjective will and source selection of some overseas journalists in specific news writing to varying degrees [9].

2.3. *Western Countries Use “Double Standards” to Accuse China.* The “double standard” of western countries is a common phenomenon in international politics. Western countries make arbitrary accusations and practice double standards by using western values and discourse on free democracy to point fingers at other countries. The “double standards” of the USA towards China have been fully demonstrated in other areas. For example, on one side, they flaunt freedom of the press, while on the other side, they obstruct normal reporting by Chinese media in the USA. The US side glorified the “Hong Kong independence” activists as “heroes,” “fighters,” and “beautiful scenery” while calling the people protesting against racial discrimination in the US “thugs.” They criticized Hong Kong police, China for their restraint and civilized law enforcement but threatened to shoot at domestic protesters and even used the National Guard.

Taking COVID-19 as an example, the *New York Times* reported that “China has blocked nearly 60 million people and imposed strict quarantine and travel restrictions on hundreds of millions of people to fight the corona-virus. This action has cost people their daily lives and their freedom.” on Facebook on March 7 and Twitter on March 8. However, the re-reporting of the Italian lockdown turned into “Update: Italy has locked down Milan, Venice and much of the north of the country at economic risk as it tries to contain Europe’s worst corona-virus outbreak.” There was only a 20-minute gap between the two news, and the illustration was a “double standard” between civilians and officials. The *New York Times* commented that China’s lockdown caused great loss to people’s life and freedom and was against human rights, while

it said that Italy’s lockdown took an economic risk and was noble. This is a typical “double standard” of Western countries. The *New York Times* criticized China under the headline “The World needs Masks Made in China, but China hides Them from Others,” saying, “China not only stopped selling masks but also bought most of the rest of the world’s supply.” However, the fact that China donated masks and other protective items to 82 countries around the world makes the US “double standard” untenable. When China used big data drones for epidemic prevention and control, CNBC reported that China was accelerating the deployment of surveillance machines. However, when the United States needed to use big data and other technologies for epidemic prevention and control, the headline changed to “The United States can learn from China to use robots and telemedicine to combat novel Corona-virus outbreaks.” When the USA announced that it would donate to China in the early stage of the epidemic, it made a big name of humanitarian aid, but when China donated to other countries in the world, it said that China was “expanding the world” for political purposes. When China offered help to Europe, it was criticized by western countries for “China’s ambition” and “vigilance against China’s generous policies.” “Italian residents sing patriotic songs on balconies during lockdown,” read *The Guardian*’s headline about the “Spanish lockdown” are “What new restrictions?” “Spain calls for lockdown to fight COVID-19.” Britain’s *Guardian* newspaper said the lockdown was “a long-awaited moment of joy.” But, in reporting on China, sealing city is “the destruction of human rights,” “China’s reaction to the coronavirus outbreak violates the human rights,” and “China’s coronavirus lockdown strategy in China: brutal but effective.” In addition to the “double standard” of the title content, the illustration also embodies the double standard. The image of Italian people enjoying music on their balconies is in stark contrast to the depressed Chinese elderly men in masks standing in front of rubbish dumps.

Table 4 shows the “double standard” of the English-speaking world’s media in reporting COVID-19 in China.

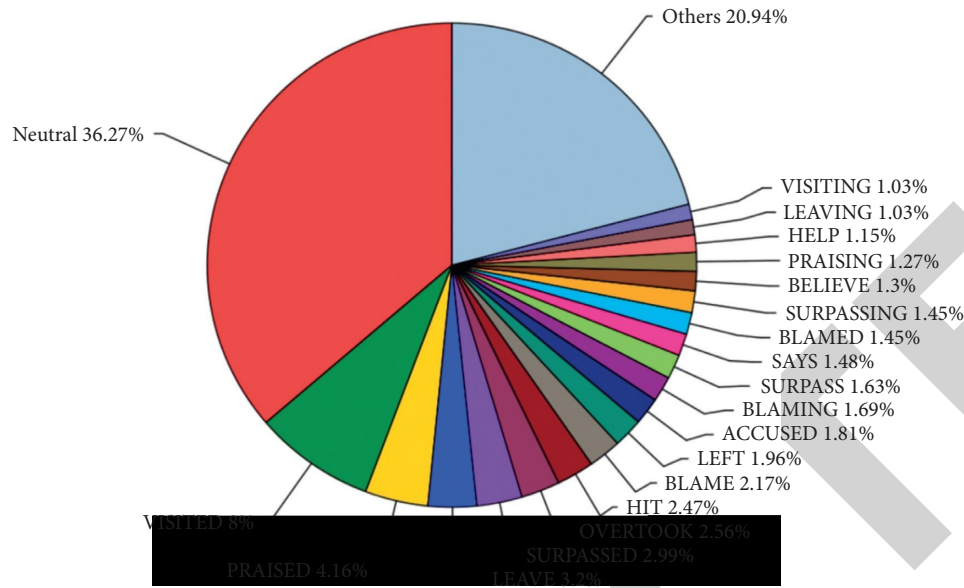


FIGURE 4: Proportion of stigmatized verbs in China-related news reports in the USA, the UK, Australia, and Canada during the epidemic period.

TABLE 4: Classification of “double standard” reports on China by media of English-speaking countries.

	Lockdown	Donation	China’s aids	Mass surveillance
Italy	Italians sing patriotic songs from their balconies and make harmonies across empty streets to lift spirits and pass time ( <i>The Guardian GB</i> ). Orderly, dour, cowed: How my beloved Italy is changed by coronavirus? ( <i>The Guardian GB</i> ).	Humanitarian aid		
China	China’s reaction to the coronavirus outbreak violates the human right ( <i>The Guardian GB</i> ). China’s corona-virus lockdown strategy is brutal but effective ( <i>The Guardian GB</i> ). The scale of China’s Wuhan shutdown is believed to be without precedent. ( <i>The New York Times</i> ).	Political purpose; be aware of China’s generous policy	The World needs masks. China makes them but has been hoarding them. ( <i>The New York Times</i> )	Coronavirus could be a catalyst for China to boost its mass surveillance machine, experts say (CNBC USA).
Spain	Spain orders nationwide lockdown to battle coronavirus ( <i>The Guardian GB</i> ).			
UK	UK lockdown: what are the new coronavirus restrictions? ( <i>The Guardian GB</i> ). A long-awaited and joyful moment ( <i>The Guardian GB</i> ).			
USA	Listen to the medical experts. It is time for a national lockdown ( <i>The New York Times</i> ).			What America can learn from China’s use of robots and telemedicine to combat the corona-virus (CNBC USA)?

**3. Conclusion**

In communication activities, there must be receivers of the misinterpretation of the communicator’s intention [10]. However, this does not mean that media reports can deliberately distort and deviate from the actual situation to make negative reports. Since the outbreak of the epidemic, especially during the global outbreak, China has taken global

epidemic prevention and control as a general situation, practiced the idea of “a community with a shared future for mankind,” and built its image as a responsible major country. However, the English world reports about the virus situation in China are subjective, lack of fair, and “double standards” and even makes negative construction of the image of China. In the face of this negative image crisis, on the one hand, we should constantly reveal the ideological

## Retraction

# Retracted: Improved CEEMDAN, GA, and SVR Model for Oil Price Forecasting

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] Y. Lu, J. Luo, Y. Cui, Z. He, and F. Xia, "Improved CEEMDAN, GA, and SVR Model for Oil Price Forecasting," *Journal of Environmental and Public Health*, vol. 2022, Article ID 3741370, 11 pages, 2022.

## Research Article

# Improved CEEMDAN, GA, and SVR Model for Oil Price Forecasting

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Accurate prediction of crude oil prices (COPs) is a challenge for academia and industry. Therefore, the present research developed a new CEEMDAN-GA-SVR hybrid model to predict COPs, incorporating complete ensemble empirical mode decomposition with adaptive noise (CEEMDAN), a genetic algorithm (GA), and support vector regression machine (SVR). First, our team utilized CEEMDAN to realize the decomposition of a raw series of COPs into a group of comparatively simpler subseries. Second, SVR was utilized to predict values for every decomposed subseries separately. Owing to the intricate parametric settings of SVR, GA was employed to achieve the parametric optimisation of SVR during forecast. Then, our team assembled the forecasted values of the entire subseries as the forecasted values of the CEEMDAN-GA-SVR model. After a series of experiments and comparison of the results, we discovered that the CEEMDAN-GA-SVR model remarkably outperformed single and ensemble benchmark models, as displayed by a case study finished based on a time series of weekly Brent COPs.

## 1. Introduction

As a vital strategic resource, crude oil has a pivotal role in the economic activities of countries worldwide [1]. However, as COPs are often nonlinear and affected by many unobservable factors, it is difficult to forecast them accurately; thus, exploring new paths and methods to accurately forecast COPs is vital for optimising production and managerial strategies, anticipating future oil price fluctuations, and avoiding market risks [2]. Although experts have not established an agreement on the methods and models used to forecast oil prices, this crucial and difficult problem has been extensively researched. [3–6]. However, COPs are influenced by numerous complex factors, both observed and unobserved [7–9]. Therefore, COP forecast is still a hot spot in the academic literature and in industry. At present, the common and highly accurate methods for predicting COPs can be preliminarily classified into five types: (1) statistic methods, (2) artificial intelligence (AI), (3) decomposition

and ensemble, (4) hybrid model methodology, and (5) parameter optimisation.

Subsequently scholars have proposed statistical modeling methods to predict COPs, mostly using linear time series models to ameliorate the accuracy of COP prediction. Some have adopted an autoregressive integrated moving average (ARIMA) modeling method to forecast COP [10–12]. The autoregressive model is a classical method that is widely used in economics, energy, and other fields and achieves good prediction results [13]. For example, Mohammadi and Su forecasted crude oil prices using generalised autoregressive conditional heteroskedasticity models [14]. Later, more complex statistical methods including hidden Markov models, dynamic model averaging, and the autoregressive conditional heteroskedasticity approach were employed to forecast the distribution and trends of COPs in the short-term [15–17]. Some progress and breakthroughs have been made in forecasting oil prices using these statistical methods. However, owing to the inherent nonlinear and

nonstationary features of COPs, statistical methods are not powerful for crude oil price prediction. The effect of traditional statistical methods on crude oil prediction is very limited.

With the advancement of machine learning technology, the application of machine learning algorithms for oil price prediction has become a mainstream trend in current research, and such approaches are becoming increasingly popular. The support vector regression machine (SVR), which can capture nonlinearity, is a popular predictive modeling method for the prediction of COPs [5, 17, 18]. For example, Yu et al. deemed user-defined variables as indeterminate (or random) factors to establish an LSSVR (least squares support vector machine for regression) ensemble training method for oil price forecasting [19]. SVR has the benefit of being able to effectively solve nonlinear and overfitted problems [20]. The artificial neural network (ANN) is another popular model in deep learning [21, 22]. However, although neural network methods have strong self-learning and self-adaptive abilities, they can easily fall into local minima [23]. AI techniques including SVR and ANN display strong capacity for nonlinear modeling. Nevertheless, they are affected by problems such as overfitting and poor stability [24]. Therefore, it is necessary to properly combine the AI techniques mentioned above to uplift the accurateness of COP forecast by exploiting the strengths and avoiding the weaknesses of the various methods.

It is hard to realize good forecast results by virtue of certain raw time series owing to their complex characteristics. To address this problem, some researchers have introduced a framework referred to as “decomposition and ensemble” into time series forecasting. This framework is capable of decomposing the time series into simplified parts, uses a predictor to independently predict a single component, and finally integrates all the predictions to form the final prediction results [4, 25–31]. Some researchers have applied this idea to COP forecast. They found that the original complex sequence of COPs could be divided into multiple subseries, after which each single predictor is utilized for prediction and then combined with all single prediction results to form a final prediction. Abdollahi built an ensemble prediction model integrating wavelet decomposition and LSSVM for forecasting oil prices [5]. Wu et al. put forward a new modeling method on the foundation of ensemble empiric mode decomposition (EEMD) and long short-term memory (LSTM) for international crude oil markets [15]. Li and Wang proposed a novel hybrid neuronetwork forecast modeling method based on the combination of EEMD and stochastic recurrent wavelet neuronetwork (SRWNN) for COP prediction [32].

For the sake of ameliorating the accurateness of model prediction and deal with the drawbacks of single-model methods, hybrid models are increasingly applied for oil price prediction and have led to progress in field of crude oil price prediction [25, 33–35]. For instance, SVR is often used as a basic model in the framework of a hybrid modeling method to uplift the accurateness of COP prediction. Li et al. developed hybrid modeling methods for COP prediction

monthly via variation mode decomposition and SVM optimised by a GA [36]. In addition, the neuronetwork approach has been proved to be relatively suitable for the prediction of residual series containing noise factors. Safari and Davallou combined ARIMA and a nonlinearity autoregression neuronetwork to increase the accuracy of forecasting crude oil prices. They discovered that the neural network modeling method was appropriate for forecasting residual sequences containing substantial amounts of complex information and white noise [37]. Researchers have also shown that the forecast ability of generalised regression neuronetwork (GRNN) models is better than that of ANN models [38, 39]. GRNN models have also been incorporated in hybrid models to uplift the accurateness of forecast [40, 41]. Owing to the different advantages of SVR and GRNN models, combining the two can lead to more accurate predictions.

In addition, nonparametric prediction models have been improved from the perspective of parameter optimisation, mainly using GA [42–44]. Li et al. proposed hybrid models containing SVM optimised by GA; the prediction results demonstrated that the optimised models were more robust and accurate [36]. Xiao et al. proposed a hybrid migration learning model (HTLM) for COP prediction and introduced a GA to identify the best match of 2 vital variables in the HTLM [45]. These results show that it is necessary to optimise model parameter by GA in order to achieve better predictions of COPs.

Previous work has demonstrated the effectiveness of hybrid and parameter-optimised models (“hybrid and combination”), decomposition and ensemble, and AI approaches. In these frameworks, the selection of a suitable decomposition approach and predictor is essential to improve prediction ability [4]. Given the prediction abilities of CEEMDAN, SVR, GRNN, and GA for parameter optimisation, we have developed a CEEMDAN-GA-SVR-GRNN hybrid modeling method for time series prediction of COPs. First, CEEMDAN is used to realize the decomposition of the complex raw time series of COPs into a group of comparatively simplified subseries. Second, SVR is utilized to predict the target values of every subseries separately. Owing to the intricate parametric settings of SVR, GA is introduced to search for the optimum parametric results for SVR. Afterwards, our team assemble the predicted values of all subseries as the predicted values of the CEEMDAN-GA-SVR model.

The primary contributions of our research are stated below:

- (1) Our team put forward a new hybrid model incorporating CEEMDAN, GA, and SVR for COP prediction, which fully utilizes the AI arithmetic strengths of GA and SVR. To our knowledge, this is the first time that a CEEMDAN-GA-SVR hybrid modeling method has been utilized for COP prediction.
- (2) GA is utilized to optimise the parametric settings for SVR, which aims to further improve forecasting performance.

- (3) Experiments demonstrate that our proposed CEEMDAN-GA-SVR hybrid model performs significantly better than single and ensemble benchmark models for COP prediction.

The primary innovations of our paper involve these 3 aspects:

- (1) Owing to the strong decompositional ability by CEEMDAN, the potent optimisation capability of GA, and the robust forecast ability of SVR, a new ensemble model combining the 4 modeling methods is proposed for COP prediction.
- (2) CEEMDAN-GA-SVR are first combined and GA is utilized to optimise the variables of SVR simultaneously.
- (3) A CEEMDAN-GA-SVR hybrid modeling method is first proposed for predicting COPs, and the strength of the CEEMDAN-GA-SVR hybrid model is proved by experimental results.

The remaining sections of the article are arranged as follows. Section 2 briefly introduces CEEMDAN, GA, and SVR and introduces the concept and algorithm of the CEEMDAN-GA-SVR hybrid model. Section 3 reports experimental results involving forecasting of weekly Brent crude oil prices. Section 4 provides some discussion and insights on the foundation of experiment outcomes. Some discoveries are presented in Section 2.

## 2. Materials and Methods

**2.1. CEEMDAN.** Empirical mode decomposition (EMD) is a classical method for decomposing time series. This method decomposes the signal according to the time scale characteristic of the data itself, without setting any basis function in advance. However, a main drawback of EMD was the mode blending issue [46]. To solve such concern, EEMD was developed to average the outcomes of some EMD parameters with the addition of Gaussian white noise based on a raw time series [47]. However, EEMD led to a new concern in signal decomposition, i.e., that residual noise may affect the accuracy of the signal sequence generated from the raw time series by EEMD. For the sake of optimise the ability of EEMD, Torres et al. developed a novel decompositional method referred to as CEEMDAN [48]. Therein, adaptive white noise is supplemented into the raw time series during all decomposition stages; this can enhance the effectiveness of reconstruction of the original signals and enable the method to outperform spectral separation of intrinsic mode functions (IMFs). Compared with EEMD, CEEMDAN requires a smaller quantity of sifting iterative process and has a reduced reconstruction error, leading to a decrease in computational cost. Owing to the validity, the CEEMDAN approach is extensively utilized in energy prediction [4, 25, 26, 49]. Therefore, in our study, we considered utilizing for the purpose of decomposing raw COP series.

**2.2. Genetic Algorithm.** The GA was put forward by Goldberg and Holland, on the foundation of the evolutionary

theory [50], and has become an important optimisation algorithm that has been used in many studies [51–53]. In this work, we use GA to find the optimal punishment parameter  $C$ , the insensitive loss function, and the radial basis function (RBF) kernel parameters  $\gamma$  in the SVR modeling method and establish a GA-SVR modeling method to forecast time series of crude oil prices. The procedure is stated below.

- (1) Select an encoding method and specify the values of genetic parameters such as population size, selection, crossover, mutational method, crossover possibility, and mutation possibility. As GA uses individual fitness values to evaluate the pros and cons of an individual and determine the size of their genetic opportunities, our team set the evolution algebra to 200 generations, the population size to 20, and the fitness function to MSE (mean squared error). This is the MSE generated by the validation subset from the cross-validation (CV) mechanism. It can validly identify the pros and cons of chromosomes in regressive forecast problems and can prevent or reduce the phenomenon of overfitting after CV. In this work, we adopted a 5-fold CV process with the following fitness function formula:

$$\text{MSE} = \frac{1}{n} \sum_{i=1}^n (y_p - y_p^*)^2, \quad (1)$$

where  $y_p$  is the observed value,  $y_p^*$  is the predicted value, and  $n$  is the learning set sample size for the fuzzy information particle. The smaller the fitness value, the superior the individual effect and the greater the probability of being selected.

- (2) According to the feature subset encoding of each chromosome, complete the encoding operation and generate the initial population  $P$  randomly. Generally, the choice of encoding strategy relies on the problem feature. The usual encoding strategies include binary encoding and real number coding; binary coding is utilized in most cases.
- (3) Compute the fitness values of all individuals within the group as per the fit function. Perform genetic operations using selection, crossover, and mutation operators to produce the next generation of populations.
- (4) Estimate if the fitness value satisfies the determined standard; if not, return to the last step or return to step 2, execute the optimisation arithmetic, reach the termination condition, and finally use the individual with the smallest fitness during the evolutionary procedure as the optimum individual.

SVR models have excellent performance in categorization or regression, whereas their optimal generalisation performance depends greatly on the setting of parameters. For a given dataset, the most important task is to identify the optimum parameters. Practically, the issue of selecting parameters has not been well resolved. At present, parameters are primarily chosen through assays or a low-efficient grid search approach for CV.

As a steady search arithmetic that can be used for optimisation of complex systems, GA has unique advantages compared with other intelligent algorithms for optimisation. GA can easily find the global optimal solution. Because of the utilization of natural selection with survival of the fittest and simplest gene operations, GA is not restricted by conditions like the search space during calculation, and no other auxiliary information is required.

**2.3. Support Vector Regression Machine.** The essence of SVR is the support vector machine, which is a neural network model developed by Vapnik in the 1990s to analyze relatively smaller specimens and smaller probabilistic events [54]. It has been utilized in regressive forecast and applied in many research areas [53]. SVR relies on the principle of structure risk minimisation for regressive estimation; this structural risk is speculated using the insensitive loss function. In addition, SVR uses a risk function that is a combination of penalty terms derived from the principle of empiric error and structure risk minimisation. The establishment principle of the nonlinear  $\varepsilon$ -SVR used in this work is as follows.

Consider a set of data  $G = \{(x_i, y_i)\}_i^n$ , in which  $x_i$  denotes the input feature vector,  $y_i$  denotes the target value, and  $n$  denotes the sample size of the time series data. The fundamental purpose of nonlinearity SVR aims at mapping data  $x$  to a high-dimensional feature space (HDFS) via a nonlinearity mapping  $\Phi$  and complete linearity regressive analysis in such space:

$$f(x) = \omega^T \Phi(x) + b, \quad (2)$$

$$\Phi: R^n \longrightarrow F, \quad \omega \in F. \quad (3)$$

In equations (2) and (3),  $b$  is the liminal value and  $\Phi$  is the HDFS, which is the nonlinear image of the input space  $x$ . We need to estimate  $\omega$  and  $b$  to solve the optimisation problem; the result can be given by the following equation's minimum value:

$$\frac{1}{2} \|\omega\|^2 + C \sum_{i=1}^i (\xi_i + \xi_i^*), \quad (4)$$

$$\text{s.t} \begin{cases} y_i - \omega \cdot \varphi(x) - b \leq \varepsilon + \xi_i, \\ \omega \cdot \varphi(x) + b - y_i \leq \varepsilon + \xi_i^*, \\ \xi, \xi_i^* \geq 0, \quad i = 1, \dots, n. \end{cases} \quad (5)$$

In formula (5),  $C$  is the punishment parameter,  $\xi, \xi_i^*$  is the slack variable, and  $\varepsilon$  is the insensitive loss function. The utilization of  $\varepsilon$  uplifts the speculation stability. When conducting empiric research, we need to select the parameters  $C$  and. Dual theory is generally used to solve the problems above and then transform the problems into a convex quadratic programming issue. The Lagrange transform of equation (5) can be obtained as follows:

$$\begin{aligned} L = & \frac{1}{2} \|\omega\|^2 + C \sum_{i=1}^i (\xi_i + \xi_i^*) - \sum_{i=1}^i \lambda_i (\varepsilon + \xi_i - y_i + (\omega, x_i) + b) \\ & - \sum_{i=1}^i \lambda_i^* (\varepsilon + \xi_i^* + y_i - (\omega, x_i) - b) - \sum_{i=1}^i (\eta_i \xi_i + \eta_i^* \xi_i^*). \end{aligned} \quad (6)$$

In formula (6), and the partial derivative of the Lagrangian function with respect to the variable  $\omega, b, \xi_i, \xi_i^*$  is 0. Inputting the Lagrangian operator and optimisation restriction formula, the decision function of formula (6) becomes the following formula:

$$f(x) = \sum_{i=1}^i (\lambda_i - \lambda_i^*) k(x, x_i) + b. \quad (7)$$

In formula (7),  $k(x, x_i)$  is the kernel function of SVR. SVR can use the kernel function to map the low-dimensional nonlinearity raw data to the HDFS when dealing with nonlinear problems, followed by linear processing in the HDFS. Common kernel functions involve linearity kernel functions, multinomial kernel functions, and the Gaussian RBF kernel. Previous research experience indicates that RBF has the best effect when the sample data lacks prior knowledge [38]. Herein, our team utilized RBF as the kernel function in the following form:

$$k(x, x_i) = \exp\left(-\gamma \|x - x_i\|^2\right), \quad \gamma > 0. \quad (8)$$

The core parameter in formula (8) is  $\gamma$ . The selection of the  $\gamma$  value has an important influence on the kernel function. If it is set too large, it will cause overfitting; if it is set too small, it will weaken the generalisation ability of the model.

**2.4. CEEMDAN-GA-SVR: Developed Method for COP Prediction.** Based on the idea of ‘‘decomposition and ensemble,’’ our team propose a hybrid modeling method combining CEEMDAN, GA, and SVR, termed CEEMDAN-GA-SVR, to forecast COPs. This hybrid modeling method includes 3 phases, as presented by Figure 1.

**Stage 1. Decomposition.** CEEMDAN is utilized to realize the decomposition of a raw series of COPs into (1)  $N$  IMFs, denoted  $\text{IMFi}$  ( $i = 1, 2, \dots, N$ ), and (2) one residue  $R$ .

**Stage 2. Individual prediction.** Each IMF or residue is divided into a learning dataset and testing dataset in an equal manner. Then, every SVR forecast model on the foundation of GA optimisation is trained on every learning dataset in an independent manner, and the forecast modeling method is utilized on every testing dataset.

**Stage 3. Ensemble.** Addition aggregation is used to assemble the forecasted value of every decomposed part as the eventual forecasted outcome, which are referred to as the predicted results of the CEEMDAN-GA-SVR model.



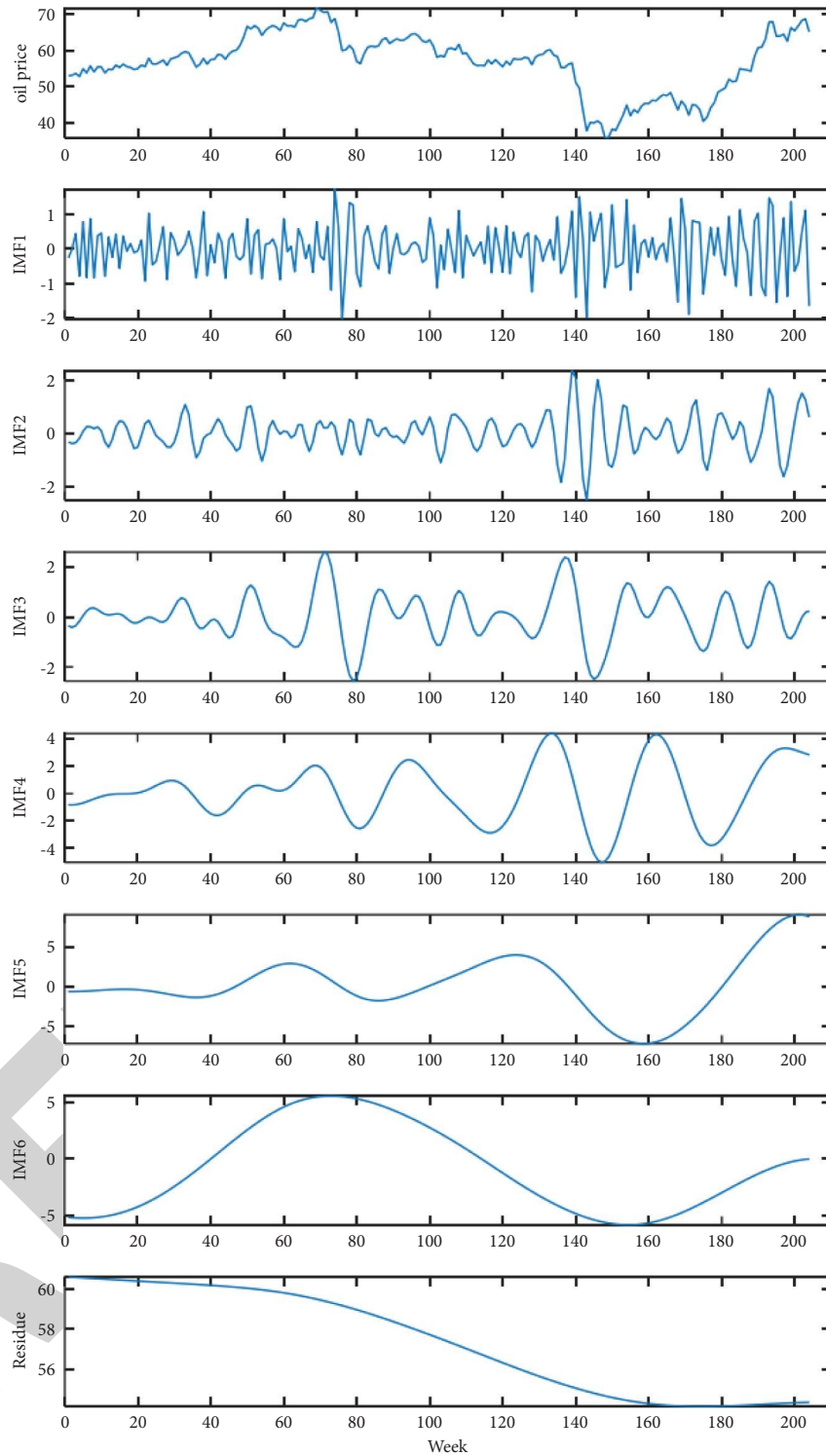


FIGURE 1: COPs and the relevant decomposed parts by CEEMDAN.

The modeling method’s flowchart is shown in Figure 2.

The developed CEEMDAN-GA-SVR hybrid modeling method uses not only the “decomposition and ensemble” approach that is widely employed in energy economics but also a “hybrid and combination” approach [55–59]. First, CEEMDAN is employed to separate the volatility and complexity series of COPs into a group of comparatively

simplified subseries, comprising multiple IMFs and one residue. Second, SVR utilizing GA optimisation is utilized for every decomposed subseries for forecasting. We chose SVR as the predictor as it had been demonstrated to be suitable for COP prediction in previous researches [60–62]. As CEEMDAN and SVR have many parameters, it is hard to set the optimal values of these variables beforehand. Hence,

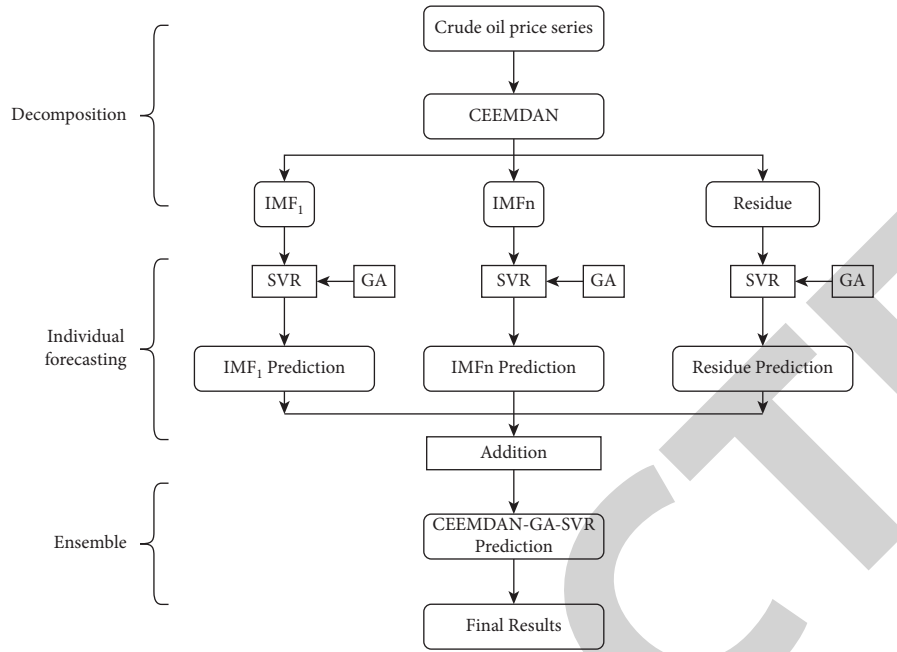


FIGURE 2: Flowchart of the developed CEEMDAN-GA-SVR combined model algorithm.

GA is employed to find the optimal variables for SVR; this can obviously enhance the prediction effectiveness of every separate subseries. Eventually, the values forecasted by SVR modeling methods for every decomposed subseries are utilized to produce the CEEMDAN-GA-SVR forecasted COPs via addition aggregation. The “decomposition and ensemble” and “hybrid and combination” aspects of CEEMDAN-GA-SVR are expected to contribute to improving the ability of COP prediction.

Certain previous researches also used SVR modeling methods to predict crude oil price series. Our study is different from previous work mainly regarding the decompositional process, hybrid model, and parameter-optimised method, in that (1) previous studies decomposed raw COP series based on the EEMD method and (2) previous studies constructed the SVR model using constant parameter settings. In contrast to the previous literature, our study employs CEEMDAN to realize the decomposition of raw COP series and applies GA to rapidly search for optimal variables for SVR in a simultaneous manner.

### 3. A Case Study in the Brent Oil Market

**3.1. Experimental Dataset Source and Evaluation Criteria.** Brent crude oil is manufactured in the Brent area of the North Atlantic and the North Sea. Its crude oil futures account for more than 2/3 of the crude oil futures trading volume across the globe, and it is the benchmark for futures prices of crude oil in the international market [63]. The data utilized herein were acquired from Bloomberg and consisted of the weekly settlement prices of North Sea Brent (Brent) crude oil futures between June 2, 2017, and May 21, 2021. There were an overall 204 specimens in the dataset. For the sake of confirming the validity of our approach, the weekly COP time series for Brent was separated into learning and

test datasets. Following some previous reports in the literature, the first 80% of the total observations in each time series were utilized as the learning dataset, while the remaining 20% were utilized as the test dataset [4, 29, 30]. Of the total samples, 163 observations were used as the training set, and 41 observations were utilized as a testing dataset to check the model’s effectiveness [64].

Five indicators were used to evaluate the experimental results: MSE, root MSE (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), and the Diebold-Mariano (DM) test [52]:

$$\begin{aligned}
 \text{MSE} &= \left(\frac{1}{N}\right) \sum_{t=1}^N (\text{Observed}_t - \text{Predicted}_t)^2, \\
 \text{RMSE} &= \sqrt{\left(\frac{1}{N}\right) \sum_{t=1}^N (\text{Observed}_t - \text{Predicted}_t)^2}, \\
 \text{MAE} &= \left(\frac{1}{N}\right) \sum_{t=1}^N |\text{Observed}_t - \text{Predicted}_t|, \\
 \text{MAPE} &= \frac{1}{N} \sum_{t=1}^N \left| \frac{\text{Observed}_t - \text{Predicted}_t}{\text{Observed}_t} \right| * 100,
 \end{aligned} \tag{9}$$

in which  $N$  is the size of the assessed specimens, and  $\text{Observed}_t$  and  $\text{Predicted}_t$  represent the real and forecasted results at time  $t$ , separately. The DM analysis was utilized to calculate the statistic differences in the prediction accurateness of model pairs.

**3.2. Description of COP Time Series.** The weekly COP time series for Brent has obvious nonlinear characteristics, and its

TABLE 1: Descriptive statistics for weekly brent COPs.

	Observations	Mean	Standard deviation	Minimum	Maximum
Oil price	204	56.7140	8.0580	35.8800	71.7300

change trend shows strong volatility. For example, the price of Brent crude oil was approximately 60.2 USD/barrel in Jan 2020, before plummeting to 35.88 USD/barrel in April 2020; this change in just a few months is an example of the dramatic fluctuations and nonstationary features of COP time series [63].

As shown in Table 1, the average of the weekly Brent COP time series was 56.7140, indicating that the weekly Brent crude oil prices fluctuate at around 56 USD/barrel. The highest value of the time series was 71.7300 USD/barrel, while the lowest was 35.8800 USD/barrel. There was thus a large difference between the maximum and minimum prices; moreover, the standard deviation was 8.0580. These results indicate that the weekly Brent COP time series fluctuates violently.

Figure 1 shows the original COPs and the decomposed parts. Clearly, the raw COPs show remarkable fluctuations. Amongst the decomposed parts, IMF1 to IMF4 show obvious high-frequency features in narrow ranges, whereas IMF5 to IMF6 and the residue show obvious low-frequency features in wide ranges. After obtaining the decomposed parts, the initial complex COP series prediction can now be divided into predictions of several simpler components.

**3.3. Experimental Settings.** The proposed CEEMDAN-GA-SVR model was evaluated and analyzed in two ways in our study. First, without any decomposition and ensemble, we compared the GA-SVR single model with other single models, which involved 1 important statistic model (ARIMA), three classical AI approaches (GRNN, back propagation neuronnetwork [BPNN], and particle swarm optimisation SVR [PSO-SVR]), and the original SVR. Second, as previously finished studies have revealed that ensemble models using the “decomposition and ensemble” framework show better forecast abilities in contrast to single models for COP prediction, we compared forecast abilities between the developed CEEMDAN-GA-SVR and the rest of ensemble forecast modeling methods. Hence, the entire single models were employed to the forecast phase in ensemble models. Based on the identical COP series, our team tested if the developed CEEMDAN-GA-SVR model could significantly ameliorate the forecast ability. To prove the capacity of the proposed CEEMDAN-GA-SVR in prediction and CEEMDAN in decomposition, our study also compared CEEMDAN-GA-SVR with CEEMDAN-PSO-SVR, CEEMDAN-SVR, CEEMDAN-GRNN, CEEMDAN-BPNN, and CEEMDAN-ARIMA. The parameters of the GA, PSO, BPNN, and ARIMA methods and the parameter ranges of CEEMDAN used in the assays are presented by Table 2. The parametric values for CEEMDAN, GA, PSO, BPNN, and ARIMA were taken from the literature [26, 60]. All

TABLE 2: Parameter settings.

Method	Description	Parameters
CEEMDAN	Complete EEMD with adaptive noise	Noise standard deviation: 0.2 Number of realizations: 100
GA	Genetic algorithm	Number of evolutionary algebras: 200 Size of population: 20 Fitness function: MSE
PSO	Particle swarm optimisation	Number of iteration generations: 200 Size of particle: 20 Fitness function: MSE
BPNN	Back propagation neural network	Size of the hidden layer: 10 Maximal training epochs: 1000 Learning rate: 0.001
ARIMA	Autoregressive integrated moving average	Akaike information criterion to decide parameters ( $p-d-q$ )

TABLE 3: Outcomes of single models.

Model	Test dataset			
	MSE	RMSE	MAE	MAPE (%)
GA-SVR	<b>2.8436</b>	<b>1.6863</b>	<b>1.3228</b>	<b>2.4389</b>
PSO-SVR	4.9332	2.2211	1.6365	2.9448
SVR	4.6938	2.1665	1.9537	3.6541
GRNN	7.4742	2.7339	3.0092	4.5098
BPNN	8.9135	2.9855	2.5545	4.8120
ARIMA	12.9069	3.5926	3.0092	5.5907

experiments were performed in the MATLAB R2018b environment.

### 3.4. Results and Analyses

**3.4.1. Single Models.** Without any decompositional process, the single models were applied straightly to the raw series of COPs. Our team compared the initial SVR and GA-SVR approaches with 1 important statistic modeling method, ARIMA, and three classical AI modeling methods, PSO-SVR, GRNN, and BPNN. The experiment outcomes are presented by Table 3, in which the optimum forecast outcomes were displayed in bold.

As shown in Table 3, amongst the entire single models, GA-SVR obtained the lowest MSE, RMSE, MAE, and MAPE values, whereas the ARIMA modeling method achieved the greatest MSE, RMSE, MAE, and MAPE values. Among the AI models, PSO-SVR achieved the lowest MSE, RMSE, MAE, and MAPE values. Among the SVR-related modeling methods, GA-SVR achieved lower MSE, RMSE, MAE, and MAPE values in contrast to the PSO-SVR and SVR models, revealing that the former outperformed the latter in terms of COP prediction. To put it in another way, use of the GA optimisation approach to search the optimal parametric results for SVR can uplift the forecast ability.

TABLE 4: Results of DM test for single models.

Tested model	Benchmark model				
	PSO-SVR	SVR	GRNN	BPNN	ARIMA
GA-SVR	-1.996 (0.0459)**	-3.376 (0.0007)***	-3.929 (0.0001)***	-4.258 (0.0000)***	-6.691 (0.0000)***
PSO-SVR		-0.562 (0.5741)	-0.9291 (0.3528)	-1.505 (0.1324)	-2.652 (0.0080)***
SVR			-1.178 (0.2388)	-1.827 (0.0677)**	-4.684 (0.0000)***
GRNN				-1.01 (0.3125)	-5.417 (0.0000)***
BPNN					-2.356 (0.0185)**

\*\*\*statistical significance at 1%, \*\*statistical significance at 5%.

TABLE 5: Outcomes for ensemble models.

Model	Test dataset			
	MSE	RMSE	MAE	MAPE (%)
CEEMDAN-GA-SVR	0.1709	0.4134	0.3158	0.6311
CEEMDAN-PSO-SVR	0.7765	0.8812	0.4715	0.8773
CEEMDAN-SVR	2.5747	1.6046	1.0355	1.8520
CEEMDAN-GRNN	2.3951	1.5476	1.2431	2.3158
CEEMDAN-BPNN	4.9801	2.2316	1.8398	3.4331
CEEMDAN-ARIMA	7.7860	2.7903	2.2769	4.2513

TABLE 6: Outcomes of DM test for ensemble models.

Tested model	CEEMDAN					ARIMA
	GA-SVR	PSO-SVR	SVR	GRNN	BPNN	
GA-SVR	-1.972 (0.0486)**	-2.363 (0.0181)**	-4.776 (0.0000)***	-4.077 (0.0000)***	-4.27 (0.0000)***	
PSO-SVR		-1.742 (0.0816)*	-3.111 (0.0019)***	-3.547 (0.0004)***	-3.673 (0.0002)***	
SVR			0.2545 (0.7991)	-2.324 (0.0201)**	-4.431 (0.0000)***	
GRNN				-2.808 (0.0050)***	-3.764 (0.0002)***	
BPNN					-6.081 (0.0000)***	

\*\*\*statistical significance at 1%, \*\*statistical significance at 5%.

Regarding the directional statistics, as presented by Table 3, the GA-SVR modeling method achieved the highest values, indicating that it performed best in direction prediction among all the single prediction models. In addition, the DM analysis was utilized to evaluate if the forecast ability of GA-SVR remarkably outperformed other single modeling methods. Table 4 displays the statistical results of the DM analysis and p values (in brackets).

The DM test outcomes presented by Table 4 reveal that the GA-SVR modeling method remarkably outperformed the statistic modeling method ARIMA and the AI modeling methods PSO-SVR, SVR, GRNN, and BPNN, as the relevant DM statistics were far lower than 0 and every p value was <0.05. The GA-SVR model also outperformed the PSO-SVR and SVR modeling methods as per the DM statistics, and the relevant p values were again <0.05, demonstrating that GA-SVR is significantly superior to PSO-SVR and the SVR in the majority of cases.

**3.4.2. Ensemble Models.** Given the effectiveness of the “decomposition and ensemble” approach, our team introduced the decompositional approach CEEMDAN into the developed ensemble model herein. Thus, using the same decomposition approach (i.e., CEEMDAN), we compared

the CEEMDAN-GA-SVR predictor with CEEMDAN-PSO-SVR, CEEMDAN-SVR, CEEMDAN-GRNN, CEEMDAN-BPNN, and CEEMDAN-ARIMA. The experiment simulation outcomes for the ensemble models are presented by Table 5.

CEEMDAN-GA-SVR achieved the best prediction results with the lowest MSE, RMSE, MAE, and MAPE values in every case, demonstrating that the developed CEEMDAN-GA-SVR modeling method outperformed every other ensemble model. The superior forecast performance of the developed CEEMDAN-GA-SVR model could be attributed to 2 primary reasons: the valid decompositional process of CEEMDAN, the better forecast capability of SVR with GA optimisation. Overall, the proposed CEEMDAN-GA-SVR achieved better prediction performance in contrast to the other prediction modeling methods.

To enhance the persuasiveness of the outcomes, we introduced the DM test to study the forecast outcomes of the ensemble models; the statistic results and the relevant p values are presented by Table 6.

As shown in Table 6, when we compared the prediction outcomes of the developed CEEMDAN-GA-SVR modeling method with other models, the DM statistics were much smaller than 0 and the relevant p values were near 0 ( $p < 0.05$ ), indicating that CEEMDAN-GA-SVR significantly outperforms

other models for crude oil price forecasting. Furthermore, CEEMDAN-GA-SVR was significantly superior to CEEMDAN-PSO-SVR, CEEMDAN-SVR, CEEMDAN-GRNN, CEEMDAN-BPNN, and CEEMDAN-ARIMA. In addition, the AI models (CEEMDAN-GA-SVR, CEEMDAN-PSO-SVR, CEEMDAN-SVR, CEEMDAN-GRNN, and CEEMDAN-BPNN) showed similar prediction performance to each other but all significantly outperformed the statistic modeling method ARIMA, indicating that AI modeling methods are superior to statistic models for COP prediction. In addition, CEEMDAN-GA-SVR was remarkably better than the initial SVR. For instance, the DM test statistic value between CEEMDAN-GA-SVR and SVR was  $-2.648$ , and the corresponding  $p$  value was approximately 0, proving that the former was significantly better than the latter. The DM analysis outcomes have evidenced that combining CEEMDAN decomposition, SVR prediction, GA optimisation, and the GRNN residual correction model can remarkably reinforce the forecast ability of crude oil price forecasting [65, 66].

#### 4. Conclusions

Accurate forecast of COPs is a common problem faced in theoretical research on energy economics and in industry. The present work focuses on the weekly North Sea Brent crude oil futures settlement price from June 2, 2017, to May 21, 2021. To uplift the prediction of COPs, we established a CEEMDAN-GA-SVR hybrid model incorporating CEEMDAN, GA, and SVR. This model enriches the current research on time series forecasting of international COPs and has certain practical and theoretical significance. First, CEEMDAN is used to realize the decomposition of the complex raw time series of COPs into a group of comparatively simpler subseries. Second, SVR is utilized to predict the target values of every decomposed subseries separately. Owing to the intricate parametric settings of SVR, GA is introduced to search for the optimum parametric values for SVR. Subsequently, our team assemble the predicted values of all individual subseries as the predicted values of the CEEMDAN-GA-SVR model. As far as we know, this is the first time that such a CEEMDAN-GA-SVR hybrid model has been introduced in the field of COP prediction.

First, the experiment outcomes reveal the following: (1) in contrast to benchmark models, our CEEMDAN-GA-SVR hybrid model shows significantly enhanced forecast ability for COP prediction; (2) CEEMDAN performs better than EEMD for the decomposition of raw COP series; (3) GA can efficiently search for the optimal parameters for SVR, thereby improving the prediction of COPs.

Second, the primary benefit of our CEEMDAN-GA-SVR is that it takes full advantage of the benefits of CEEMDAN, GA, and SVR, respectively, and can remarkably ameliorate the ability of COP prediction in contrast to certain latest forecast models. As SVR is suitable for the prediction of complex nonlinear series, the ensemble prediction model has comparatively strong interpretability in contrast to conventional regressive models. However, as we utilize GA to search for the best parametric settings for SVR, the overall

execution time of the developed model is longer in contrast to other prediction models based on fixed parameters. In summary, our CEEMDAN-GA-SVR model shows significantly enhanced prediction performance and has promise for applications in crude oil price forecasting.

Third, through empirical study on the weekly data of Brent crude oil futures settlement price in the North Sea, we predicted the trend of crude oil prices with relative accuracy. As an important commodity and strategic material, crude oil has important practical significance for the productivity and activities of countries and enterprises. The research results presented here could help government authorities to better forecast global COPs and to form more accurate oil price expectations in order to plan production and business activities more scientifically, which is vital for optimising the production structure of the national government authorities and preventing the risk of oil price fluctuations.

#### Data Availability

All data generated or analyzed during this study are included within the article.

#### Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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## Retraction

# Retracted: Construction of Teaching Supervision System of Applied Undergraduate Colleges and Universities under the Perspective of “Internet+”

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article’s content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] S. Zhang and F. Zhao, “Construction of Teaching Supervision System of Applied Undergraduate Colleges and Universities under the Perspective of “Internet+,”” *Journal of Environmental and Public Health*, vol. 2022, Article ID 9277583, 10 pages, 2022.

## Research Article

# Construction of Teaching Supervision System of Applied Undergraduate Colleges and Universities under the Perspective of “Internet+”

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With the wide application of “Internet +” in education and the transformation and development of applied colleges and universities, teaching supervision is an important part of colleges and universities’ teaching quality assurance system. However, there are still the following problems in the actual teaching supervision. The first is emphasizing “theory” teaching rather than “practice” teaching; the second is unstable supervisory team; the third is emphasizing “supervision” rather than “guidance”; the fourth is single ways and methods of teaching supervision; the fifth is lack of integration of teaching evaluation information. In order to ensure that the teaching quality of applied undergraduate colleges and universities can meet the requirements of local social development, teaching supervision work must be rooted in reality and focused on the future to build an effective teaching supervision system. Therefore, six suggestions are put forward. The first is to attach importance to the practicality of teaching, that is, application. The second is to insist on the part-time subjectivity of the supervision team. The third is to form a supervision culture of “guidance as to the main focus, supervision as the supplement, combination of supervision, and guidance to promote teaching quality through feedback.” The fourth is to implement a triple superposition of regular supervision, inspection supervision, and special supervision. The fifth is to strengthen the synergy and innovation of supervision methods. The sixth is to establish an information-based teaching supervision and management platform so as to solve the deficiencies of the teaching supervision system in application-oriented colleges and universities in function, organization, culture, methods, methods, technology, and so on.

## 1. Introduction

At present, China is in a critical period of deepening the reform and quality construction of higher education, and it is also a key stage to accelerate the development of high-level undergraduate education and internal connotation. In 2018, the Ministry of Education issued a circular to eliminate “poor quality classes” and create “high-quality classes,” striving to improve undergraduate education and teaching. Universities have carried out undergraduate education work and great discussions on ideas, setting off the tide of quality construction. The teaching supervision system is an important guarantee for monitoring the quality of talent training in colleges and universities. It plays an important role in ensuring the quality of teaching in colleges and

universities, promoting the construction of the teacher team, promoting the construction of teaching and learning styles in colleges and universities, and providing advice and suggestions for the development of schools. At present, some local universities are in a period of “transformation.” Although they have established the cultivation goal of application-oriented talents, due to the lag of education and teaching management, the uneven construction of information technology, “Internet+” technology has not been effectively used in the supervision work of universities, and there are a series of problems in the supervision system of universities in general. For example, it emphasizes the supervision of “theoretical courses” rather than “practical courses”; the supervision team is unstable; it emphasizes “supervision” rather than “guidance”; the methods and



approaches are single and simple and lack technical support. To a certain extent, this has hindered the idea and correct guidance of the cultivation of applied talents in teaching, thus failing to ensure the quality of the cultivation of applied talents, and is not conducive to the development of innovation and entrepreneurship education and the integration of industry, education, and research. Therefore, giving full play to applying “Internet+” technology in teaching supervision, innovative teaching management, and building an effective teaching supervision system have become important themes and inevitable trends in the reform and development of teaching management in universities.

## 2. Importance of Teaching Supervision Work

Undergraduate teaching is the key issue that the university way should grasp. “We must place undergraduate education at the core position of building a strong country of higher education, the key position of training socialist builders and successors, and the pioneering position of national prosperity and national rejuvenation to understand and promote. We should systematically plan and promote it in terms of ideas, concepts, standards, models, culture, and systems, establish educational confidence, reflect Chinese characteristics, pursue world-class, and form a Chinese program for high-level undergraduate education” [1]. This is the speech made by Minister Chen Baosheng at the launch of the Six Excellence and One Top Notch Plan 2.0. Undergraduate education is based on undergraduate teaching, and there is no way to talk about undergraduate education without teaching. The quality of undergraduate teaching requires assurance through teaching supervision, which means that teaching supervision is significant for strengthening undergraduate teaching.

*2.1. Ensure the Orientation of School Running.* Applied universities emphasize the social service function of universities, oriented to service development needs, and focus on professional knowledge, professional skills training, and training to cultivate application-oriented talents as the goal [2]. At present, China’s applied universities and local universities lack the awareness of serving the local area and the level of service. Consequently, the deviation of the insufficient concept of serving the local economy in teaching should be corrected through teaching supervision work, and the concept of serving the local area should be established. Furthermore, it relies on various local resources, integrates into local economic development, cultivates high-quality applied talents rooted in the local area, and delivers a certain quantity and quality of professional talents to the local area. In this way, it ensures the sustainable development of the local economy and provides a constant source of power and resources for the universities to meet the needs of local economic and social development.

*2.2. Assist in Optimizing the Construction of Teaching Staff.* Teachers in applied colleges and universities are responsible for serving local economic development and cultivating

applied talents. In addition to solid professional knowledge, a high level of scientific research, and teaching ability, teachers should also have the practical ability to operate skillfully and have excellent technical skills. By monitoring and guiding teachers throughout the teaching process, the teaching supervision work can promptly identify the problems in the teaching process of teachers, especially the phenomenon of emphasizing theoretical teaching and ignoring practical teaching among teachers. It should give teachers helpful evaluation, targeted guidance, and intentional guidance for cultivating “dual-teacher” and “dual-competent” teachers in applied colleges and universities to optimize teachers’ construction.

*2.3. Promote the Construction of Teaching and Learning Styles in Universities.* The teaching and learning style of a school is an important reflection of the spirit of teachers and students in a university. “Emphasis on academics rather than teaching” has always been a common problem in all universities; although almost all universities will talk about putting teaching in the first place, in the actual assessment, especially in the title assessment, it is still based on teachers’ projects and papers. Therefore, it is not surprising that teachers are busy declaring projects and writing papers. “Emphasis on academics rather than teaching” is likely to lead to teachers being “perfunctory” in their teaching. Simultaneously, through supervision, it continues to deepen the reform of teaching content, methods, and means, promote teaching reform, and improve the status of the main students. Meanwhile, through field trips, student seminars, or individual interviews, it is possible to gain an in-depth understanding of whether students can receive timely and effective assistance and guidance when they encounter doubts in the learning process and to understand students’ requirements and opinions on teaching materials, teaching progress, and teachers’ teaching [3]. Thus, strengthening the supervision of teaching helps to detect bad teaching and learning styles among teachers and give timely correction. It creates a good campus culture [4].

*2.4. Provide Advice and Suggestions for the Development of Teaching in the University.* The teaching supervision department is an advisory body of the school, independent of the Academic Affairs Office and the teaching department. It can more objectively supervise, inspect, guide, and evaluate the whole teaching practice, give timely and objective feedback on the current teaching situation, analyze the existing problems, evaluate the quality of teaching, and put forward suggestions for improvement [5]. The teaching supervision work itself is not directly involved in management, but it can summarise the common problems in teaching through classroom listening, teaching inspection, and student seminars. The information from supervision is summarised, concluded, and analyzed in time to provide a basis for decision-making for the school’s teaching department to improve teaching management and teaching staff to improve their teaching ability, such as teachers’ teaching, students’ learning, teaching status, teaching effect,

and teaching management cooperation. It delivers timely teaching information and puts forward opinions or suggestions so that school leaders or teaching management departments can quickly grasp the teaching situation and make correct judgments and decisions. This will ensure that the teaching and learning process is standardized, orderly, and good [6].

### 3. Problems of Teaching Supervision in Applied Undergraduate Universities under the Perspective of “Internet+”

3.1. *Emphasis on “Theory” Teaching rather than “Practice” Teaching.* Whether it is the transformation of local undergraduate colleges and universities to application-oriented colleges and universities or the transformation of higher vocational high schools to application-oriented undergraduate colleges and universities, they are still in the early stage or transition stage. Applied universities cultivate application-oriented talents, which is different from academic universities and skill-oriented high vocational high schools in the past. It should be said that it cultivates both academic ideas and high-level, high-quality skill-oriented talents. Therefore, on the one hand, in the teaching supervision, we pay more attention to the teaching of theory courses than practice courses. It is a problem of the supervisors’ own transformation of the idea of “application-oriented.” According to the statistics of a university’s supervisors’ manuals for listening and evaluating classes in the academic years of 2017-2018, 2018-2019, and 2019-2020, the proportion of listening to practical classes is 12%, 18%, and 20% respectively. On the other hand, there is a lack of perfect practical teaching evaluation standard in the teaching evaluation standard. The supervisor generally divides the practical teaching into experiment, practical training, and social practice. Therefore, the practical teaching evaluation should include these three categories. At present, the evaluation of practical teaching mostly focuses on practical operation ability, and the evaluation standard is too general to scientifically and reasonably evaluate the process and effect of practical teaching. Teaching evaluation has not yet been truly in line with the criteria for training applied talents. Therefore, using theoretical, experiment, social practice, and practical training courses targeted the form of teaching supervision [7]. In the transformation to application-oriented, how to evaluate teachers’ teaching quality and strengthen the supervision of practical teaching to improve the quality of practical teaching is a topic for further research and discussion by supervisors [8]. In addition, the rapid development of “Internet+” education is bound to cause continuous reform and updating of teaching ideas, teaching modes, teaching methods, and teaching means in colleges and universities. Supervisors must adapt to the changes in educational technology and strengthen supervision of practical teaching [9]. However, at present, some universities do not pay attention to the training of teaching supervisors and do not have corresponding learning and training plans. The lack of internal and external learning and training is also

an important reason why supervisors are not strong enough to supervise “practical” teaching.

3.2. *Unstable Supervisory Team.* The work of teaching supervision involves various disciplines and majors in each second-level college, and it is obviously not very realistic to have full-time supervisors corresponding to them. The small number of full-time supervisors is a common phenomenon in all universities. Especially in private universities, due to the allocation of funds, apart from a few full-time supervisors, supervisory work is mostly performed by teachers with associate or higher titles who are more senior, experienced in teaching, and responsible in the second-level colleges. Although the university also appoints secondary college supervisors for two years in general, in fact, there are cases where part-time supervisors leave their posts, and so on, to varying degrees each semester. As shown in Table 1 and Figure 1, from a review of the supervisory teams of an undergraduate university in the second semester of the 2017-2018 academic year, the 2018-2019 academic year, and the 2019-2020 academic year, the departure rate was as high as 38%. The new part-time entry was as high as 43%, with only the PE Department and the Computer Science Department having no part-time supervisory staff turnover for five consecutive semesters, with the Computer Science Department also introducing one person. Secondly, the Business Administration Department had no part-time supervisors for four semesters in two consecutive academic years, and the Logistics Department had no part-time supervisors for three consecutive semesters.

The reason for this is that, firstly, these part-time supervisors have to apply for supervisory work according to the teaching work arrangement of the second-level colleges, or they are assigned by the leaders of their departments according to their workload. Due to the high mobility of teachers in private universities, teachers’ workload is not fixed every semester, sometimes more, sometimes less, and if they are responsible for part-time supervisory work when the workload is high, they will exceed the workload limit of the college. If colleges do not have additional subsidies, it will greatly reduce the motivation of part-time supervisors to participate. Secondly, part-time supervisors have to complete the teaching and research tasks of secondary colleges, then they also have to find time for supervisory management work, which is a distraction in terms of time and energy, and they are unable to cope with it, thus giving up the work of part-time supervisors. Finally, as part-time supervisors are mostly supervising and managing their own secondary colleges and monitoring their own colleagues, on the one hand, some supervisors are too harsh in their words when giving feedback afterward. On the other hand, some teachers are prejudiced against supervisors, thinking that supervision is to pick faults, so those part-time supervisors are often physically and mentally exhausted and lose their enthusiasm for supervisory work. In short, the instability of the supervisory team directly affects the consistency of the school supervisory department in listening to opinions and suggestions, the “supervision” of teachers only remains an issue,

TABLE 1: Turnover of part-time supervisors.

Department	Academic year														
	2017-2018-2			2018-2019-1			2018-2019-2			2019-2020-1			2019-2020-2		
	On duty	Leaving post	Recruitment	On duty	Leaving post	Recruitment	On duty	Leaving post	Recruitment	On duty	Leaving post	Recruitment	On duty	Leaving post	Recruitment
Department of Economy	2	0	0	4	1	3	4	0	0	3	1	0	3	0	0
Department of Electronic Studies	2	2	2	2	2	2	2	1	1	2	0	0	2	1	1
Department of Music	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1
Department of Foreign Languages	2	1	1	0	2	0	0	0	0	2	0	2	2	0	0
Accounting Department	2	1	1	2	0	0	4	0	2	4	1	1	3	1	0
Department of Business and Administration	2	0	0	2	0	0	2	0	0	3	1	2	2	1	1
Department of Fine Arts	1	1	1	1	0	0	1	0	0	2	1	2	1	1	0
Logistics Department	3	0	0	3	0	0	3	2	2	2	1	0	2	0	0
Computer Department	2	0	0	3	0	1	3	0	0	3	0	0	3	0	0
Department of Physical Education	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Department of Basic Courses	1	1	1	1	1	1	1	0	0	1	1	1	2	1	2
Ideological and Political Department	1	1	1	1	1	1	1	0	0	0	1	0	0	0	0
Total	20	7	7	21	8	9	23	4	6	24	7	8	22	6	5

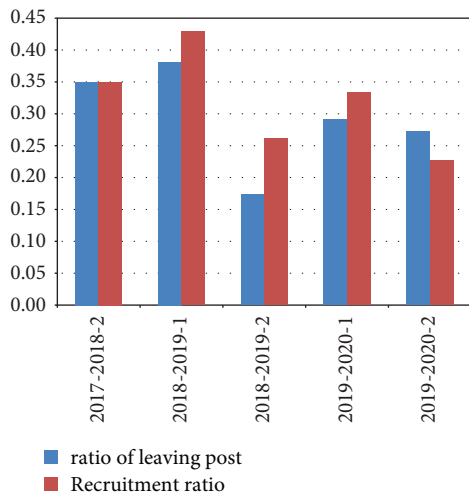


FIGURE 1: Proportion of part-time supervisors leaving/recruiting.

and the “guidance” becomes a mere word. This affects the continuity and effectiveness of teaching supervision.

**3.3. Emphasis on “Supervision” rather than “Guidance”.** In the work of teaching supervision, the phenomenon of emphasizing “supervision” over “guidance” is still very common, thus causing a disconnection between “supervision” and “guidance.” On the one hand, it is easier to do “supervision” than “guidance,” which is equivalent to inspection, and the results of supervision and evaluation only come from a few classroom visits [10], so it is easy to find problems, record them, and give feedback on them. However, finding out the reasons behind the problems and guiding teachers to correct them is a task that requires much effort and continuous follow-up and requires more time and energy. In reality, most supervisors prefer to give feedback in writing to the teacher’s faculty leader or the teacher himself after they have found problems in the course of listening to or inspecting a class, and even if they are able to communicate face-to-face, it is only basically once, and rarely can they follow up and guide the teacher so that the teachers can move from immaturity to maturity to full maturity in the shortest possible time.

**3.4. Single Ways and Methods of Teaching Supervision.** The central part of teaching is classroom teaching activities. The level of teaching and management is reflected in classroom teaching, so the primary task of supervision is to listen to classes in-depth [11]. In terms of teaching supervision methods and approaches, at present, the traditional form of simple classroom listening and evaluation is still adopted; one or several supervisors listen to a teacher’s class and then give corresponding evaluation guidance to the teacher. This is a relatively convenient way and method of supervision. However, as China’s higher education progresses towards becoming an educational powerhouse and traditional undergraduate universities transform into application-oriented universities, this single way of listening to

and evaluating lessons is no longer sufficient to ensure teaching quality, especially as it is difficult to conclude just one or two listening sessions. It is not always possible to conclude multiple listening sessions, and the workload of the supervisors can be very heavy, which in turn can create a very tense situation for teachers and even disrupt their teaching plans and cause resentment. In addition, in practice, some teachers do not pay attention to or rectify the feedback they receive from supervisory experts and lack motivation for teaching reform [12].

**3.5. Lack of Integration of Teaching Evaluation Information.** Although “Internet+” education has made a deep development, it does not seem to be really reflected in the field of teaching supervision work. Due to the lack of modern information technology support, the supervisors’ evaluation of teachers’ teaching is only retained in the paper lecture record book, and each supervisor’s evaluation information is of a single-line type. If a school-level supervisor or the head of a second-level college wants to know the evaluation of a teacher by a number of supervisors for different classes, or even more so, if the teacher wants to know the information about his teaching evaluation by the supervisory institute in the past, this is undoubtedly a huge workload. At the same time, it is not easy to follow up on each teacher’s evaluations as they are all messy and hidden.

## 4. Construction of Effective Teaching Supervision System of Applied Undergraduate Universities

**4.1. Pay Attention to the Unity of Teaching Theoreticity and Practicality.** In order to ensure the quality of applied talents training in private applied undergraduate colleges and universities, it is necessary to change the teaching ideas and methods that teachers used to focus only on theoretical teaching and neglect practical teaching. Thus, teaching supervision should continue to pay attention to the supervision and guidance of theoretical courses and gradually raise the requirements for practical teaching and formulate practical teaching evaluation standards. For example, whether the applicability of practical courses is reasonable, whether the hardware environment of practical teaching can serve to teach normally and effectively, and whether the teachers’ attitude towards practical teaching, teaching content, and teaching effect meet the requirements of practical teaching. Quantitative and qualitative evaluation continuously improve the supervision of practical teaching and strengthen the supervision and guidance of practical teaching [13].

**4.2. Adhere to the Part-Time Subjectivity of the Supervisory Team.** Supervisors in higher education institutions are basically composed of school leaders and leaders of second-level colleges or professors. As a new private university, Guangzhou College of Technology and Business needs to build more projects and spend more money at the early stage of construction, making it difficult to set up a full-time supervisory team. In order to cut costs without affecting the

smooth development of supervision work, Guangzhou College of Technology and Business has always adhered to the principle of “full-time supervision as the leader and part-time supervision as the main body” over the years. It has established a relatively stable supervision team and a relatively stable supervisory team and has shown a situation of “two high and one good.” The full-time supervisors are experts who are well versed in the laws of higher education teaching, have rich teaching experience, are impartial and healthy, and have senior associate titles or above. Part-time supervisors are professors and associate professors with rich teaching experience and profound professional foundation or lecturers with certain teaching experience and top teaching evaluation selected by each department. With the expansion of the scale of schooling, more and more professors and associate professors have been introduced to each department. At present, the number of part-time supervisors with the title of associate professor or above has reached more than 90%, which has brought the comprehensive quality of the supervisory team to a new level. Secondly, the high enthusiasm of work: most of the new private colleges and universities with the title of associate professor or above are those old teachers who have retired from public colleges and universities. The full-time and part-time supervisors are precisely the highly respected old professors selected from these people. They are often responsible, upright, and patient, and according to the arrangement of supervision work, they can all complete their tasks on time and in quality. Some even often overcomplete the task of listening to and evaluating lectures, showing high enthusiasm for their work, as shown in Table 2. Thirdly, the supervision effect is good. The biggest advantage of “part-time supervisors as the main body” is that it makes full use of teachers’ resources in each department and makes up for the shortage of full-time supervisors as the focus of teaching supervision is generally on those new teachers, external teachers, or teachers with problems reflected by students. The number is often large at the beginning of the construction of private colleges and universities. The task of listening to and evaluating lessons involves various departments of the college and various specialties, which is often limited by the ability and energy of full-time supervisors alone. This allows the part-time supervisors to bring their respective professional levels into play and listen in a structured, focused, and targeted manner according to the characteristics of different disciplines and specialties in their departments, making the supervisory work more professional, distinctive, and refined. At the same time, it has also drawn the attention of each department to the teaching work and received good results. In addition, the cooperation between schools and enterprises in applied colleges and universities is getting closer and closer, and enterprises are more and more involved in the work of raising talents in colleges and universities. The enterprise element in colleges and universities is getting stronger and stronger. For this reason, introducing the evaluation standards of industrial enterprises and employing experts from industrial enterprises as teaching supervisors will evaluate teaching supervision more scientifically and reasonably [5].

*4.3. Form a Service-Oriented Supervisory Culture Combining Supervision and Guidance.* Supervision of education and teaching is a very serious task. In the past, most teachers believed that supervisors would only pick on teachers and would not praise them. Therefore, to make more teachers better accept the supervision work, the majority of supervisors must update their concepts, change the way they supervise, shift from inspection style supervision to service style supervision, and enhance their sense of service [14]. The Guangzhou College of Technology and Business Supervision Office, based on the principle of starting from the actual work of supervision, has formulated a 16-word supervision policy after careful study and discussion, namely, “summarise the experience, explore highlights, discover problems, and discuss improvement.” In the supervision, a service-oriented teaching supervision and monitoring culture with “guidance as to the main focus, supervision as the supplement, combination of supervision, and guidance to promote teaching quality through feedback” have been formed. In the practice of supervision, the 16-word policy has become the basic principle of full-time and part-time supervision. When listening to and evaluating lessons, supervisors should firstly respect teachers’ supervisory philosophy of respecting the classroom and listen to and evaluate lessons from summing up experiences and digging up highlights. It is important to understand teachers through listening to lessons, summarising their teaching experience, digging out the highlights that teachers can develop sustainably, and promoting teachers’ confidence in engaging in education rather than discouraging them. In educational practice, “teaching should have methods but there is no fixed method” should become the guiding ideology of supervision work to summarise the experience and explore the highlights. Secondly, the supervisory work should change its concept, insist on reform and innovation, supervise with the attitude of academic research [15], and help teachers reform their classroom teaching methods, form their own teaching style, and improve the quality of classroom teaching, based on the principle of “finding problems, discussing and improving.” When supervisors listen to classes, once they find problems, they should solve them utilizing seminars, and by discussing the problems in teaching, they should guide teachers to develop and innovate, instead of mainly criticizing to frustrate teachers’ enthusiasm for teaching. In recent years, the Supervision Office has followed the 16-word supervisory principles in several types of special supervision and achieved a better supervisory effect. For example, in the supervision and evaluation of undergraduate teaching plans, we adopted the method of recommending ten teaching plans by the department, selecting the excellent teaching plans by experts, and then summarising the excellent teaching plans, in theory, to refine the core content the excellent teaching plans. Through the supervision bulletin to the whole college, thus guiding the college’s educational teaching reform, especially solving the theoretical problems in lesson plan writing. Another example is that we have conducted special supervision of 30 teachers with top and bottom student evaluations in two semesters in the special evaluation of teachers’ teaching. Through the

TABLE 2: Attendance statistics for full-time and part-time supervisors, 2018–2020.

Academic year	Number of lectures	Semester 1	Semester 2	Total lectures (section)
2018-2019	27	1089	1269	2358
2019-2020	25	1470	1386	2856

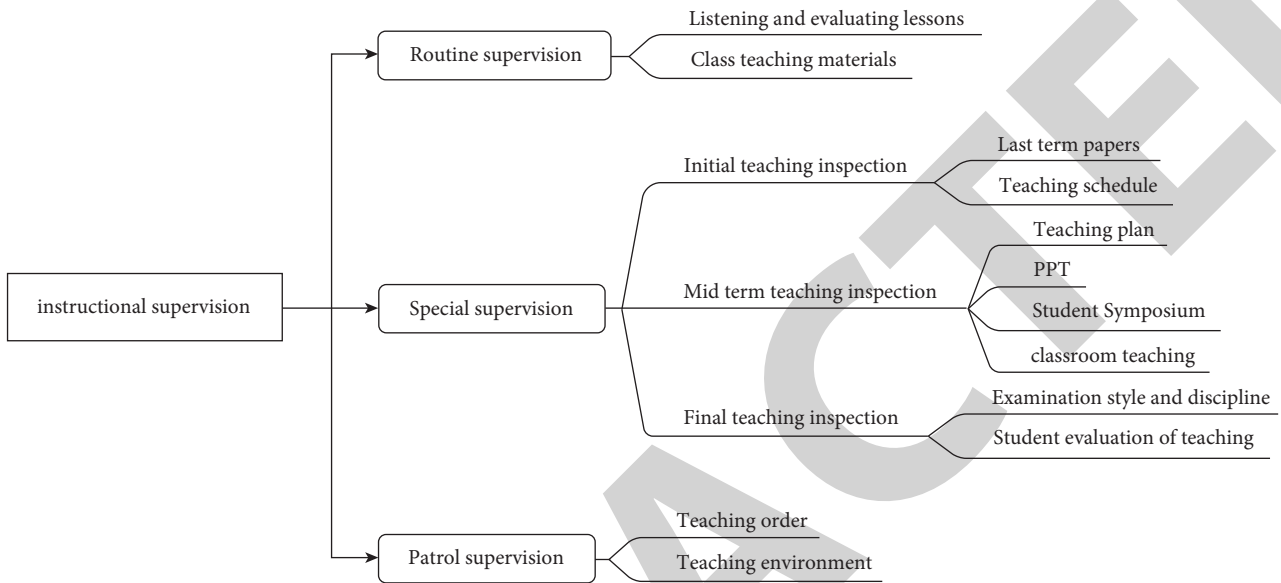


FIGURE 2: The triple stacked supervision approach.

supervision of the two poles of teaching evaluation, the Supervision Office formed two issues of special supervision briefs based on the experts’ opinions. The first issue is a summary of the experience and supervision of outstanding teachers. It affirmed some of the teachers from the perspective of “Golden Course Teachers,” raised the teaching behaviors of outstanding teachers to a theoretical level, described the qualities of “Golden Course Teachers,” sorted out the “Golden Course Teachers” teaching behaviors, and formed an influential teaching philosophy. The newsletter is published for all young and midcareer teachers to learn from and emulate. The other issue is a supervisory briefing for teachers who have fallen behind in their evaluations. Analyzing the problems and why teachers ranked low in their evaluations helped teachers clarify their educational philosophy, establish professional ideals, enhance their professional quality, strengthen their learning from theory, and train and grow in practice. They went deep into the classroom and into practice, offering valuable solutions and suggestions on many key hot issues and weak links in teaching [16].

**4.4. Implement a Triple Superimposed Supervision Method.** Educational teaching supervision is both a policy-oriented and artistic supervision, and its supervision methods determine the quality and effect of supervision. In order to improve the coverage of supervision and create an excellent quality control culture, the Supervision Office of Guangzhou College of Technology and Business has formed a new idea

in the way of supervision and innovated the way of supervision, as shown in Figure 2. It divides the traditional single supervision method into regular supervision, special supervision, and inspection supervision, realizing a triple overlay of supervision methods and receiving a good effect of comprehensive quality monitoring. Routine supervision refers to the supervision method that the Supervision Office follows up the quality of classroom teaching according to the supervision regulations of the college, and its behavior is regular, comprehensive, and universal, which is customary behavior. It mainly solves the general problems of teaching quality monitoring. The early teaching inspection focuses on the guarantee of teaching conditions, preparation for teaching, and implementation and execution of teaching tasks in each teaching unit. Midterm teaching inspection focuses on teaching and research activities, lecture listening, lesson plans, student evaluation, teaching operation, and practical teaching development in each teaching unit. The final teaching inspection focuses on teaching tasks, tutorials, Q&A, examinations, examination style, discipline, and so on. The period also includes regular and irregular inspections of classes and visits to classes by school leaders, teaching management departments, and student management departments to understand the teaching operation [17]. Special supervision refers to the special supervision carried out by the Supervision Office according to the current situation of the college’s development, by understanding the problems that exist in a certain aspect of education and teaching or the experience that needs to be promoted and summarised and promoted. It conducts an in-

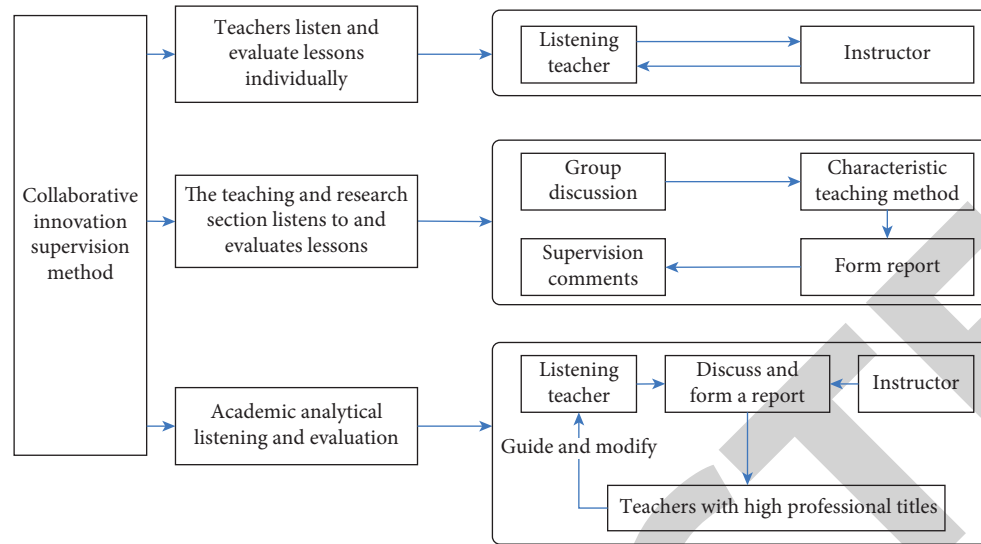


FIGURE 3: Collaborative and innovative approach to supervision.

depth and systematic understanding and deep-seated dissection of a prominent problem or highlight in teaching and learning and proposes targeted guidance through collective research and diagnosis [18]. It has the nature of timeliness, specialization, and uniqueness and is special supervision to guide the management and development of education and teaching. Inspection supervision refers to the Supervision Office, according to the work needs, under the arrangement of the board of trustees and the leadership of the college, to carry out comprehensive, partial, and special problem of education and teaching work inspection. It has the nature of supervision and guidance and is a simpler way of supervision work, such as classroom teaching order inspection and campus nurturing environment inspection. It can simply understand a certain aspect of the college and provide timely and effective supervision feedback.

**4.5. Strengthen the Collaborative Innovation of Supervision Methods.** Collaborative innovation in supervision methods is a principle that has been adhered to by the Supervision Office of Guangzhou College of Technology and Business. The innovative supervision method is proposed according to the actual construction of teachers' teams in private colleges and universities. At present, there is a common phenomenon of two more and one less in the teaching team of private colleges and universities: more retired old teachers, more new graduate students, and fewer middle-aged teachers with teaching experience; such a teacher structure poses a challenge to improve the quality of classroom teaching. In order to improve the quality of classroom teaching, let new teachers stand firmly on the podium and stand well on the podium, let veteran teachers give full play to their enthusiasm, and let young and middle-aged teachers better accumulate teaching experience; to truly play the role of classroom teaching in the education of people in the university, the College Supervision Office has changed the traditional simple mode of listening to and evaluating

classes, as shown in Figure 3. It gives full play to the role of part-time supervisors and old professors to pass on, help, and lead and constantly innovates the methods of classroom teaching supervision, using "old to lead new," "new to promote new," "point to promote surface," and "excellent to promote teaching," receiving good results. In recent years, the Supervision Office has put forward three listening requirements for regular listening to lessons according to the relevance and effectiveness of part-time supervisors' listening to lessons. The first is understanding listening: listening to new teachers' lessons and external teachers' lessons to grasp the teaching dynamics of new teachers. The second is supportive listening: listening to the lessons of teachers who have been evaluated by previous students and giving precise help. The third is induction listening: listening to the lessons of new teachers so that young teachers can be competent for their posts and stand firmly on the podium. Three approaches were used in the implementation of the collaborative and innovative supervisory approach. The first is to innovate and extend the traditional form of listening and evaluating lessons by teachers on their own, in the form of a single, random lesson. For example, the PE Department has upgraded this work to include teaching and research in the same sport, with peers in the same sport communicating and evaluating the "professional competence" of their teachers in a two-way manner and judging the professional teaching ability of their peers in a realistic manner to achieve the goal of mutual learning and improvement. The second is to establish a collective work form of listening to and evaluating lessons with the teaching and research department as the main body; that is, the director of the teaching and research department takes the lead in organizing the teachers of the department to collectively listen to and evaluate the lessons of some or individual teachers with teaching characteristics. After the collective discussion and diagnosis, the teaching and research department director will designate a person to write the first draft of the collective listening report of not less than 2,000 words, which will be

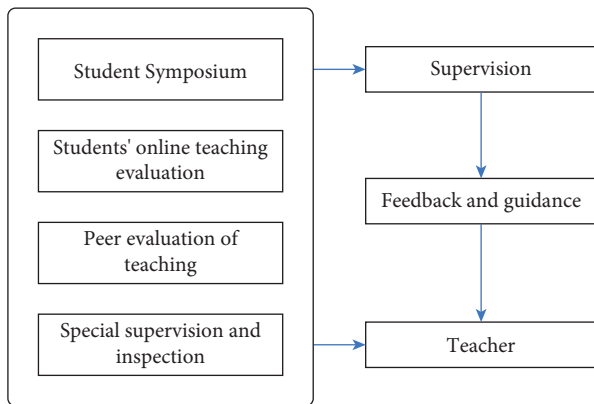


FIGURE 4: Functions of the information-based teaching supervision management platform.

submitted to the part-time supervisor for review and modification. Then, the final draft will be formed after repeated modifications through collective discussion. Through this way of collective listening and evaluation activities, it can strengthen the atmosphere of scientific research and teaching and research in the teaching and research department and at the same time form a natural habit of academic thought exchange through collective discussion, which truly reflects the supervisory purpose of collaborative innovation. The third is to improve the academic analysis of young teachers, mainly in the form of listening and evaluation work, that is, the teachers who perform supervisory work from time to time to select young teachers who do not have classes, together with random listening to a teacher's classroom teaching. After listening to a class, the participating teachers discuss it with each other. Finally, the part-time supervisor or a teacher with a higher title asks questions related to the course's knowledge system and methodological system and with certain academic significance. It requires the young teachers to refine the lecturer's "shining" points according to the actual situation of the lecture they have listened to and to make constructive suggestions in a debatable tone for the shortcomings. The young teachers who have listened to the lecture will write a lecture report of at least 1500 words under the guidance of a highly qualified teacher (or supervisor). The above-mentioned innovative ways of listening to and evaluating lectures improve the teaching standard of young teachers and cultivate their academic thinking, broaden their academic vision, and enhance their academic sensitivity.

**4.6. Establish an Information-Based Teaching Supervision and Management Platform.** In order to ensure that the evaluation of teachers' teaching is scientific, objective, fair, and comprehensive, comprehensive integration of teachers' evaluation information is needed, and an evening information-based teaching supervision and management platform must be established, as shown in Figure 4. In this platform, there can be both daily and regular evaluation channels. The daily evaluation mainly includes daily evaluation of teachers by informants, daily teaching inspections,

and listening to and evaluating lessons. Regular evaluation channels mainly include teaching information feedback, student evaluation symposiums, student online teaching evaluation, peer evaluation, and special teaching inspections [19]. Cloud inspection is implemented in the special supervision of special teaching materials to achieve high efficiency. All teaching materials are uploaded to the Xuexitong Cloud, and electronic versions of the materials are accessed. The preparation of teachers' teaching materials is discovered promptly through inspection, and those that are incomplete are promptly fed back into the system for rectification [20]. In this platform, the system will automatically generate a summary and aggregated evaluation of a particular teacher. Individual teachers will see all the evaluation results about themselves and will only be able to view the identity of the evaluator and not who the evaluator is. However, the results of all teachers' teaching evaluations are only available to individuals; for example, general supervisors can only see the evaluations of their peer supervisors, and school-level supervisors can see everyone's evaluations. Here, teachers' privacy can be ensured, while the information of teachers' teaching evaluation can be integrated and summarised, effectively ensuring the scientific, fair, and authoritative teaching supervision and evaluation results. At the same time, within the information management platform, there will also be a record of the supervisor's follow-up guidance to teachers so that the "guidance" to teachers can be traced and documented, thus ensuring the effectiveness of supervision. Therefore, teaching supervision departments should speed up the construction of information technology and develop an information-based teaching supervision management platform suitable for their own schools to escort the creation of a high-level applied university.

## 5. Conclusion

This paper expounds the significance of teaching supervision and describes the problems in the teaching of "Internet plus" supervision, as shown in Table 1. From 2017 to 2020, the number of types of resignation supervision has reached more than 30%. As shown in Table 2, in the 2019-2020 academic year, 25 part-time supervisors attend 2856 classes a year, with 32 teaching weeks a year, with an average of 114.24 class hours per supervisor per year. Therefore, it constructs the teaching supervision system of application-oriented undergraduate colleges and universities.

With the rapid development of "Internet +" and the application-oriented and efficient transformation, it is very necessary to build an effective teaching supervision system. The follow-up research will focus on the following aspects:

- (1) Establish an information-based teaching supervision and management platform to facilitate the development of supervision work.
- (2) The supervision mode of triple superposition is implemented in practice, and the work is clear.
- (3) Strengthen the subjective role of part-time supervision and coordinate the synchronization of part-time supervision in supervision and teaching.



## Retraction

# Retracted: A Study on Parents' Attitudes towards Middle School Students' Online Learning Based on Statistical Analysis

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.





The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] G. Chen, S. Zheng, J. He, and X. Wang, "A Study on Parents' Attitudes towards Middle School Students' Online Learning Based on Statistical Analysis," *Journal of Environmental and Public Health*, vol. 2022, Article ID 4848738, 17 pages, 2022.

## Research Article

# A Study on Parents' Attitudes towards Middle School Students' Online Learning Based on Statistical Analysis

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Based on the role separation scenario in which students need parental support, this paper explores the effect of parents' attitude on secondary school students' online learning. Through structural equation model analysis and regression analysis of 745 valid responses to a questionnaire, the data results show that parents' subjective dimension includes perceived gain and perceived loss, and social factor dimension includes teachers' influence and online comments. Perceived value is the key influencing factor of parents' attitude towards secondary school students in online learning platform. Perceived usefulness and platform information influence parents' attitude positively and significantly, while perceived risk influences parents' attitude negatively and significantly. In the dimension of social factors, teachers' influence positively influences parents' attitude, and online comments modulate the influence of perceived value on parents' attitude.

## 1. Introduction

Since COVID-19 broke out globally in 2020 and is expected to coexist with humans for some time to come, countries have started online learning. Online learning has gradually changed from the role of auxiliary teaching to the leading role of stage teaching and has received unprecedented attention and rapid development, so online learning has become the new normal in the learning of middle school students.

The research is focused on parents' attitudes towards students' use of online learning platforms. Most middle school students in China are teenagers aged between 12 and 18 with a certain subjective awareness of learning. As direct users of online learning platforms, they have their own feelings about the platform, and their choice of online learning platforms is more influenced by parents' attitudes. This leads to the separation of direct users (middle school students) and indirect users (parents). Although there are extensive researches on online learning platforms at present, the research on parents' attitudes

towards students' use of online learning is still in the blank stage, which makes this research of great significance.

## 2. Variables and Research Hypothesis

*2.1. Perceived Usefulness and Perceived Value: Parent Attitude.* In information systems and technology research, perceived usefulness has been broadly used as a key indicator for predicting technology reception. Keng-boon Ooi et al. reported that perceived usefulness, perceived ease of use, and belonging have an obvious direct effect on satisfaction, while satisfaction directly affected learners' website attachment and continuous use [1]. Chang et al. investigated the influencing factors of behavioral intention of e-learning for educational purposes among Azerbaijani college students, finding a strong beneficial impact of perceived usefulness on college students' attitude toward using e-learning [2]. Zhang who conducted a study on user selection factors of online Chinese education in Thailand found that perceived

usefulness does not leave any direct impact on respondents' willingness of the online learning Chinese in Russia but indirectly affects the perceived value, which is one of the highest path coefficients, suggesting the mediating effect of perceived value on perceived usefulness on adoption intention [3]. For online learning, perceived usefulness is an important direct factor influencing customer attitudes, or indirectly through perceived value. The effect of perceived usefulness on perceived value and parents' views is investigated in this paper using perceived usefulness as an antecedent variable for perceived value. This paper proposes the following hypotheses:

H1: Parents' perceived usefulness of e-learning platforms positively affects parents' attitudes.

H2: Parents' perceived usefulness of e-learning platforms positively affects parents' perceived value.

*2.2. Platform Information and Perceived Value: Attitudes of Middle School Students' Parents.* For users, information serves as a provider as well as a recommender. Information can serve as a provider of relevant product or service material to users, as well as a recommender to assist them in making decisions [4]. Customers can make better selections when purchasing online if they have access to a number of objective product information [5]. Yang et al. found that the online and offline information integration significantly promotes perceived profit. Correspondingly, perceived profit positively affects perceived value and indirectly influences usage attitudes through it when conducting the influence of physical experience and information integration on consumers' use of conventional commerce and e-commerce [6]. The platform information for students and parents provides an important basis for shaping consumers' perceived value and attitude while building an online learning platform. The platform information can not only provide students and parents with the information they need about the platform services and courses, but also assist parents to make decisions on whether to let students continue to use the online learning platform. The following hypotheses are thus proposed:

H3: The information of online learning platform positively affects the attitudes of parents of middle school students.

H4: The information of online learning positively affects the perceived value of parents of middle school students.

*2.3. Perceived Risk and Perceived Value: Parents' Attitudes of Middle School Students.* Uncertainty, loss, and lack of control for a product or service are all examples of perceived risk. Foreign studies have verified the repeated negative effect of perceived risk on mobile services' perceived value [7], mobile payment's perceived value [8], utilitarianism, and hedonic value in B2C e-commerce. Domestic studies have also reached similar conclusions. When Yan looked at the elements that influence college students' desire to accept

MOOCs, she discovered that perceived risk, as portion of perceived profit and loss, has a negative and significant effect on perceived value [9]. Jiang found that perceived risk negatively significantly affects perceived value and trust when conducting research on factors influencing mobile O<sub>2</sub>O application attitude [10]. There is a general consensus at home and abroad that perceived risk can have a marked negative effect on perceived value. Customers, on the other hand, tend to avoid risks in unclear situations, and parents of middle school students who use online learning platforms similarly tend to avoid risks when taking decision. Perceived risk causes a detrimental effect to product/service perceived value and attitude in general. This paper proposes the following hypotheses:

H5: Perceived risk negatively affects parents' perceived value for online learning platforms.

H6: Perceived risk negatively affects the attitudes of parents of middle school students for online learning platforms.

*2.4. Perceived Cost and Perceived Value: Attitudes of Middle School Students' Parents.* Perceived cost (also known as perceived price) is a key component influencing customer demand, user acceptance, and innovation implementation in many information systems, marketing, and economic models. Perceived cost generates an adverse effect on perceived value at the judgment stage under the monetary standpoint. Wang et al. examined the adoption of mobile hotel booking (MHR) from the value and found that perceived value was the predictor of customer adoption of MHR. In terms of perceived profit and loss, technical effort and perceived cost significantly affect perceived value [11]. Wang et al. investigated the determinants of mobile app users' behavioral intention based on the consumption value theory, and the results showed that consumption value greatly influenced the behavioral intention of consumers in using mobile applications. Among them, affective value and cognitive value have strong relationship with behavioral intention. Furthermore, by the mediating effect of other consumption values (functional value, social value, emotional value, and cognitive value), conditional value affects mobile app users' behavioral intention [12]. This paper proposes the following hypotheses:

H7: Perceived cost negatively affects parents' perceived value for online learning platforms.

H8: Perceived cost negatively affects parents' attitudes towards online learning platforms.

*2.5. Teachers' Influence and Perceived Value: Parents' Attitudes of Middle School Students.* New users have less product or service knowledge and no prior experience than existing users. As a result, new users are more likely to base their decisions on the evaluation and social recognition of reference groups. The research by Huang explores how social features and interaction affect users' online experience, supporting the usage of stimulus-organic-response (S-O-R)

models in social network sites. The study also demonstrates ways to integrate environmental features to enhance the online experience and purchase intention of users [13]. Cheung et al.'s study explores how members of virtual Internet platforms assess their knowledge sharing experiences and how such assessments affect their decision of continually sharing knowledge in online practice communities. It turns out that members are satisfied when they receive the reciprocity that they anticipate. Similarly, they will be delighted, and their knowledge self-efficacy can be strengthened if they discover that they can support other members according to their expectations [14]. Parents of middle school students seem to be more cautious in selecting and using digital training platforms for their children when they pay greater attention to their students' education. Teachers are the most important reference group, and parents will pay more attention to teachers' recognition and suggestions on online learning platforms. This paper suggests the following hypotheses based on existing research findings:

H9: The perceived value of online learning platforms from parents of middle school students was positively affected by teacher influence.

H10: The attitudes towards online learning platform from parents of middle school students were positively affected by teacher influence.

**2.6. Online Comments and Perceived Value: Parents' Attitudes of Middle School Students.** In this information-rich society, customers' decisions are often made in the context of the whole social environment. Online comments on products or services (which tend to be online information exchange between strangers) should be considered [15]. The perceived risks and uncertainties can be efficiently minimized through referring to online reviews [16]. Consumers believe that online reviews, whether positive or negative, offered by product or service suppliers are preferable to information provided by online reviews. These will be used as a key reference point in decision-making [17]. Studies have shown that customer behavior is influenced by online comments [18–20]. Customers can use online comment information as a source of real reference information to affect their decision-making behavior. As online learning platforms continually grow, the companies try to seek means to utilize online reviews to affect client attitudes, as well as altering their marketing tactics based on the results of online reviews. This paper proposes the following hypothesis:

H11: Online comments positively moderate perceived value and parents' attitudes on online learning platforms.

**2.7. Perceived Value and Parents' Attitudes of Middle School Students.** According to the empirical study with 222 young adult SMS users, Turel et al. found that perceived value was a critical multidimensional determinant for behavioral intention [21]. Yang and Jolly investigated how consumers' perceived value and subjective norms affected their use of mobile data services in the United States and South Korea.

The negative impacts of the four categories of customer perceived value were discovered to reflect distinct behavioral intents to utilize mobile data services in these two nations. Emotional value has the greatest impact on consumer use of mobile data services in both nations. Subjective norms are an important another factor of American consumers' attitude and behavioral intention for the use of mobile data services, while they are insignificant among Korean consumers [22]. Hong et al.'s study analyzed the influencing factors of persistence attitude of smart watches and found that persistence intention is directly influenced by hedonic value and utilitarian value of perceived value [23]. According to research, the perceived value of Internet items or services has a positive effect on behavioral intentions to use and acquire them. In essence, middle school students' learning behavior on online learning platforms is to gain an educational environment and learning services and relevant information from associated online products. This paper proposes the following hypothesis:

H12: Perceived value positively affects the attitudes of parents of middle school students towards online learning platforms.

To sum up, the authors put forward the research hypothesis of this paper after reasoning analysis, as shown in Table 1.

### 3. Research Model and Design

**3.1. Research Model.** Through sorting out the relation of variables included in the current studies, the attitude model for middle school students' parents under the perceived value theory is finally determined and formed. Perceived value theory is generally thought to be made up of two parts, perceived gains and perceived benefit, so the independent variables of perceived usefulness, platform information, perceived risk, and perceived cost are classified as variables affecting perceived gain in perceived value (perceived usefulness and platform information) and the variables that affect perceived loss (perceived risk and perceived cost). External situational variables include teachers' influence and adjustment of the variables in the independent variable network comments. Teachers' influence is closely related to the user of the key groups opinion on its attitude, while network review focuses on the new groups for the comments and opinions of products required for the influence of parents' attitude, combined with the perceived value model (VAM), to generate the theoretical model for the current research. Figure 1 exhibits the hypothesis relation and model.

**3.2. Measurement Scales.** For ensuring measurement scale reliability and validity, the variables to be measured are all used in the existing mature measurement scale in the existing literature, and appropriate adjustments are made according to the research purpose and research situation of this paper, so as to be used as a measurement tool for data collection. All questions related to the structure of the paper used a 5-point Likert scale, in which 1 represented "disagree"

TABLE 1: Research hypotheses.

SN	Hypothesis content
H1	Parents' perceived usefulness of e-learning platforms positively affects parents' attitudes.
H2	Parents' perceived usefulness of e-learning platforms positively affects parents' perceived value.
H3	The information of online learning platform positively affects the attitudes of parents of middle school students.
H4	The information of online learning positively affects the perceived value of parents of middle school students.
H5	Perceived risk negatively affects parents' perceived value for online learning platforms.
H6	Perceived risk negatively affects the attitudes of parents of middle school students for online learning platforms.
H7	Perceived cost negatively affects parents' perceived value for online learning platforms.
H8	Perceived cost negatively affects parents' attitudes towards online learning platforms.
H9	The perceived value of online learning platforms from parents of middle school students was positively affected by teacher influence.
H10	The attitudes towards online learning platform from parents of middle school students were positively affected by teacher influence.
H11	Online comments positively moderate perceived value and parents' attitudes on online learning platforms.
H12	Perceived value positively affects the attitudes of parents of middle school students towards online learning platforms.

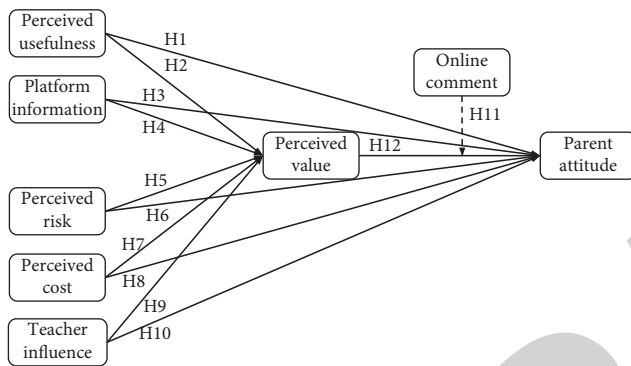


FIGURE 1: Model and hypothesis.

and 5 represented “agree.” Based on the relationship between variables studied, this paper divides them into independent variables, mediating variables, moderating variables, and dependent variables. The specific dimensions and measurement items are as follows.

### 3.2.1. Measurement of Independent Variables

#### ① Perceived usefulness

In the context of the current research, perceived usefulness means the extent to which parents of secondary school students perceive that the content of the curriculum matches the needs of their children. For measurement, a 5-point Likert scale was used, in which (1) represented “strongly disagree” and (5) represented “strongly agree.” Perceived usefulness is the independent variable of perceived gains, and the three questions are adapted from the scale of Davis [24], as seen in Table 2.

#### ② Platform information

In the current research, platform information refers to the detailed introduction of learning resources, course arrangement, teaching content, and other relevant information on the network by the online learning platform in order to attract users, enhance user experience and shape, and maintain high-quality user relationship. For measurement, a 5-point Likert scale was used, in which (1) represented “strongly

disagree” and (5) represented “strongly agree.” Platform information is the independent variable of perceived gain, and the three questions are adapted from the scale of Li [25], as shown in Table 3.

#### ③ Perceived risk

The perceived risk in this study refers to customers' awareness of the significance of the potential downside consequences of using the incorrect e-learning product and the probability of making the poor decision in an e-commerce setting. For measurement, a 5-point Likert scale was used, in which (1) represented “strongly disagree” and (5) represented “strongly agree.” Perceived risk is the independent variable of perceived profit and loss, and the three items are adapted from Zhao et al. [26], as shown in Table 4.

#### ④ Perceived cost

In this study, perceived cost refers to the cost perceived by middle school students to purchase learning equipment, pay Internet fees, or go to Internet cafes for learning on the online learning platform. A 5-point Likert scale is adopted for measurement, in which (1) represented “strongly disagree” and (5) represented “strongly agree.” Perceived cost is the independent variable of perceived profit and loss, and the four questions are adapted from Wang et al. [27], as shown in Table 5.

#### ⑤ Teacher influence

In this study, teacher influence refers to the influence of teachers in students' real schools on parents' attitudes towards students using online learning platforms. A 5-point Likert scale is adopted for measurement, in which (1) represented “strongly disagree” and (5) represented “strongly agree.” The four questions of teacher influence are adapted from Ashwin et al. [28], as shown in Table 6.

**3.2.2. Measurement of Dependent Variables.** As the dependent variable of this study, parent attitude refers to the stable psychological tendency of middle school students' parents towards the use of online learning platforms. In the design process of this study, parent attitudes towards online

TABLE 2: Measurement scale of perceived usefulness.

Latent variables	Item code	Questionnaire content design	Source
Perceived usefulness	PU1	Online learning platforms currently in use can improve children's learning results.	Davis [24]
	PU2	Online learning platforms are being used to meet the needs of children.	
	PU3	Online learning platforms are being used to solve children's learning puzzles.	

TABLE 3: Measurement scale of platform information.

Latent variables	Item code	Questionnaire content design	Source
Platform information	PI1	The online learning platform is rich in resources and can satisfy children's learning needs.	Li [25]
	PI2	The video quality of online learning platform is high and can satisfy children's learning needs.	
	PI3	The online learning platform is rich in information about courses, which is helpful for children to learn.	

TABLE 4: Measurement scale of perceived risk.

Latent variables	Item code	Questionnaire content design	Source
Perceived risk	PR1	Online learning platform course content does not match the description, and the quality of the course is not up to standard.	Zhao et al. [26]
	PR2	Children use online learning platform to learn courses, and the learning effect is not obvious.	
	PR3	Online learning platform related content offline services are not guaranteed.	

TABLE 5: Measurement scale of perceived cost.

Latent variables	Item code	Questionnaire content design	Source
Perceived cost	PC1	Online learning platforms require additional purchase of expensive learning equipment.	Wang et al. [27]
	PC2	Online learning platforms take children more time to get used to and be familiar with.	
	PC3	Online learning platforms have other hidden and additional fees.	
	PC4	Online learning platforms require parents to spend a lot of time and energy monitoring their children's learning process.	

TABLE 6: Measurement scale of teacher influence.

Latent variables	Item code	Questionnaire content design	Source
Teacher influence	TI1	The course content of the online learning platform currently in use is recognized by the school teachers.	Ashwin et al. [28]
	TI2	Teachers in the school recognize the curriculum design and teaching methods of the online learning platform.	
	TI3	School teachers support online learning after school.	
	TI4	School teachers see online learning as a useful complement to classroom learning.	

learning platforms are mainly influenced by independent variables directly and indirectly through perceived value. A 5-point Likert scale is adopted for measurement, in which (1) represented "strongly disagree" and (5) represented "strongly agree." Three items for parent attitudes are based on the version of Raghu et al. [29] and appropriately adjusted according to the context that is easy for parents to understand on the online learning platform, as shown in Table 7.

**3.2.3. Measurement of Intermediary Variables.** Perceived value is the mediating variable of this study. In this study,

perceived value is mainly determined by customers' perceived gain and rendition. Customers will comprehensively measure their perceived gains and losses and finally judge their perceived value. A 5-point Likert scale is adopted for measurement, in which (1) represented "strongly disagree" and (5) represented "strongly agree." Four items for perceived value (PV) are based on the version of Wang et al. [27] and adjusted and modified appropriately according to the context of online learning platform, as shown in Table 8.

**3.2.4. Measurement of Adjusting Variables.** Online comments are a moderating variable of this study. Different from

TABLE 7: Measurement scale of parents' use intention.

Latent variables	Item code	Questionnaire content design	Source
Parent attitude	PA1	I am willing to spend more money to choose and use effective online learning platforms.	Raghu et al. [29]
	PA2	I want to take more time to help children choose and use online learning platforms.	
	PA3	I will create a good learning environment and support children to use the online learning platform.	

TABLE 8: Measurement scale of perceived value.

Latent variables	Item code	Questionnaire content design	Source
Perceived value	PV1	Children learn better when they use online learning platforms.	Wang et al. [27]
	PV2	Online learning platforms provide targeted services for children.	
	PV3	Using online learning platforms, children can learn key knowledge more efficiently.	
	PV4	Online learning platform helps children to quickly find the right learning content.	

TABLE 9: Measurement scale of online comments.

Latent variables	Item code	Questionnaire content design	Source
Online comment	OC1	When choosing an online learning platform, I refer to other people's comments.	Zhao et al. [26]
	OC2	I prefer to let kids use online learning platforms with good reviews on content.	
	OC3	I prefer to use an online learning platform with a famous teacher.	
	OC4	Negative comments will affect my choice and use of online learning platforms.	

the way of information transmission in the real society under the influence of teachers, online comments achieve the transmission of information through online comments and then influence the decision-making behavior of customers. As network comments in external situation factors, 5-point Likert scale is applied in measurement, and the anchoring range ranges from "strongly disagree" (1) to "strongly agree" (5). Four items are based on the version of Zhao et al. [26] and adjusted and modified appropriately according to the context that parents of online learning platform could easily understand, as shown in Table 9.

#### 4. Questionnaire Delivery and Data Collection

**4.1. Distributing and Collecting Questionnaires.** The questionnaire consisted of two main parts: basic information and the structure of the paper research. The former looks at the respondents' gender, age, education level, and economic status, while the second focuses on parents' sentiments toward online learning platform aspects.

The online survey platform (Wenjuanxing) distributed 900 questionnaires, and 792 were collected. After processing the sample data, 745 appropriate data samples for empirical analysis were found. The questionnaire recovery rate was 88 percent, while the effective rate was 94 percent. The following criteria were used to determine whether a questionnaire was invalid: too many items have been missed; all the answers are the same; there are obvious contradictory reactions before and after the questions.

**4.2. Sample Description.** Sample population statistics are shown in Table 10, in which the male to female ratio is roughly 1:3, 191 men (25.6%) and 554 women (74.4%),

which mirrors the fact that the education of children in China is mostly undertaken by mothers. The analysis shows that there is no significant difference between the families where mothers undertake the children's education and those where fathers undertake it, which does not affect the study. In order to improve the coverage rate of samples, this study deliberately selected some counties and towns schools for investigation. Most middle school students' parents have junior high school (49.5%) or junior college/bachelor's diploma (32.6%) (32.6%), aged 36–45 years old, accounting for 73.1%, and over half of the families earn less than 5,000 yuan each month. Through the analysis of the questionnaire, it is concluded that no marked difference among students' parents in rural and urban schools in their investment in their children's learning is found, and no marked difference between students' parents with higher and lower education is found. The survey also found some low-income families, whose investment in children's learning is "huge," and there is no significant difference with high-income families. The sample was adequate for this study given the ratio of sample size to items [30].

Descriptive statistics were analyzed for the measurement items in this study. Table 11 presents the results. Table 11 covers the maximum, minimum, mean, and standard deviation for all items in the eight variables of perceived usefulness, platform information, perceived risk, perceived cost, online comments, teacher influence, perceived value, and parent attitude, as well as skewness coefficient and kurtosis coefficient describing data distribution state. From the skewness coefficient, it is found that the parameters are generally negative, and the data generally show a trend of left skewness. It can be seen from the kurtosis coefficient that the kurtosis coefficient is generally below 0, indicating the entire data distribution is relatively average in comparison with

TABLE 10: Demographic data.

Population profile	Category	Frequency number	Frequency	Cumulative percentage (%)
Gender	Male	191	25.6	25.6
	Female	554	74.4	100.0
Education level	Master or above	14	1.9	1.9
	Junior college/undergraduate	243	32.6	34.5
	Senior middle school	119	16.0	50.5
	Junior middle school	369	49.5	100.0
Age range	30–35	52	7.0	7.0
	36–40	238	31.9	38.9
	41–45	255	34.2	73.2
	46–50	135	18.1	91.3
	Others	65	8.7	100.0
Monthly income level	8000 above	63	8.5	8.5
	6500–8000	41	5.5	14.0
	5000–6500	88	11.8	25.8
	3500–5000	208	27.9	53.7
	2000–3500	345	46.3	100.0

TABLE 11: Descriptive statistics of items.

	N	Min	Max	Mean	SD	Skewness	SE	Kurtosis	SE
	Statistics	Statistics	Statistics	Statistics	Statistics	Statistics		Statistics	
PU1	745	1.000	5.000	3.790	1.158	-0.683	0.090	-0.198	0.179
PU2	745	1.000	5.000	3.880	1.147	-0.785	0.090	-0.076	0.179
PU3	745	1.000	5.000	3.740	1.154	-0.613	0.090	-0.250	0.179
PI1	745	1.000	5.000	3.690	1.121	-0.489	0.090	-0.309	0.179
PI2	745	1.000	5.000	3.730	1.145	-0.488	0.090	-0.511	0.179
PI3	745	1.000	5.000	3.850	1.097	-0.625	0.090	-0.247	0.179
PR1	745	1.000	5.000	2.650	1.384	0.294	0.090	-1.114	0.179
PR2	745	1.000	5.000	2.910	1.304	0.100	0.090	-0.983	0.179
PR3	745	1.000	5.000	2.980	1.426	-0.004	0.090	-1.267	0.179
PC1	745	1.000	5.000	3.830	1.206	-0.782	0.090	-0.261	0.179
PC2	745	1.000	5.000	4.100	1.128	-1.090	0.090	0.366	0.179
PC3	745	1.000	5.000	3.590	1.276	-0.532	0.090	-0.671	0.179
PC4	745	1.000	5.000	3.820	1.159	-0.656	0.090	-0.360	0.179
TI1	745	1.000	5.000	3.570	1.185	-0.438	0.090	-0.458	0.179
TI2	745	1.000	5.000	3.750	1.151	-0.602	0.090	-0.363	0.179
TI3	745	1.000	5.000	3.380	1.217	-0.252	0.090	-0.645	0.179
TI4	745	1.000	5.000	3.780	1.161	-0.673	0.090	-0.243	0.179
PV1	745	1.000	5.000	3.370	1.081	-0.117	0.090	-0.245	0.179
PV2	745	1.000	5.000	3.520	1.111	-0.262	0.090	-0.428	0.179
PV3	745	1.000	5.000	3.570	1.121	-0.296	0.090	-0.485	0.179
PV4	745	1.000	5.000	3.590	1.114	-0.327	0.090	-0.424	0.179
OC1	745	1.000	5.000	3.580	1.231	-0.458	0.090	-0.628	0.179
OC2	745	1.000	5.000	3.470	1.234	-0.362	0.090	-0.671	0.179
OC3	745	1.000	5.000	3.490	1.212	-0.397	0.090	-0.541	0.179
OC4	745	1.000	5.000	3.740	1.158	-0.613	0.090	-0.267	0.179
PA1	745	1.000	5.000	3.800	1.125	-0.654	0.090	-0.194	0.179
PA2	745	1.000	5.000	3.880	1.116	-0.717	0.090	-0.143	0.179
PA3	745	1.000	5.000	3.830	1.138	-0.730	0.090	-0.092	0.179

normal distribution and has a flat peak. Thus, it can be said that the data in this study do not conform to the standard multivariate normal distribution.

**4.3. Data Analysis Methods.** According to the research purpose, research content, research object, theoretical model, research hypothesis, and sample data, the authors

adopt the following three empirical research data analysis methods.

**4.3.1. Descriptive Statistical Analysis.** Descriptive statistical analysis aims to analyze and explain the overall characteristics of the data samples, so as to have a more accurate and detailed understanding of the overall characteristics of the



samples and data, such as gender, education level, age range, and monthly income level in respondents. At the same time, this method also comprehensively describes the basic characteristics and distribution of sample data, such as the frequency number, frequency, and cumulative percentage of variables or attributes in the sample, and forms a preliminary judgment before in-depth analysis of the data. Data analysis software SPSS Statistics 22.0 was used in this study.

**4.3.2. Reliability and Validity Analysis.** Reliability and validity analysis shows the authenticity and accuracy of sample data used to measure the study variables. Reliability analysis is mainly concerned with measuring the stability of the measurement target structure, that is, if repeated measurements under similar conditions can produce reliable and stable measurement findings. Reliability is defined as the extent to which a measurement tool is free from the influence of random errors. Validity is mainly to determine whether the scale can really measure constructs [31], which mainly refers to the accuracy of measurement. High reliability means small random error, while high efficiency means small random error and systematic error. Reliability is a necessary condition for validity. If a measurement value is unreliable, it cannot be valid. However, reliability is not an adequate qualification for validity, because even if the random error is zero, there may still be systematic error. Therefore, although the measured value has good consistency and stability, it may still deviate from the true value. AMOS 24.0 and SPSS 22.0 are used for confirmatory factor analysis to calculate the standardized factor load, item reliability, component reliability, convergence validity, and discriminant validity of each variable scale to ensure that the scale measured the research construct. The specific results are detailed in the latter part of this chapter.

**4.3.3. Structural Equation Model.** Structural equation model (SEM) has obtained wide application in management research. This method is a combination of regression analysis, factor analysis, and path analysis and other statistical analysis methods, through statistical analysis, to test and explain the causality of research variables, and a measurement model is established. And the latent variable is measured with the help of a structured way, with the help of a structural model of the theory of structural relations of latent variables to construct. The complicated relation among numerous variables and multiple measurement errors can be processed and analyzed simultaneously. In conclusion, this study uses SPSS 22.0 AMOS 24.0 software to investigate the structural equation model. When estimating the structural equation model, the structural equation model's correctness was verified by the model fit.

**4.3.4. Mediating Effect.** In this study, the direct effect, indirect effect, and total effect of the path are deeply analyzed when the mediation effect of variables is tested. Bootstrapping method is employed for exploring the mediation

effect of variables. In general, the most widely used approach is the Casual Steps Approach proposed by Baron and Kenny in 1986, which requires researchers to estimate each path in a model and determine whether variables act as mediators based on statistical criteria [32]. Although this method is relatively simple and widely understood, it has been severely criticized by scholars in many aspects [33, 34]. Another mediation analysis method commonly used at present is Sobel Test [35]. A fatal flaw in Sobel test lies in its assumption for the normal sampling distribution of indirect effects, whereas AB sampling distribution is asymmetric. The Sobel Test method, while being useful, is often used as a complement to Baron and Kenny rather than a replacement. Therefore, Bootstrapping is a more reasonable research method to study the mediation effect in this paper. At present, Bootstrapping has been implemented in some SEM software, such as Mplus, AMOS, and EQS. Studies show that Bootstrapping is better than Sobel test and causal step method to predict the mediating relationship between variables [36].

#### 4.4. Data Analysis and Hypothesis Testing

##### 4.4.1. Exploratory Factor Analysis

**(1) Exploratory Factor Analysis of Perceived Usefulness.** According to Table 12, the KMO value for exploratory factor analysis sample used for perceived usefulness is 0.726, greater than the minimum standard value of 0.5. The chi-square value in Bartlett's spherical test is 1796.925, with a degree of freedom of 3, and has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with an eigenvalue of  $2.581 > 1$  was obtained. The factor loading values of item PU1, PU2, and PU3 were 0.947, 0.887, and 0.947, respectively, which exceeded the minimum standard value of 0.5, and accounted for 86.03% of the variance variation, which was greater than 50% of the minimum standard value. Therefore, the factor structure of the perceived usefulness variable can be judged to be consistent with the preset structure.

**(2) Exploratory Factor Analysis of Platform Information.** According to Table 13, the KMO value for exploratory factor analysis sample used for platform information is 0.671, above the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 1054.302, with a degree of freedom of 3, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with an eigenvalue of  $2.268 > 1$  was obtained. The factor loading values of PI1, PI2, and PI3 were 0.782, 0.908, and 0.912, respectively, above the minimum standard value of 0.5, explaining 75.61% of the variance variation and greater than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of the platform information variable is consistent with the preset structure.

TABLE 12: Results of exploratory factor analysis of perceived usefulness.

Item code	Perceived usefulness
PU1	0.947
PU2	0.887
PU3	0.947
Eigenvalue	2.581
Cumulative variation interpretation	86.03%
KMO value = 0.726	
Bartlett's spherical test chi-square value = 1796.925	
DOF = 3	
(Sig.) $p = 0.000$	

TABLE 13: Results of exploratory factor analysis of platform information.

Item code	Platform information
PI1	0.782
PI2	0.908
PI3	0.912
Eigenvalue	2.268
Cumulative variation interpretation	75.61%
KMO value = 0.671	
Bartlett's spherical test chi-square value = 1054.302	
DOF = 3	
(Sig.) $p = 0.000$	

TABLE 14: Results of exploratory factor analysis of perceived risk.

Item code	Perceived risk
PR1	0.831
PR2	0.834
PR3	0.864
Eigenvalue	2.134 (%)
Cumulative variation interpretation	71.12
KMO value = 0.705	
Bartlett's spherical test chi-square value = 686.901	
DOF = 3	
(Sig.) $p = 0.000$	

(3) *Exploratory Factor Analysis of Perceived Risk.* According to Table 14, the KMO value for exploratory factor analysis sample used for perceived risk is 0.705, greater than the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 686.901, with a degree of freedom of 3, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with characteristic value of  $2.134 > 1$  was obtained. The factor loading values of PR1, PR2, and PR3 were 0.831, 0.834, and 0.864, respectively, which exceeded the minimum standard value of 0.5, and accounted for 71.12% of the variance variation and more than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of perceived risk variable is consistent with the preset structure.

TABLE 15: Results of exploratory factor analysis of perceived cost.

Item code	Perceived cost
PC1	0.827
PC2	0.768
PC3	0.767
PC4	0.822
Eigenvalue	2.537 (%)
Cumulative variation interpretation	63.43
KMO value = 0.743	
Bartlett's spherical test chi-square value = 1012.681	
DOF = 6	
(Sig.) $p = 0.000$	

(4) *Exploratory Factor Analysis of Perceived Cost.* According to Table 15, the KMO value for exploratory factor analysis sample used for perceived cost is 0.743, exceeding the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 1012.681, with a degree of freedom of 6, and has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with characteristic value of  $2.537 > 1$  was obtained. The factor loading values of PC1, PC2, PC3, and PC4 were 0.827, 0.768, 0.767, and 0.822, respectively, which exceeded the minimum standard value of 0.5, explaining 63.43% of the variance variation and greater than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of the perceived cost variable is consistent with the preset structure.

(5) *Exploratory Factor Analysis of Teacher Influence.* According to Table 16, the KMO value for exploratory factor analysis sample used for teacher influence is 0.804, exceeding the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 1340.387, with a degree of freedom of 6, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with characteristic value of  $2.809 > 1$  was obtained. The factor loading values of TI1, TI2, TI3, and TI4 were 0.870, 0.809, 0.834, and 0.838, respectively, which exceeded the minimum standard value of 0.5, and accounted for 70.21% of the variance variation and more than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of teacher influence variable is consistent with the preset structure.

(6) *Exploratory Factor Analysis of Network Comments.* According to Table 17, the KMO value for exploratory factor analysis sample used for online reviews is 0.743, exceeding the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 951.353, with a degree of freedom of 6, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with characteristic value of  $2.509 > 1$  was obtained. The factor loading values of OC1, OC2, OC3, and OC4 were 0.774, 0.825, 0.829, and 0.736, respectively, which exceeded the

TABLE 16: Results of exploratory factor analysis of teacher influence.

Item code	Teacher influence
TI1	0.870
TI2	0.809
TI3	0.834
TI4	0.838
Eigenvalue	2.809
Cumulative variation interpretation	70.21%
KMO value = 0.804	
Bartlett's spherical test chi-square value = 1340.387	
DOF = 6	
(Sig.) $p = 0.000$	

TABLE 17: Results of exploratory factor analysis of online comments.

Item code	Online comment
OC1	0.774
OC2	0.825
OC3	0.829
OC4	0.736
Eigenvalue	2.509
Cumulative variation interpretation	62.72%
KMO value = 0.743	
Bartlett's spherical test chi-square value = 951.353	
DOF = 6	
(Sig.) $p = 0.000$	

minimum standard value of 0.5, explaining 62.72% of the variance variation and greater than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of the network comment variable is consistent with the preset structure.

(7) *Exploratory Factor Analysis of Perceived Value.* According to Table 18, the KMO value for exploratory factor analysis sample used for perceived value is 0.808, greater than the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 2119.720, with a degree of freedom of 6, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with a characteristic value of 3.154 > 1 was obtained. The factor loading values of item PV1, PV2, PV3, and PV4 were 0.863, 0.884, 0.905, and 0.899, respectively, which exceeded the minimum standard value of 0.5, and accounted for 78.85% of the total variance variation, which was greater than 50% of the minimum standard value. Therefore, it can be judged that the factor structure of the perceived value variable is consistent with the preset structure.

(8) *Exploratory Factor Analysis of Parents' Attitude.* According to Table 19, the KMO value for exploratory factor analysis sample used for parents' attitudes is 0.756, greater than the minimum standard value of 0.5. The chi-square value of Bartlett's spherical test is 1559.966, with a degree of

TABLE 18: Results of exploratory factor analysis of perceived value.

Item code	Perceived value
PV1	0.863
PV2	0.884
PV3	0.905
PV4	0.899
Eigenvalue	3.154
Cumulative variation interpretation	78.85%
KMO value = 0.808	
Bartlett's spherical test chi-square value = 2119.720	
DOF = 6	
(Sig.) $p = 0.000$	

TABLE 19: Results of exploratory factor analysis of parents' use intention.

Item code	Parent attitude
PA1	0.922
PA2	0.934
PA3	0.914
Eigenvalue	2.559
Cumulative variation interpretation	85.31%
KMO Value = 0.756	
Bartlett's spherical test chi-square Value = 1559.966	
DOF = 3	
(Sig.) $p = 0.000$	

freedom of 3, and it has passed the significance test, indicating good data quality and suitable for exploratory factor analysis. Through exploratory analysis, a factor structure with a characteristic value of 2.559 > 1 was obtained. The factor loading values of item PA1, PA2, and PA3 were 0.922, 0.934, and 0.914, respectively, which exceeded the minimum standard value of 0.5, and accounted for 85.31% of the variance variation, which was higher than 50% of the minimum standard value. Therefore, it can be determined that the factor structure of parental attitude variable is consistent with the preset structure.

4.4.2. *Model Testing.* To examine the link between putative observed variables and putative potential variables, confirmatory factor analysis (CFA) is performed under the measurement model using AMOS24.0 and SPSS 22.0. Platform information, perceived usefulness, perceived risk, perceived cost, teacher influence, perceived value, online comments, and parent attitudes were all subjected to CFA analysis. Tables 20 and 21 summarize the findings. The standardized factor loadings of all eight dimensions are above 0.6 and signed, and the question reliability is above 0.36. The 8 dimensions' constituent reliability is more than 0.7, showing high internal consistency. The convergence validity (mean variance extraction amount) exceeding 0.5 proved the favorable convergence effect. The research results meet the criteria of factor load higher than 0.5, composition reliability higher than 0.6, and convergence validity higher

TABLE 20: Confirmatory factor analysis results.

Dimensionality	Title	Parameter significance estimation				Standardized factor load Std.	Title reliability SMC	Composite reliability CR
		Unstd.	S.E.	<i>t</i> -value	<i>p</i>			
PU	PU1	1.000				0.942	0.887	0.921
	PU2	0.826	0.028	29.718	***	0.785	0.616	
	PU3	0.998	0.023	42.638	***	0.943	0.889	
PI	PI1	1.000				0.610	0.372	0.849
	PI2	1.484	0.085	17.559	***	0.887	0.787	
	PI3	1.446	0.083	17.456	***	0.902	0.814	
PR	PR1	1.000				0.720	0.518	0.798
	PR2	0.951	0.058	16.426	***	0.726	0.527	
	PR3	1.164	0.071	16.507	***	0.814	0.663	
PC	PC1	1.000				0.766	0.587	0.809
	PC2	0.833	0.050	16.501	***	0.682	0.465	
	PC3	0.927	0.057	16.264	***	0.670	0.449	
	PC4	0.939	0.053	17.677	***	0.748	0.560	
TI	TI1	1.000				0.835	0.697	0.859
	TI2	0.854	0.041	20.813	***	0.734	0.539	
	TI3	0.945	0.043	21.914	***	0.769	0.591	
	TI4	0.901	0.041	21.909	***	0.768	0.590	
PV	PV1	1.000				0.775	0.601	0.910
	PV2	1.072	0.046	23.533	***	0.808	0.653	
	PV3	1.208	0.045	26.785	***	0.902	0.814	
	PV4	1.189	0.045	26.522	***	0.893	0.797	
PA	PA1	1.000				0.879	0.773	0.914
	PA2	1.031	0.031	33.263	***	0.913	0.834	
	PA3	0.987	0.032	30.765	***	0.857	0.734	
OC	OC1	1.000				0.663	0.440	0.803
	OC2	1.185	0.072	16.395	***	0.783	0.613	
	OC3	1.159	0.071	16.372	***	0.780	0.608	
	OC4	0.862	0.063	13.745	***	0.607	0.368	

Note: (1) PU = perceived usefulness; PI = platform information; PR = perceived risk; PC = perceived cost; TI = teacher influence; PV = perceived value; PA = parent attitude; OC = online comment; Unstd. = nonstandardized factor load; S.E. = standard error; *t*-value = *t* value; NA = not available (regression coefficient fixed at 1.0); Std. = standardized factor load; SMC = topic reliability; CR = constituent reliability. (2) \*\*\* means  $P < 0.001$ ;  $N = 745$ .

TABLE 21: Validity evaluation of discriminant validity.

Dimension	Convergent validity			Discriminant validity					
	AVE	PU	PI	PR	PC	TI	OC	PV	PA
PU	0.860	<b>0.927</b>							
PI	0.756	0.694	<b>0.869</b>						
PR	0.711	-0.311	-0.289	<b>0.843</b>					
PC	0.635	0.144	0.143	0.140	<b>0.797</b>				
TI	0.702	0.722	0.708	-0.321	0.210	<b>0.838</b>			
OC	0.627	0.750	0.683	-0.319	0.271	0.843	<b>0.792</b>		
PV	0.788	0.722	0.787	-0.376	0.091	0.738	0.720	<b>0.888</b>	
PA	0.852	0.838	0.725	-0.351	0.227	0.768	0.761	0.767	<b>0.923</b>

Note: (1) PU = perceived usefulness; PI = platform information; PR = perceived risk; PC = perceived cost; TI = teacher influence; OC = online comments; PV = perceived value; PA = parental attitude; AVE = convergence validity. (2) The diagonal elements in the matrix are AVE square root values, and the nondiagonal elements represent the correlation of related dimensions.

than 0.5 proposed by Fornell and Larcker [37] and Hair et al. [38]. By analyzing the association between the AVE square root value and other dimensions, the discriminant validity is verified. In this study, eight variables, including independent variable, intermediary variable, moderating variable, and dependent variable, are studied for discriminant validity. Table 21 shows the results. Except for the AVE square root value of

teacher influence, which is relatively lower than the correlation coefficient with network comments, all other AVE square root values in the matrix are higher than the correlation coefficient between the AVE square root value and associated dimensions. As THE AVE method is a relatively rigorous method for determining discriminant validity, generally speaking, the results of discriminant validity are acceptable.

TABLE 22: Modified model fitting index.

Amount of inspection	Absolute fitness index				Value added fit index				
	$\chi^2/df$	GFI	AGFI	RMSEA	NFI	RFI	IFI	TLI	CFI
Good standard	<3	>0.9	>0.9	<0.08	>0.9	>0.9	>0.9	>0.9	>0.9
Model	1.44	0.97	0.97	0.02	0.97	0.97	0.99	0.99	0.99

Note: this is the fitting degree of bootstrap model for 2000 times.

TABLE 23: Hypothesis test.

Hypothesis	Standardized path coefficient	Nonstandardized path coefficient	S.E.	<i>t</i> -value	<i>P</i>	Result
Hypothesis 1: PU→PA	0.687	0.468	0.026	18.301	***	True
Hypothesis 2: PU→PV	0.406	0.239	0.020	12.132	***	True
Hypothesis 3: PI→PA	0.106	0.079	0.026	3.050	**	True
Hypothesis 4: PI→PV	0.458	0.297	0.023	12.689	***	True
Hypothesis 5: PR→PV	-0.153	-0.084	0.018	-4.688	***	True
Hypothesis 6: PR→PA	-0.088	-0.056	0.018	-3.217	**	True
Hypothesis 7: PC→PV	-0.051	-0.038	0.024	-1.630	0.103	False
Hypothesis 8: PC→PA	0.161	0.139	0.023	5.936	***	False
Hypothesis 9: TI→PV	0.481	0.327	0.026	12.397	***	True
Hypothesis 10: TI→PA	0.279	0.220	0.030	7.384	***	True
Hypothesis 12: PV→PA	0.191	0.221	0.058	3.811	***	True

Note: (1) PU = perceived usefulness; PI = platform information; PR = perceived risk; PC = perceived cost; TI = teacher influence; PV = perceived value; PA = parent attitude. (2) \*\*\* means  $P < 0.001$ ; \*\* means  $P < 0.01$ ; \* means  $P < 0.05$ .

The constructed model is measured by two types of fitting indexes: absolute fit index and value-added fit index.  $\chi^2/DF$ , GFI, AGFI, and RMSEA are all part of the absolute fitness index. The value-added fitness indexes are NFI, RFI, IFI, TLI, and CFI. It is impossible for data in SEM analysis to correspond to a multivariate normal distribution [39], while nonmultivariate normal is easy to cause  $\chi^2$  inflation. Therefore, Bollen-Stine Bootstrap *p* procedure is used in this paper to compensate for the lack of multivariate normality, and the model fitting and parameter estimation must be adjusted [40, 41]. After modification, the findings are presented in in Table 22, and the absolute fitness index and value-added fitness index basically present a good situation.

**4.4.3. Impact Path Test.** As shown in Table 23 and Figure 2, perceived usefulness significantly positively affects parent attitudes (PU→PA:  $\beta = 0.687$ ,  $t = 18.301$ ,  $P < 0.001$ ), supporting Hypothesis 1. Perceived usefulness positively significantly affects perceived value (PU→PV:  $\beta = 0.406$ ,  $t = 12.132$ ,  $P < 0.001$ ). Hypothesis 2 is true. Platform information positively affected parent attitude (PI→PA:  $\beta = 0.106$ ,  $t = 3.050$ ,  $P < 0.01$ ). Hypothesis 3 is true. Platform information significantly positively affects perceived value (PI→PV:  $\beta = 0.458$ ,  $T = 12.689$ ,  $P < 0.001$ ), and hypothesis 4 is true. Hypotheses 1–4 indicate that the perceived usefulness and platform information as perceived benefits have a favorable effect on perceived value and parent attitudes. Perceived risk has a significant negative effect on perceived value (PR→PV:  $\beta = -0.153$ ,  $t = -4.688$ ,  $P < 0.001$ ). Hypothesis 5 is true. Perceived risk significantly negatively affects parent attitudes (PR→PA:  $\beta = -0.088$ ,  $t = -3.217$ ,  $P < 0.01$ ). Hypothesis 6 is true. Perceived cost has no significant negative influence on perceived value (PC→PV:  $\beta = -0.051$ ,  $t = -1.630$ ,  $P = 0.103 > 0.05$ ), and hypothesis 7 is not true. Perceived cost significantly positively affects parents' attitudes (PC→PA:  $\beta = 0.161$ ,  $t = 5.936$ ,  $P < 0.001$ ), contrary to hypothesis 8, which is not valid. Hypothesis 5 assumes that the establishment of the 6 shows the negative influence perceived risk as part of the benefit of perception value perception and attitude of parents, but assumptions 7 and 8 do not explain the perceived costs as part of the perceived benefit of not negative influence perceived value and attitude of parents, and perceived cost does not significantly affect online learning platform use. Teacher influence has a significant positive impact on perceived value (TI→PV:  $\beta = 0.481$ ,  $T = 12.397$ ,  $P < 0.001$ ). Hypothesis 9 is true. The influence of teachers significantly positively affects parents' attitudes (TI→PA:  $\beta = 0.279$ ,  $T = 7.384$ ,  $P < 0.001$ ). Hypothesis 10 is true. Teacher influence as a third party environmental factor of online learning platform influences the connection between parents of middle school students and online learning platforms. Perceived value significantly

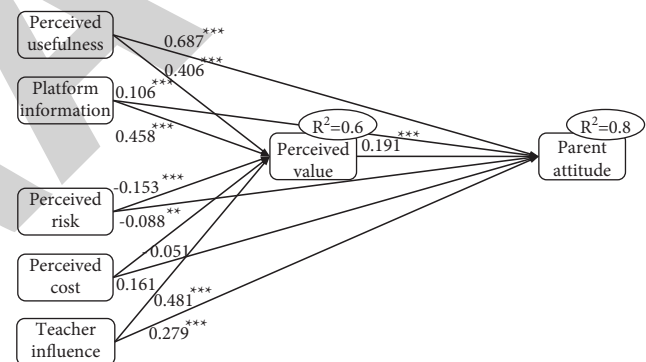


FIGURE 2: Hypothesis test results. Note: (1) \*\*\* means  $P < 0.001$ ; \*\* means  $P < 0.01$ ; \* means  $P < 0.05$ .

$\beta = -0.051$ ,  $t = -1.630$ ,  $P = 0.103 > 0.05$ ), and hypothesis 7 is not true. Perceived cost significantly positively affects parents' attitudes (PC→PA:  $\beta = 0.161$ ,  $t = 5.936$ ,  $P < 0.001$ ), contrary to hypothesis 8, which is not valid. Hypothesis 5 assumes that the establishment of the 6 shows the negative influence perceived risk as part of the benefit of perception value perception and attitude of parents, but assumptions 7 and 8 do not explain the perceived costs as part of the perceived benefit of not negative influence perceived value and attitude of parents, and perceived cost does not significantly affect online learning platform use. Teacher influence has a significant positive impact on perceived value (TI→PV:  $\beta = 0.481$ ,  $T = 12.397$ ,  $P < 0.001$ ). Hypothesis 9 is true. The influence of teachers significantly positively affects parents' attitudes (TI→PA:  $\beta = 0.279$ ,  $T = 7.384$ ,  $P < 0.001$ ). Hypothesis 10 is true. Teacher influence as a third party environmental factor of online learning platform influences the connection between parents of middle school students and online learning platforms. Perceived value significantly

TABLE 24: The mediating effect tests.

Variable	Point estimate	Product of coefficients		Bias-corrected		Percentile	
		S.E.	Z	Lower	Upper	Lower	Upper
PU->PV->PA	0.053	0.021	2.524	0.017	0.104	0.013	0.097
PU->PA	0.468	0.045	10.400	0.380	0.563	0.384	0.567
TOTAL EFFECT PU->PV->PA	0.521	0.044	11.841	0.430	0.606	0.433	0.608
PI->PV->PA	0.066	0.026	2.538	0.020	0.124	0.016	0.117
PI->PA	0.079	0.039	2.026	0.003	0.160	0.002	0.159
TOTAL EFFECT PI->PV->PA	0.145	0.033	4.394	0.083	0.218	0.078	0.210
PR->PV->PA	-0.019	0.009	-2.111	-0.043	-0.005	-0.040	-0.003
PR->PA	-0.056	0.024	-2.333	-0.104	-0.012	-0.101	-0.009
TOTAL EFFECT PR->PV->PA	-0.075	0.024	-3.125	-0.127	-0.029	-0.122	-0.024
TI->PV->PA	0.073	0.028	2.607	0.024	0.134	0.018	0.126
TI->PA	0.220	0.061	3.607	0.115	0.349	0.119	0.352
TOTAL EFFECT TI->PV->PA	0.292	0.055	5.309	0.196	0.406	0.197	0.409

Note: (1) PU = perceived usefulness; PI = platform information; PR = perceived risk; PC = perceived cost; TI = teacher influence; PV = perceived value; PA = parent attitude. (2) Unstandardized estimating of 2000 bootstrap sample.

positively affects parent attitude (PV → PA:  $\beta = 0.191$ ,  $t = 3.811$ ,  $P < 0.001$ ). Hypothesis 12 is supported.

$R^2$  is one of the main criteria used to evaluate the path of a structural model. This coefficient measures the model's predictive power and computes the variance of real and predicted values of a particular endogenous variable, which is the sum of the changes caused by all exogenous variables. Larger  $R^2$  indicates the model's stronger explanatory power. As shown in Figure 2, the  $R^2$  value of the endogenous variable of perceived value is 0.63, which is between 0.33 and 0.67, indicating that the model has a moderate degree of explanation. The  $R^2$  value of the endogenous variable of parents' attitude is 0.81 greater than 0.67, indicating that the model had a high degree of explanation.

**4.4.4. Mediating Effect Test.** In addition to testing the proposed hypothesis, this study tests the mediation effect of variables and conducts in-depth analysis of the direct effect, indirect effect, and total effect of the path. Bootstrapping method is employed for exploring variable mediation effect. In this study, AMOS24 software is used to resample 2000 times under 95% confidence interval for Bootstrapping analysis of variables [42].

The nonstandardized direct effect, indirect effect, and total effect are analyzed under the hypothetical model. Table 24 presents the findings. The model assumes that five independent variables, including perceived usefulness, platform information, perceived risk, perceived cost, and teacher influence, both directly affect parent attitudes and indirectly affect parent attitudes through perceived value. In the Perceived usefulness (PU) → Parent attitude (PA) path, as  $Z = 10.400$  is greater than threshold 1.96, and the range of bias-corrected and Percentile excludes 0, it can be seen that the direct effect of perceived usefulness (PU) → Parent attitude (PA) path exists. In the Perceived usefulness (PU) → perceived value (PV) → Parent attitude (PA) path, as  $Z = 2.524$  is greater than threshold 1.96, and the range of bias-corrected and Percentile excludes 0; therefore, the indirect effect of perceived usefulness (PU) →

perceived value (PV) → parent attitude (PA) exists. The total effect from perceived usefulness (PU) to parental attitude (PA) also exists ( $Z = 11.841 > 1.96$ , and the range of Bias-corrected and Percentile excludes 0). At this point, perceived value is a partial mediation between perceived usefulness (PU) and parental attitude (PA). In the Platform information (PI) → Parent attitude (PA) path, as  $Z = 2.026$  is greater than threshold 1.96, and the range of bias-corrected and Percentile excludes 0. The direct effect of platform information (PI) → parent attitude (PA) path exists. In the Platform information (PI) → perceived value (PV) → Parent attitude (PA) path, as  $Z = 2.538 > 1.96$ , and bias-corrected and Percentile ranges do not contain 0, it can be seen that the indirect effect of platform information (PI) → perceived value (PV) → parent attitude (PA) path exists. The total effect of platform information (PI) → parent attitude (PA) also exists ( $Z = 4.394 > 1.96$ , and bias-corrected and Percentile ranges do not contain 0). At this point, perceived value serves as a partial intermediary between platform information (PI) and parent attitude (PA).

In the Perceived risk (PR) → Parent attitude (PA) path, as the absolute value of  $Z = -2.333$  is greater than threshold 1.96, the range of bias-corrected and Percentile excludes 0. The direct effect of perceived risk (PR) → parent attitude (PA) path exists. In the Perceived risk (PR) → perceived value (PV) → Parent attitude (PA) path, as the absolute value of  $Z = -2.111$  is above 1.96, the range of bias-corrected and Percentile excludes 0. Thus, the indirect effect of perceived risk (PR) → perceived value (PV) → parent attitude (PA) exists. The total effect of perceived risk (PR) → parental attitude (PA) also exists ( $Z = -3.125$ , the absolute value of  $Z$  is above 1.96, and the range of bias-corrected and Percentile excludes 0). At this point, perceived value is a partial intermediary between perceived risk (PR) and parental attitude (PA). As the hypothesis of the path of perceived cost (PC) → parent attitude (PA) has been proved to be invalid in the hypothesis testing above, the mediating effect of perceived cost (PC) → parent attitude (PA) is not analyzed.

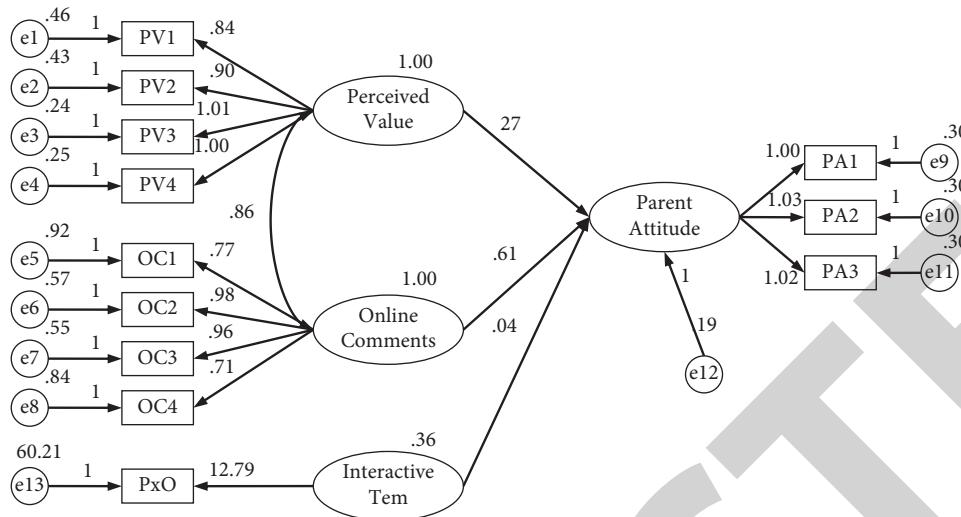


FIGURE 3: Moderating model of online reviews.

In the Teacher influence (TI) → Parent attitude (PA) path, as  $Z = 3.607$  is greater than threshold 1.96, the range of bias-corrected and Percentile excludes 0. Thus, the direct effect of teacher influence (TI) → parent attitude (PA) path exists. In the Teacher influence (TI) → perceived value (PV) → Parent attitude (PA) path, as  $Z = 2.607 > 1.96$ , the range of bias-corrected and Percentile excludes 0. Thus, the indirect effects of teacher influence (TI) → perceived value (PV) → parent attitude (PA) path exist. The total effect of teacher influence (TI) → parent attitude (PA) also exists ( $Z = 5.309 > 1.96$ , and the range of bias-corrected and Percentile excludes 0). At this point, perceived value is a partial intermediary between teacher influence (TI) and parent attitude (PA).

In conclusion, perceived value can in part mediate the relation between perceived gain factors (perceived usefulness and platform information) and dependent variables (parent attitudes), while perceived value can in part mediate the relation between perceived loss (perceived risk) and dependent variables (parent attitudes). Perceived value can also in part mediate the relation between the external environmental variable (teacher's influence) and the dependent variable (parent attitude). It can be seen that perceived value as an important part of the mediation variable in the study of parent attitudes towards online learning platforms affects the connection between independent variables and dependent variables.

**4.4.5. Test of Regulatory Effect.** In general, there is some difficulty in using potential variables when analyzing interactions through structural equations. Upon detecting the impacts of the interaction, nonlinear constraints should be firstly imposed on fixed factor coefficients and error variances. Second, whether indicators for the interaction term are normally distributed can be hardly confirmed even if every variable that makes up the interaction term is present. To address the above issues and explore the moderating relationship between online reviews on perceived value and parental attitudes, AMOS 24.0 adopts the two-step technique proposed by PING, eliminating the nonlinear

TABLE 25: Moderating effect of online reviews.

Path	Std.	S.E.	t-value	P
PV → PA	0.266	0.061	4.339	***
OC → PA	0.611	0.064	9.508	***
PxO → PA	0.039	0.006	6.454	***

Note: (1) Std. = Standardized factor load; S.E. = standard error; T - value = t value. (2) \*\*\* means  $P < 0.001$ ; \*\* means  $P < 0.01$ ; \* means  $P < 0.05$ .

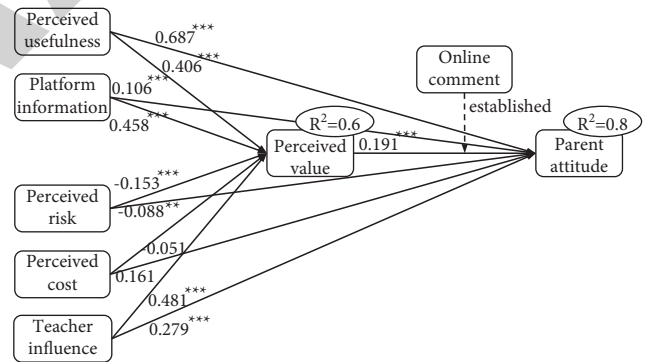


FIGURE 4: Final test results. Note: (1) \*\*\* means  $P < 0.001$ ; \*\* means  $P < 0.01$ ; \* means  $P < 0.05$ .

constraint [43]. As seen in Figure 3 and Table 25, PXO, the interaction term between perceived value and online reviews, has a significant positive effect on parent attitudes. Hypothesis 11 is true, so it can be seen that online reviews influence the relationship between perceived value and parental attitudes in a favorable way.

Through the above SPSS analysis and AMOS verification, we obtained the results for empirical research (Figure 4).

## 5. Results and Discussion

### 5.1. The Results Show the Following

- (1) The two variables of perceived gain have a positive and significant effect on perceived value and parent

attitude. Perceived usefulness significantly positively affects parents' attitude (PU→PA:  $\beta = 0.687$ ,  $T = 18.301$ ,  $P < 0.001$ ), and perceived usefulness significantly positively affects perceived value (PU→PV:  $\beta = 0.406$ ,  $T = 12.132$ ,  $P < 0.001$ ). Platform information significantly positively affects parents' attitude (PI→PA:  $\beta = 0.106$ ,  $T = 3.050$ ,  $P < 0.01$ ), and platform information significantly positively affects perceived value (PI→PV:  $\beta = 0.458$ ,  $T = 12.689$ ,  $P < 0.001$ ).

- (2) Perceived profit and loss are composed of perceived risk and perceived cost. Perceived risk significantly negatively affects perceived value (PR→PV:  $\beta = -0.153$ ,  $t = -4.688$ ,  $P < 0.001$ ), and perceived risk significantly negatively affects parents' attitude (PR→PA:  $\beta = -0.088$ ,  $t = -3.217$ ,  $P < 0.01$ ). However, perceived cost has no significant negative influence on perceived value (PC→PV:  $\beta = -0.051$ ,  $T = -1.630$ ,  $P = 0.103 > 0.05$ ), and perceived cost has a significant positive influence on parents' attitude (PC→PA:  $\beta = 0.161$ ,  $t = 5.936$ ,  $P < 0.001$ ), contrary to the original hypothesis, so the result is not valid. As a part of perceived profit and loss, perceived cost does not negatively affect perceived value and parents' attitudes, indicating the insignificant effect of perceived cost on online learning platform use. Therefore, middle school students' parents are more concerned about if their children can learn useful knowledge on online learning platforms, rather than the perceived cost.
- (3) The influence of teachers on social factors significantly positively affects perceived value (TI→PV:  $\beta = 0.481$ ,  $T = 12.397$ ,  $P < 0.001$ ), and the influence of teachers on parents' attitude (TI→PA:  $\beta = 0.279$ ,  $T = 7.384$ ,  $P < 0.001$ ). Teacher influence as the third party environmental factors of online learning platform influences the relationship between middle school students' parents and online learning platforms.
- (4) Social variables and online comments positively moderate the relation between perceived value and parent attitudes, and the interaction terms of perceived value and online comments positively affected parent attitudes (PXO→PA:  $t = 6.454$ ,  $P < 0.001$ ). Therefore, creating positive online comments during the publicity process of the online learning platform is helpful in shaping the corporate image and enhancing the perceived value and recognition of parents.
- (5) As a partial intermediary, perceived value influences the relationship between perceived gain variables (perceived usefulness and platform information), perceived loss variables (perceived risk), and dependent variables (parental attitude). Perceived value also partially mediates the relationship between the external environmental variable (teacher's influence) and the dependent variable (parent's attitude). It can be seen that perceived value as an important part of the mediation variable in the study

of parent attitudes towards online learning platforms affects the relation between independent variables and dependent variables. Therefore, for online learning platforms, it is extremely important for parents of middle school students to perceive the value of learning, which can help improve their attitude towards online learning platforms.

## 6. Conclusion

This part mainly discusses the influencing factors of parents' attitude towards secondary school students' online learning platform. Based on the theory of perceived value, the factor model of parents' attitude of secondary school students' online learning platform is established from the subjective dimension and social factor dimension. Through the questionnaire survey of parents' attitude towards secondary school students in online learning platform, 745 valid questionnaires are analyzed by structural equation model and regression analysis. The main research findings are as follows:

- (1) Perceived value plays an intermediary role in this research model. Perceived usefulness, platform information, and perceived risk not only influence parents' attitude directly and positively, but also indirectly influence parents' attitude through perceived value.
- (2) Perceived cost does not have a direct negative influence on parents' attitude, nor does it have an indirect influence on parents' attitude through perceived value.
- (3) The moderating effect of online comments is established. Teachers, the influencing factor of external situation, influence parents' attitude towards online learning platform through perceived value, both directly and indirectly.

## Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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## Retraction

# Retracted: Analysis of the Relationship between Employee Health Level and Building Office Space and Environment

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] S. Ma, "Analysis of the Relationship between Employee Health Level and Building Office Space and Environment," *Journal of Environmental and Public Health*, vol. 2022, Article ID 7779922, 12 pages, 2022.

## Research Article

# Analysis of the Relationship between Employee Health Level and Building Office Space and Environment

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The arrival of the era of big data provides new research methods and perspectives. In view of the problem that the current building office space environment design does not consider the level of human health, which leads to the low comfort and the poor environmental quality of building office space, this paper puts forward the comfort analysis and environment design of building office space considering the health level of employees. By analyzing the theoretical basis of architectural office space by big data, the paper studies the elements and the esthetic characteristics of architectural office space, understands the development and classification of architectural office space, and obtains the esthetic characteristics of architectural office space. Considering the health level of employees, the factors affecting the comfort of building office space are analyzed. The research object is selected as a building office space; the method of questionnaire survey is used for the establishment of building office space comfort evaluation factor set; and from the two aspects of enterprise employees' psychological behavior and physical environment, the comfort of building office space of the research object is analyzed. The results of case study show that the proposed method has good environmental quality of building office space and can effectively improve the comfort of building office space.

## 1. Introduction

Office building is a common building type and is one of the most representative buildings. It not only has high scientific and technological content and architectural design characteristics, but also has high vitality and great creativity [1]. At this stage, the development of urban social life and business planning activities is increasing, which makes the demand for office buildings increase. However, office buildings are mainly composed of building office space, and the office efficiency and physical and mental health of enterprise employees mostly depend on the environmental quality of building office space [2]. The humanized and comfortable building office space environment can directly affect the efficiency of office work, enable enterprise employees to adjust their own mentality and further effectively feel the fun of work, and to a certain extent determine the health level of employees and office timeliness [3]. In addition, in today's society, comfort design can effectively reflect the environmental quality of building office space. In

order to improve the environmental quality of building office space, the comfort of building office space must be improved. Therefore, it is of great significance to analyze the comfort of building office space.

Reference [4] proposed the use mode and comfort analysis of gardens in 8 nursing homes in Chengdu and measured three microclimate parameters in them. The results showed that all gardens had seasonal cooling, humidification, and solar radiation weakening effects. Even small internal gardens can produce cooling effect in the four seasons. Only in summer, the coverage of landscape has a significant impact on microclimate. On average, 29.98% of the elderly use these internal gardens every day, and over 68% of the elderly prefer to sit in the rest area. The microclimate of the garden deviates from the comfort level of the elderly; especially in winter, the comfort of the rest area is the worst for the elderly. Reference [5] proposed the analysis of energy-saving performance and summer thermal comfort of traditional courtyard buildings in desert climate, and the research was divided into two stages. In the first stage, the

influence of the location of each partition around the courtyard on its indoor energy consumption and thermal comfort is studied. The results show that due to the influence of solar radiation in summer, the east and west sides of the courtyard have the highest requirements for cooling. In addition, the longest time of discomfort occurred in the eastern region. In the second stage, the hourly temperatures inside and outside the courtyard on the longest day of the year were compared. The results show that the average temperature inside the courtyard is 1.2°C lower than that outside. In addition, it was observed that the temperature fluctuation outside the courtyard was higher than that inside the courtyard. In conclusion, the results show that the courtyard can provide cool microclimate in summer. However, the above method does not consider the level of human health and has the problems of low comfort and poor environmental quality of building office space.

In view of the above problems, this paper puts forward the comfort analysis and environmental design of building office space considering the health level of employees. Through the analysis of the theoretical basis of building office space, considering the health level of enterprise employees, the factors affecting the comfort of building office space are analyzed, and the building office space environment is designed. This paper selects a building office space as the research object, uses the questionnaire survey method to construct the comfort evaluation factor set of building office space, and analyzes the comfort of building office space from the perspectives of the psychological behavior and physical environment of enterprise employees. The environmental quality of the proposed method is good, which can effectively improve the comfort of the building office space. The residential building density index depends on the organization of the courtyard, the proportion of green space, the requirements for the layout of residential buildings such as climate, fire protection, earthquake resistance, and topographic conditions, as well as the number of floors, floor height, house spacing, and arrangement factor.

## 2. Theory of Building Office Space

Everything in the world exists in space, which is the most essential existence. Space refers to the infinite extension of material in the three-dimensional space, which belongs to the part outside the entity. It is an idea. It goes beyond the concept that can be described, and it is difficult to express with language. It belongs to the starting point and ending point of architectural activities [6]. The creation of this space makes people's construction activities meaningful. Architecture is to create space. The sense of space is not only the meaning of architecture, but also the thinking idea of architects.

*2.1. Building Office Space Formation.* The formation of architectural office space is mainly through the relationship between a certain object and the feeling object. To some extent, this relationship depends on vision, but when it is used as an office space, it also involves smell, hearing, and

touch. Even in the same space, sometimes the impression will be greatly different due to the weather changes. However, when the architectural office space is in the category of visual modeling, it refers to the interaction between one entity and another entity, resulting in another environment. It can also be called the site in the entity environment, which can be realized through the length, width, and higher scale. The building office space is shown in Figure 1.

It can be seen from Figure 1 that the building office space is mainly composed of floor, wall, and ceiling, so the three major elements of the building office space can be identified as floor, wall, and ceiling. The building itself belongs to a space, but not all spaces belong to the building itself [7]. The scope of space is very wide: the largest refers to the whole universe, the smallest refers to the whole microworld, and all belong to the scope of space. Architecture belongs to the unique things in people's daily life, and the architectural office space refers to the means of people's specific life activities.

*2.2. Building Office Space Elements.* The cognitive process of general things mainly includes the appearance, internal structure, and internal meaning of things. The same is true of architectural office space, which is mainly composed of form, structure, and meaning. The elements of office space are shown in Figure 2.

*2.2.1. Form of Building Office Space.* It refers to the appearance and surface characteristics of the building office space. Among them, appearance form is the basic element of the environment of the building office space, which can directly affect the environment atmosphere, audio-visual effect, and visual perception of all the building office space. The form of office space is mainly composed of size, direction, shape, edge outline, concave and convex structure, false and real representation, color pattern, and psychological perception, and the modeling elements of architectural office space are mainly composed of points, lines, and faces.

*2.2.2. Architectural Office Space Structure.* It refers to the combination relationship between the functional systems of architectural office space, which belongs to the implicit organization network in the space form and can support the geometric structure of the space system to a certain extent [8]. The structure of architectural office space in architecture belongs to a kind of artificial schema. Designers mainly form an abstract space framework according to the logical connection and functional requirements of office space and, on this basis, integrate social, cultural, artistic, and other factors, thus forming the abstract space framework and guiding the formation of people's behavior order in architectural office space.

*2.2.3. Meaning of Architectural Office Space.* It refers to one of the levels of the internal meaning of architectural office space, which belongs to the scope of culture, can reflect the



FIGURE 1: Diagram of building office space formation.



FIGURE 2: Schematic diagram of building office space elements. (a) Spatial form, (b) Spatial structure, (c) Spatial meaning and (d) Space form and meaning.

artistic and spiritual tendency of architectural office space to a certain extent, and belongs to a kind of social attribute of architectural office space.

#### 2.2.4. Form and Meaning of Architectural Office Space.

They refer to the relationship between the form and connotation of architectural office space, which is expressed as “form outside and meaning inside.” There is a dialectical relationship between the form and connotation of architectural office space. The form is something that can be reflected in the architectural entity, and the meaning is an emotional symbol that can convey a certain meaning to a certain extent.

#### 2.3. Development and Classification of Building Office Space.

Building office space is a form of material existence; all things occupy the corresponding space position to a certain extent. To a certain extent, it is related to the philosophical thought, artistic form, time culture, regional customs,

nationality, and other related factors of the overall framework of life [9]. Therefore, in the design of architectural office space, we should not only consider the building, site, green space, and other space elements with shape expression significance, but also grasp the social, moral, folk, emotional, and other space elements with intangible expression significance. Architecture is a big field integrating social knowledge, and architectural office space design is an important part of architecture.

In the process of its development, the architectural office space has been echoing with the history of people’s civilization development. The main process is as follows.

**2.3.1. Action Space.** When people are in the primitive society, the living space only belongs to a passive action space to adapt to the environment, and its main form of expression is creative activities such as living, defense, and storage. While there is no abstract concept of thinking, its specific form cannot be described or measured by language.

**2.3.2. Conforming to Space.** When people enter the period of civilized society, through the communication of language, the definition of abstract thinking is gradually formed, and words can also be expressed, thus forming an effective cultural difference from animals. It can perceive space through conditional reflection; at the same time, it can establish clear space image, conceive activities according to needs, and describe space characteristics through written records and language, so as to enter the symbolic world, that is, to live in a meaningful world relying on symbols.

**2.3.3. Sacred Space.** When science and technology had not yet been developed, the significance of people's existence was mainly to improve their daily life through their own efforts and often repose their spirit in the God of heaven and Earth. Architectural office space has gradually formed the image of coexistence of function and spirit of life and sacrifice. Some superstitious symbols have become the labels of architectural office space.

**2.3.4. Geometric Progression Space.** When people understand things, they are often in the process from concrete to abstract, and then from abstract to concrete. In the process of architectural office space design, people constantly use scientific and rational mind to induce, abstract, and refine various objects; create common forms of geometric space; replace the original sacred space; and create an orderly world [10]. However, due to the long time in the agricultural society and the slow development of science and technology, the productivity is low, which restricts the building office space in the aspects of material, structure, and technical level, resulting in single space form and closed living space. The geometric progression space is shown in Figure 3.

**2.3.5. Modern Functional Space.** When entering the period of industrial society, especially in the era of large-scale industrial production, it promoted the rapid development of social civilization, people's social thought and group concept were obviously strengthened, and the types of architectural office space also increased. In addition, due to the increasing new materials, new structures, and modern means of new technology, the original mode of building office space has been changed, gradually forming a building office space structure that meets the functional needs of people's daily life. The modern functional space is shown in Figure 4.

**2.3.6. Human Space.** When people are in the postindustrial period of modern architecture, it provides a strong material foundation. With the enhancement of people's self-awareness and the improvement of material and technical conditions, people have higher requirements for the objective environment. Building people-oriented office space has become the consensus of the whole society. Human space is shown in Figure 5.

It can be seen from the whole development process of architectural office space that geometric progression space provides the order of people's behavior and the framework

of space, which constitutes the structure of architectural office space. To a certain extent, modern functional space can expand the field of behavior, provide a place for behavior, and meet the needs of behavior. Humanistic space will expand its activity content and connotation on the original basis, enrich its life fun and meaning, and embody people's value and dominant position to the greatest extent.

Space in architecture belongs to a polysemous compound conceptual structure. Functional space makes people expand the field of behavior, and its forms of existence and classification have diverse connotations. The details are as follows:

- (1) According to the different forms of edge, it can be divided into closed space, open space, and middle space.
- (2) According to the different combination forms, it can be divided into addition space and reduction space.
- (3) According to the different trend of space, it can be divided into dynamic and static space and flowing space.
- (4) According to the different structural characteristics, it can be divided into single space and composite space.
- (5) According to the different ways of partition, it can be divided into fixed space and changing space.

**2.4. Esthetic Characteristics of Architectural Office Space.** Architecture is a kind of art form that embodies scientific thought through structure. Architectural office space can be regarded as a complex of application space with multi-functional needs and visual space with esthetic needs [11]. The esthetic characteristics of architectural office space are mainly composed of environmental atmosphere, plastic arts, and symbolic meaning.

**2.4.1. Environment Atmosphere.** Different environment atmosphere mainly depends on different space characteristics. Generally speaking, plane regular space reflects simplicity; the space with curved surface reflects richness and lyricism; the mutually perpendicular space reflects loftiness and solemnity; mutual horizontal space reflects intimacy and comfort; and the mutually inclined spaces reflect impermanence and uneasiness. From this, we can see that different spatial forms reflect different environmental atmosphere. Function and esthetic factors mainly restrict the form of office space, and the construction of its environmental atmosphere mainly depends on the esthetic feeling.

**2.4.2. Plastic Arts.** The plastic arts of architectural office space mainly reflect the characteristics of architectural esthetics. The artistic style is a representative typical form gradually formed in different times and regional characteristics through creative conception and performance. The formation of an artistic style such as national characteristics, cultural trends, style habits, and religious beliefs is influenced by the humanistic and natural conditions of the time.



FIGURE 3: Schematic diagram of geometric series space.

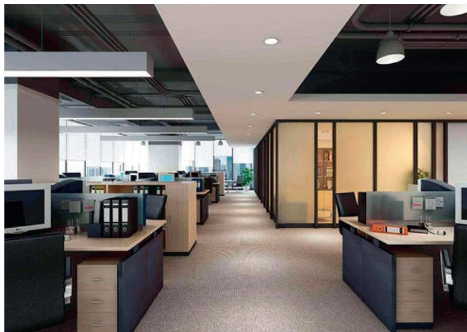


FIGURE 4: Schematic diagram of modern functional space.



FIGURE 5: Schematic diagram of human space.

*2.4.3. Symbolic Meaning.* Although architectural art can reflect life to a certain extent, different from other art forms, it cannot reflect the form of life again, the expression means of architectural office space, and cannot leave the space form required by use. We can only use some more abstract geometric forms, combined with the proportion and balance between various components, to create a certain environmental atmosphere, to express the specific internal meaning, thus clarifying that architecture is actually like a symbolic art.

### **3. Factors Influencing the Comfort of Building Office Space considering the Health Level of Employees**

Although the construction office space belongs to a kind of medium and form serving the employees, it can lead to some

behavior and play a certain role, but in fact, the enterprise employees are the real behavior subject; only the enterprise employees themselves are the main reasons for the needs and activities. According to the architectural determinism, architects believe that the behavior of enterprise employees depends on the building office space itself, and they will use and feel the environment according to the designer's intention, but they ignore the impact of the building office space environment on enterprise employees and do not consider whether the living and activity environment is suitable for enterprise employees. Therefore, building office space and enterprise staff behavior are complementary elements. This paper considers the health level of enterprise staff and studies the relationship, cognition, and evaluation of enterprise staff behavior and building office space environment, so as to form a truly comfortable building office space.

**3.1. Building Office Space Components.** Building office space is mainly for the use of enterprise employees, as almost every place is related to the activities of enterprise employees. Using certain material facilities to serve the work of enterprise employees, some form work tools, and others form the building office space environment. The building office space is an organic system, and the main elements of the building office space system are people, man-made objects, and environment [12]. The elements of building office space are shown in Figure 6.

Among these factors, environment refers to the working and living environment of employees in enterprises, and the main factors are ventilation, lighting, temperature and humidity, air quality, greening landscape, etc. Man-made objects refer to the relevant building components used by the employees of the enterprise. The main factors include doors, windows, railings, and stairs. People are the users or operators. In the office space of the building, human is the main body of the whole system and the target object of the office space design. Therefore, human is the most important part of the whole system.

**3.2. Psychological and Behavioral Factors in Building Office Space.** The design orientation of architectural office space depends on the needs of employees in architectural office space enterprises. The structural form of architectural office space is determined by various behavioral and psychological factors of employees. In social activities, employees often keep a certain distance, which will be adjusted automatically according to different events, people, and scenes. The interpersonal distance in the building office space is shown in Table 1.

The four kinds of interpersonal distance in Table 1 belong to the distance determined by the familiarity of employees with their own psychological space, which also determines the layout of building office space. As far as the whole building office space environment is concerned, each specific indoor and outdoor public space has its own different communication scale of enterprise employees, or in other words, according to the communication scale of enterprise employees, the category of building office space is defined [13]. Therefore, the human distance factors should be considered in the size and scale of the building office space, as well as the distance, orientation arrangement, and furniture design of the internal and external space.

**3.2.1. Human Health Factors.** Human health mainly includes two aspects: physical and mental health. In the process of designing the office space of building, in addition to the unreasonable scale or operation, the influence on the human health and sports system, and the unreasonable lighting and other factors, the impact on human health vision should be studied.

From the perspective of health, it is necessary to study the system health of human, and safety is a concept closely related to accidents. Usually, accidents refer to the accidents with low probability. The research on accidents aims mainly

to analyze their causes, so as to ensure the safety of building office space design.

From the perspective of management, in the modern office management system, people, materials, and information are the three major elements. The main purpose of enterprise employee management is how to maximize work efficiency. From the perspective of architectural space design, persons' work efficiency depends on their work nature, ability, tools, and working methods and on whether they can deal with the relationship between people and the environment. Take the architectural office space as an example; it is also called efficiency space, which is a link to deal with various types of information and affairs and coordinate the relationship between departments and individuals [14]. For a long time, some monotonous mechanical work is easy to make enterprise employees tired, resulting in reduced work efficiency. This requires architects to handle the relationship between people, such as the form, structure, size, material, style, color of office furniture, to be closer to the employees of the company and more suitable for the use of the company's employees. At the same time, they need to deal with the relationship between employees and the environment, reasonable illumination, appropriate temperature, and relaxed and pleasant sound effect, so that employees can improve work efficiency and work performance.

**3.2.2. Human Differences.** People belong to the main research focus of this paper. In the process of considering the health level of enterprise employees, people are different, and there are also great differences between individuals, resulting in the differences of building office space, which can be explained from two aspects: the commonness and differences of people. The commonness and difference of human body in building office space are shown in Figure 7.

The commonality and difference of employees belong to relative concepts. If the commonality of employees as a whole is called "absolute commonality," and the difference between employees is called "absolute difference," there are still many relative commonalities and differences between them. In different physiological and psychological states, the same person's perception of the same external stimulus is different. The commonness of human body has three levels: the first is the commonness of human body as a whole; the second is the commonness of different groups with obvious differences, such as the work needs and work psychology of enterprise employees; and the last is the commonness of the same combination, such as the work needs and work psychology of different regions, nationalities, gender, and other groups. Among them, the next level commonality must contain the upper level commonness. For the enterprise employee behavior in the construction office space studied in this paper, the first two levels are common, and the third level is the difference between people in the specific building office space.

**3.3. Physical Environment Factors in Building Office Space.** Not only does the design orientation of architectural office space depend on the psychological needs of the employees of



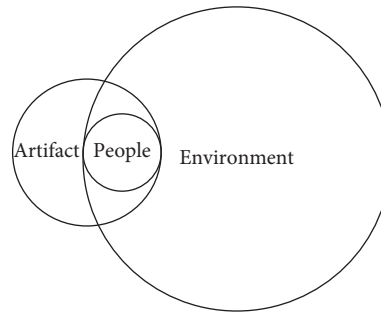


FIGURE 6: Elements of building office space.

TABLE 1: Interpersonal distance in building office space.

Type	Distance (m)	Features
Close distance	0~0.45	The distance that intimates need to keep
Individual distance	0.45~1.2	The distance of personal relationship
Social distance	1.2~3.6	The distance that colleagues need to keep
Common distance	> 3.6	The distance that needs to be kept in public

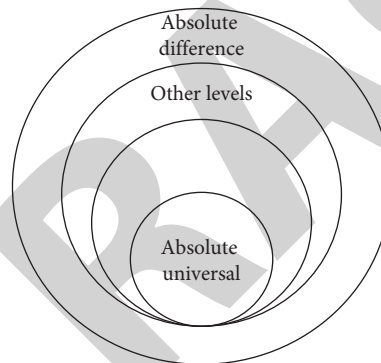


FIGURE 7: Human body commonness and difference in office space.

the construction office space enterprises, but also the physical environment factors determine the structure of the building office space. Modern high-rise buildings in cities are standing in a forest, the tightness of building office space is enhanced, air conditioning system and automatic office equipment are constantly introduced, which makes the indoor harmful gases in the building office space unable to discharge in time, and the air quality seriously harms the health of the employees. The indoor air in the building office space affects the working mood and efficiency of the enterprise employees [15].

The acoustic environment of building office space refers to people's auditory environment in building office space, which will be affected by various noise sources. Good building office space acoustic environment can help people work effectively but also can avoid emotional tension, tinnitus, and other office syndromes; building office space noise pollution affects all symptoms. For employees of construction office space enterprises, sound is a kind of natural stimulation. The minimum sound source of construction office space is more than 15 dB, and the maximum is not more than 80 dB, generally 35–50 dB.

The office space needs sufficient natural light and appropriate artificial lighting. Building office space should have sufficient natural lighting. If natural light can enter the building office space, it can improve the indoor environment quality of building office space and increase the comfort of enterprise staff.

## 4. Environment Design of Building Office Space

*4.1. Concept of Building Office Space Environment System.* In the early environmental design of building office space, the internal and external architectural office space are two distinct areas, while the organization and operation of the internal function are the focus of the design, and the external space is often ignored. From the early architectural office space, the concept of architectural office space environment is that the building volume occupies the land divided by the road network, which is a unified correspondence between buildings and streets. Since the 1960s, the design of office space has gradually become as important as the main building. The space between buildings and between

buildings and streets has become an integral part of office space, providing a distinctive place for people's external activities.

#### 4.2. Architecture of Building Office Environment System.

The external space of building office refers to the middle area between buildings and between cities and buildings. It is not only a part of building office space environment, but also a whole through urban roads, squares, green space, and urban environment. The architecture of the building office environment system is shown in Figure 8.

Office buildings are one of the most common types of buildings at present. As the most important part of office buildings, the quality of the working environment created by office space will directly affect the physical and mental health and work efficiency of employees. For engineers who are immersed in the office, the office has become their second home, and their work space environment needs great attention. The transformation of the external space and the internal space of the building office belongs to the stage of increasing attention. The semi-outdoor form of the building office space is introduced into the internal space of the building office. Regional public space is an extension of the external space of the building office, which is a multifunctional place with the characteristics of rest, business, and leisure. Taking the air shared space as a means to improve the environmental quality of the building office space is called the building office space close to the natural environment. Designing it as the form of the sky garden can make the building office space have more perfect ecological functions. While improving the environmental quality of the building office space, it can also play a better role in the energy-saving effect of the building office space.

## 5. Case Analysis

*5.1. Investigation Methods and Objects.* In order to verify the effectiveness of building office space comfort analysis and environmental design considering the health level of employees, this paper studies the influencing factors of building office space comfort. In the specific building office space environment, different requirements are put forward for the form, scale, interface, and various material facilities of the building office space. At the same time, specific psychological and physiological feelings and behavior characteristics of enterprise employees will be produced. Taking the office space of a building as the research object, this paper adopts the methods of reference [4], reference [5] and the method proposed in this paper to conduct a practical investigation on the office space of the building. Through the summary of the factors affecting the comfort of building office space, this paper designs the index to evaluate the comfort of building office space, applies it to the investigation, and makes a comprehensive analysis of the research object from the two aspects of psychological behavior and physical environment.

The survey method is mainly questionnaire survey, which is used as the data basis of the comfort research of

building office space. SPSS13.0 software was used for data input and analysis. Through a questionnaire survey of 300 employees in 10 enterprises and institutions in a city, 276 valid questionnaires were collected, and the effective rate was 92%. Among the respondents, 154 were male and 122 were female, involving large- and medium-sized state-owned enterprises, universities, private enterprises, and foreign-funded enterprises. The basic distribution of samples is shown in Table 2.

*5.2. Construction of Evaluation Factor Set.* The completeness, pertinence, and discrimination of the evaluation factor system have an impact on the quality and comparability of the final comprehensive evaluation index. The comfort of office space is evaluated and analyzed from the aspects of psychological behavior and physical environment. The set of comfort assessment factors for building office space is shown in Table 3.

Therefore, the current design of the building office space environment cannot meet the needs of the enterprise staff for the comfort of the physical environment of the building office space.

#### 5.3. Building Office Space Comfort Survey Results and Comparative Analysis

*5.3.1. Survey Results and Comparative Analysis of Psychological and Behavioral Comfort.* The survey results of psychological and behavioral comfort of building office space are shown in Table 4.

According to the survey results in Table 4, 45.7% of enterprise employees are not satisfied with the psychological and behavioral comfort of building office space, 31.5% are not satisfied, and 4.7% are very dissatisfied. Only 11.6% and 6.5% of the employees were satisfied with the psychological and behavioral comfort of the office space. The survey results show that the psychological and behavioral comfort of enterprise employees for the building office space are generally low. Therefore, the current building office space environment design cannot meet the needs of enterprise employees for the psychological and behavioral comfort of building office space.

In order to analyze the psychological and behavioral comfort of the proposed method in building office space, the method in [4], the method in [5], and the proposed method are used to compare the fitness of human health and the fitness of privacy in building office space of different methods. The comparison results are shown in Figures 9 and 10.

According to the data in Figures 9 and 10, according to the age of different subjects, the average fitness for human health and privacy of building office space in the method of [4] are 75% and 78%, respectively, and the average fitness for human health and privacy of building office space in the method of [5] are 58% and 65%, respectively. The average fitness of human health and privacy of the proposed method are 93% and 90%, respectively. It can be seen that the proposed method has high adaptability to the psychological

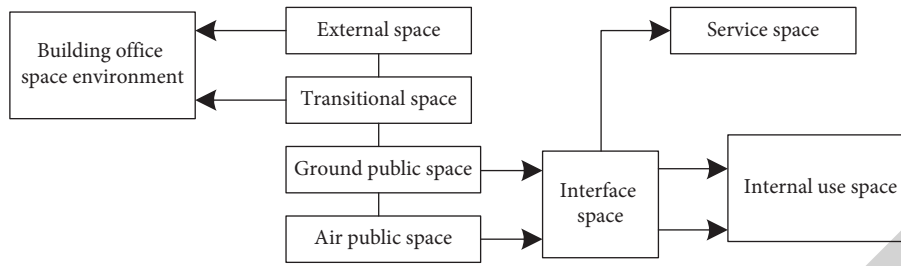


FIGURE 8: Architecture of building office environment system.

TABLE 2: Basic distribution of samples.

Variable name		Number of samples	Percentage (%)
Gender	Male	154	55.8
	Female	122	44.2
Age	20–29 years	106	38.4
	30–39 years	98	35.5
	40–49 years	46	16.7
	50–59 years	26	9.4
Types of enterprises	Large- and medium-sized state-owned enterprises	68	24.6
	Colleges and universities	43	15.6
	Private enterprises	126	42.7
	Foreign-funded enterprises	39	14.1

TABLE 3: Comfort evaluation factor set of building office space.

Name	Evaluating indicator
Psychological behavior	Human health Privacy
Physical environment	Acoustic environment Light environment

TABLE 4: Survey results of psychological and behavioral comfort evaluation of building office space.

Variable	Number of samples	Percentage (%)
Very satisfied	18	6.5
Satisfied	32	11.6
Generally satisfied	87	31.5
Dissatisfied	126	45.7
Very dissatisfied	13	4.7
Total	276	100

behavior of building office space and can effectively improve the adaptability of building office space.

5.3.2. Investigation Results and Comparative Analysis of Physical Environment Comfort. The survey results of physical environment comfort of building office space are shown in Table 5.

According to the survey results in Table 5, 49.3% of enterprise employees are not satisfied with the physical environment comfort of building office space, 20.3% are not satisfied, and 5.4% are very dissatisfied. Only 17.4% and 7.6% of the employees were satisfied with the comfort of the physical environment of the office space. According to the survey results, the comfort of the physical environment of

the building office space is generally low. Therefore, the current design of the building office space environment cannot meet the needs of the enterprise staff for the comfort of the physical environment of the building office space.

On this basis, in order to further analyze the comfort of the physical environment of the proposed method of building office space, the methods in [4] and [5] and the proposed method are used to compare the acoustic environment fitness and the light environment fitness of building office space of different methods. The comparison results are shown in Figures 11 and 12.

According to the data in Figures 11 and 12, according to the age of different subjects, the average building office space acoustic environment adaptability and light environment adaptability of the method in [4] are 63% and 62%,

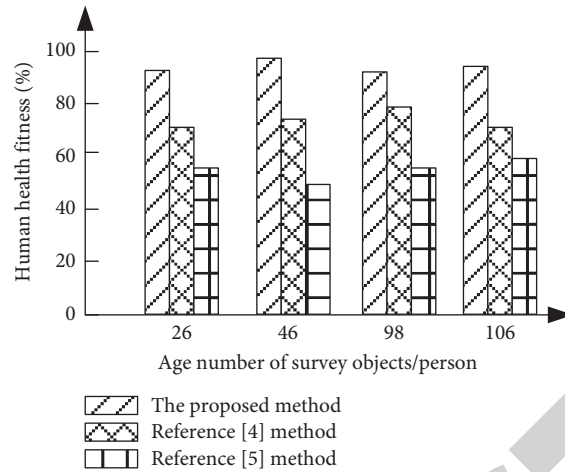


FIGURE 9: Comparison results of human health fitness of building office space with different methods.

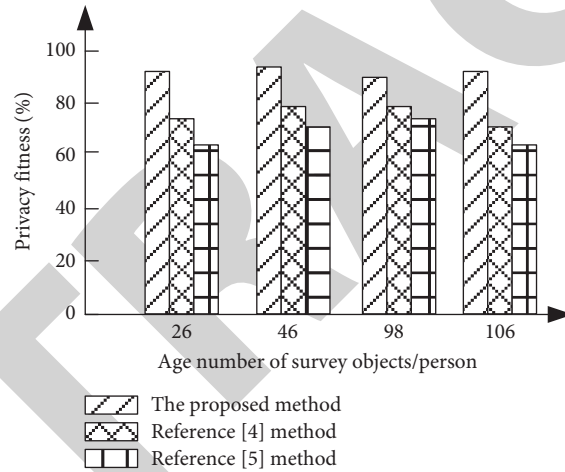


FIGURE 10: Comparison results of privacy fitness of building office space with different methods.

TABLE 5: Survey results of physical environment comfort evaluation of building office space.

Variable	Number of samples	Percentage (%)
Very satisfied	21	7.6
Satisfied	48	17.4
Generally satisfied	56	20.3
Dissatisfied	136	49.3
Very dissatisfied	15	5.4
Total	276	100

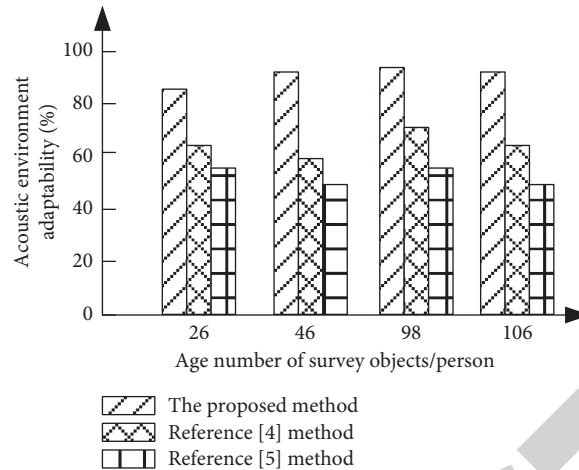


FIGURE 11: Comparison results of acoustic environment adaptability of building office space with different methods.

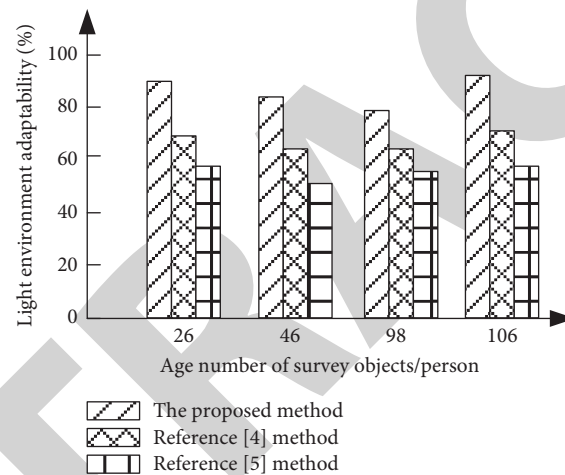


FIGURE 12: Comparison results of light environment adaptability of building office space with different methods.

respectively, and the average building office space acoustic environment adaptability and light environment adaptability of the method in [5] are 50% and 55%, respectively. The results show that the average fitness of sound environment and light environment of the proposed method are 89% and 88%, respectively. Therefore, the proposed method has high adaptability to the physical environment of building office space and can effectively ensure the environmental quality of building office space.

## 6. Conclusion

This paper puts forward the comfort analysis and environmental design of building office space considering the health level of employees. By studying the theoretical basis of building office space, considering the health level of employees, this paper analyzes the factors affecting the comfort of building office space and designs the building office space environment. This paper selects the research object as a building office space, uses the method of questionnaire survey to construct the comfort evaluation

factor set of building office space, and analyzes the comfort of building office space from the perspectives of psychological behavior and physical environment of enterprise employees. The proposed method can effectively improve the comfort of building office space and ensure the environmental quality of building office space. However, the number of studies on this algorithm is limited. Therefore, in the next research, we will fully increase the number of studies and further analyze the comfort of building office space.

## Data Availability

The datasets used and/or analyzed during the current study are available from the author on reasonable request.

## Conflicts of Interest

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Retraction

# Retracted: Innovating a Practical Teaching Base of Landscape Architecture Major Based on the Campus Environment: A Case Study of Xuzhou University of Technology (China)

### Journal of Environmental and Public Health

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- (1) Discrepancies in scope
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We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] X. Tan, P. Liu, N. Nan, and Y. Peng, "Innovating a Practical Teaching Base of Landscape Architecture Major Based on the Campus Environment: A Case Study of Xuzhou University of Technology (China)," *Journal of Environmental and Public Health*, vol. 2022, Article ID 6209454, 7 pages, 2022.

## Research Article

# Innovating a Practical Teaching Base of Landscape Architecture Major Based on the Campus Environment: A Case Study of Xuzhou University of Technology (China)

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Xuzhou University of Technology is a local newly established applied undergraduate university. The construction of a practical teaching base of landscape architecture majors was faced with the problems of short construction time and lack of funds. The feasibility, necessity, process, and achievements of the construction of the practical teaching base of landscape architecture majors based on the campus environment were studied. The guiding ideology of the campus practical teaching base for landscape architecture majors in applied undergraduate universities was put forward and the construction mode of “four in one” of practical teaching bases was discussed. The campus practical teaching base for landscape architecture majors was built and “four-stage” progressive training and teaching activities were carried out in Xuzhou University of Technology. The effective combination of the landscape architecture professional practical teaching base and the logistics resources was realized. The combination of the logistics resources and professional construction of the university was carried out as a beneficial exploration in this paper. The achievements of practical teaching base construction were mainly reflected in the improvement of the quality of talent cultivation, the beautification of campus environment, and the enhancement of teachers practical ability.

## 1. Introduction

According to the statistics of China landscape architecture education conference in 2014, more than 220 colleges and universities in China had opened undergraduate majors of landscape architecture, gardening, and related majors, and more than 50,000 students of related majors at all levels were enrolled every year [1,2]. As we all know, landscape architecture was a highly practical subject; the study of landscape architecture students should not be limited to classroom theoretical teaching and practical teaching was an important link to cultivate students' application ability and innovation ability; the practical teaching base was the main place to cultivate landscape architecture students' practical ability and innovation ability [3,4]. However, many newly built local undergraduate colleges were unable to build practical teaching bases for landscape architecture majors as

compared with those key universities due to the short construction time and lack of funds, which directly affected the quality of students' training.

Xuzhou University of Technology (hereafter abbreviated as our university) was a local established applied undergraduate university, and our university closely adhered to the mainline of local and application-oriented education, practiced the concept of “big application view, big engineering view, big life view, and big culture view,” and realized the road of innovative development of the university [5]. In order to achieve the goal of cultivating senior application-oriented talents with solid theoretical knowledge and strong practical ability in landscape architecture majors of our university, it was necessary to build a practical teaching base with strong practicability to ensure the quality of talent's cultivation. In order to save money and shorten the construction time, our university put forward the

suggestion of constructing a practical teaching base for landscape architecture major relying on the campus environment. The facts proved that the practical teaching base of landscape architecture majors established on the campus environment of our university had realized the combination of theory teaching and practice and the unity of practice and production; it had strengthened the enthusiasm of students in learning, stimulated their creativity and innovation, and narrowed the distance between teaching and production.

Therefore, the landscape architecture major of our university realized the smooth integration of students from campus practice to off-campus work and shortened the employment adaptation period of graduates [6].

## 2. Theoretical Exploration

*2.1. Guiding Ideas of the Building Practical Teaching Base of Landscape Architecture Major on the Campus.* Practical teaching referred to the practical activities carried out around teaching activities and students' personal experience, and the practical teaching base was the material basis for the development of practical teaching [7]. Our university began to recruit landscape architecture majors in 2015. There are 312 students of this major in our school at present. The major had a large number of practical courses, such as landscape botany practice, landscape architecture design practice, landscape planning and design practice, landscape engineering practice, plant landscape design practice, cognitive practice, model making, comprehensive practice, graduation design, graduation practice, etc. With the revision of the 2019 version of the talent cultivating program, the number of teaching hours of practical training had been increased. Practical teaching was 65.5 credits, accounting for 40.18% of the total credits in the talent cultivating program for landscape architecture majors. A large number of practical courses needed to be completed in the practical teaching base in order to master the practical operation skills in the field of landscape architecture and the students could get rid of the monotonous "cramming" classroom.

Therefore, the guiding ideology of the construction of the practical teaching base for landscape architecture major in our university was that the talent cultivating program combined theory with practice, aimed at cultivating students' practical ability and innovative consciousness, adhered to combine the construction, transformation, and maintenance of the campus environment with students' practical training courses. The practical teaching base of the campus environment should become a real practice environment in the garden industry and an open practice teaching base integrating teaching, production, and scientific research.

*2.2. The Mode of "Four in One" Practical Teaching Base Construction.* Relying on the campus environment, under the guidance of the leaders of university, the college and the logistics department cooperated to set up an open practical teaching base on the campus, which could realize the "four-in-one" function of practical teaching, technological

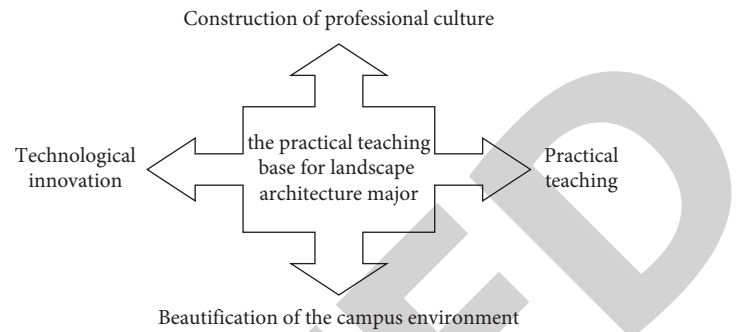


FIGURE 1: "Four in one" practical teaching base construction mode.

innovation, construction of professional culture, and beautification of campus environment (Figure 1) and the practical teaching base had strong practicability. The construction of the practical teaching base adhered to the three-dimensional principle of "landscape of the practical environment, teaching of the campus environment, and humanistic culture of the campus environment." All kinds of plants and landscape on campus not only served for professional teaching, reflected professional cultural connotation, provided the place for curriculum reform and the source of innovation but also had the function of beautifying the environment. Students on campus could recognize the main elements of landscape architecture, subtly cultivate the perception and experience of beauty, feel the sense of professional well-being, and stimulate interest in learning and professional love.

The model of "four-in-one" practical teaching base construction realized the effective cooperation of various departments in the university, improved the management efficiency of the campus environment, and saved the construction cost of the practical teaching base, so it was of great significance.

## 3. The Practice of Practical Teaching Base Construction

*3.1. Establishing a Practical Teaching Base for Landscape Architecture Major on the Campus.* The traditional form of practical training and the practical teaching system in colleges and universities was mainly based on teacher demonstration and the students in a passive position. Therefore, it was difficult for students to have interest in practical training and practical teaching, which restricted the cultivation of students' practical ability [8,9]. As a local applied undergraduate university, our university had already realized this point and the university leaders broke through the thinking barrier and innovated boldly. Under the leadership of the university, the college of environmental engineering and the logistics office had successively negotiated and signed a cooperation agreement in April 2015 based on the principle of resource sharing, complementary advantages, and mutual benefit. According to the agreement, the college of environmental engineering contracted the 110,000 square meters of green maintenance and landscape renovation projects on the campus and established a campus practical



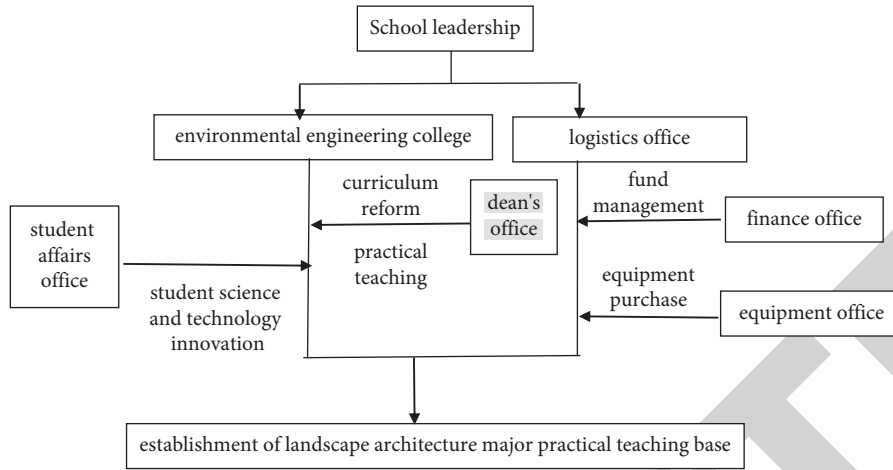


FIGURE 2: Cooperation mode of practical teaching base construction.

teaching base of landscape architecture major with the logistics office.

After nearly four years of operation, the base not only provided the course practice of landscape dendrology, floriculture, lawn science, garden plant cultivation and maintenance, landscape planning and design, plant planning and design, landscape engineering and other courses but also became the place of graduation practice, second classroom, scientific and technological innovation for some students, as well as the place for the display of landscape architecture professional culture. At the same time, the campus was beautified, the funds were saved, and the real design and construction environment was provided for students through the projects of flower planting in tree pools, *Prunus mume* forest transformation and *Cedrus deodara* forest transformation.

**3.2. Realizing the Effective Combination of the Practical Teaching Base of Landscape Architecture Major and Logistics Resources.** Campus greening maintenance and landscape transformation spent a lot of manpower, financial, and material resources every year. In order to achieve the dual objectives of mutual benefit and students' practical ability training, and to ensure the sustainability and practicability of the practical teaching base, the college of environmental engineering (Landscape architecture major belonged to the college of environmental engineering) and the logistics office signed a long-term internship cooperation agreement to build a practical teaching base of landscape architecture majors. Under the guidance of the university, leadership and the assistance of the equipment office, the finance office, the dean's office, and the student affairs office, the basic mode of co-construction of the practical teaching base between college and logistics was established (Figure 2), which formed the relationship of interdependence and in-depth cooperation.

The establishment of the campus environment practical teaching base saved the school's expenses, where the teachers and students built the campus environment as masters. The teachers and students had a sense of belonging and a stronger responsibility, so they had targeted the landscape

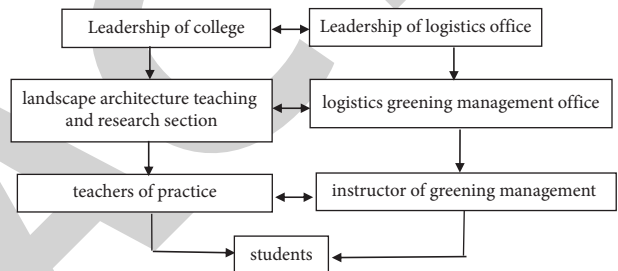


FIGURE 3: Management model of the campus's practical teaching base.

transformation of the campus environment and could create a suitable space environment for the teachers and students of the university to work, study, and live. On the other hand, the campus practical teaching base of landscape architecture majors broke the traditional single and laboratory-limited mode of the practical teaching base of landscape architecture majors, made full use of the effective logistics resources, and maximized its advantages. Therefore, the establishment of a practical teaching base of landscape architecture major based on the campus environment was an effective combination of professional teaching and logistics resources to achieve a win-win goal.

In the management of the practical teaching base, the system of co-management of college teachers and logistics personnel was explored. The college and logistics office jointly set up a leadership group to formulate a practical teaching base management program and a practical teaching model for students. The landscape architecture teachers and logistics greening team members were responsible for the content and arrangement of students' practice. The college and the logistics office selected teachers to jointly guide students' practical training (Figure 3).

**3.3. Realizing the "Four-Stage" Progressive Practical Teaching Chain.** The boring theoretical knowledge should be combined with practical teaching to understand and deepen the theoretical knowledge in practice and to develop students'

TABLE 1: “Four-stage” progressive training teaching chain form.

Training stage	Training course	Schedule
Basic practical ability training stage	Cognitive practice, art sketch, surveying practice, landscape botany practice	Semesters 1-4
Professional core skills' training phase	Landscape architecture design practice, landscape planning and design practice, landscape engineering practice Plant landscape design practice	Semesters 4-6
Comprehensive application ability training stage	Comprehensive practical training Graduation design	Semesters 6-8
Innovation and entrepreneurship capacity training stage	Innovation and entrepreneurship quality education for university students Graduation practice, innovation and entrepreneurship competition	Semesters 2-8



FIGURE 4: Landscape design competition works.



FIGURE 5: Plant pruning competition scene.

practical ability. Students' consciousness and ability of innovation and entrepreneurship should be cultivated throughout the whole teaching process [10,11]. According to students' cognitive order and the needs of campus environment construction, transformation, and beautification, a “four-stage” progressive practical teaching chain for landscape architecture

majors had formed and each stage could be completed in the campus practical teaching base.

The “four-stage” referred to the basic practical ability training stage, the professional core skill training stage, the comprehensive application ability training stage, and the innovation and entrepreneurship capacity training stage of



FIGURE 6: Campus beautification and culture construction.

the students. The training courses and time schedules of the “four-stage” corresponding ability are shown in Table 1. The “four-stage” training chain was progressively carried out in terms of students’ practical ability training, and there were overlaps and intersections in the time schedule of the training courses. For example, the cultivation of students’ innovation and entrepreneurship ability had been carried out since the second year of the course. Students were encouraged to participate in teachers’ scientific research and to declare innovative and entrepreneurship training projects; the cultivation of students’ innovation and entrepreneurship ability had continued until graduation.

In the basic practical ability training stage, students’ main practical courses included cognitive practice, art sketch, surveying practice, and landscape botany practice, which were arranged in semesters 1–4. In the professional core skills training phase, students’ main practical courses included landscape architecture design practice, landscape planning and design practice, landscape engineering practice, and plant landscape design practice, which were arranged in semesters 4–6. In the comprehensive application ability training stage, students’ main practical courses included comprehensive practice and graduation design, which were arranged in semesters 6–8. In the innovation and entrepreneurship capacity training stage, students’ main practical courses included innovation and entrepreneurship quality education for university students, graduation practice, innovation, and entrepreneurship competition, which were arranged in semesters 2–8.

#### 4. Achievements of the Practical Teaching Base

**4.1. Significant Improvement in the Quality of Talent Cultivation.** Since the foundation of the base in 2015, there

were more than 200 class hours practical training every year in the base, 30 students had graduation practice in the campus practical teaching base, and 6 students chose the theme of graduation design as campus landscape transformation. Two competitions: a “landscape design competition” (Figure 4) and a “plant pruning competition” (Figure 5) were held in the campus practical teaching base. Through the establishment of a green protection team and campus landscape renovation program bidding activities, students’ practical ability and teamwork awareness were enhanced.

At the same time, teachers guided the students to participate in the research projects of teachers, encouraged students to declare innovative projects and research topics, and conducted self-employment guidance in the practical teaching base. So far, relying on the base, the students had applied for 4 patents, applied for 6 subjects, and published 15 papers.

#### 4.2. Beautifying the Campus and Creating a Campus Culture.

According to the needs of the university landscape, the campus had been beautified and a comfortable environment for teachers and students had been created through such projects as planting flowers in tree pools, transforming *Prunus mume* forests and transforming *Cedrus deodara* forests [12]. Under the guidance of teachers, students listed plants on the campus and marked plant species and ecological habits, which could not only serve as the result of students’ practical training but also provide reference for teachers and students of other majors to gain science knowledge, so that teachers and students could better care for the campus environment (Figure 6). At present, more than 80% of plant species on campus had been listed. Under

the guidance of teachers, students took photographs and collected materials of plant species on campus and prepared to publish a book on plant Atlas of Xuzhou University of Technology.

**4.3. Improvement in the Practical Ability of Professional Teachers.** Professional teachers of landscape architecture majors learned and practiced at the base at any time, followed closely the new development of the landscape industry, and mastered the new knowledge and technology of landscape architecture in time. The professional practice ability had been exercised and the practice level of landscape architecture teachers had been improved and strengthened. At present, there were 11 professional teachers in the landscape architecture major and 7 teachers had the qualifications of practical teachers. Among them, 4 teachers had the titles of engineers and senior engineers. A well-structured “double-skilled” faculty team was initially formed.

## 5. Discussion and Conclusion

Our university made full use of the campus environment to exploratorily establish the campus practical teaching base for landscape architecture majors. This not only absorbed the theory of the production practical teaching base in higher vocational colleges but also applied it in applied undergraduate universities in combination with practice [13–16]. Our university constantly summarized and refined the combination of theory and practice, and in turn guided the construction of practical teaching bases and teaching reforms. The practical teaching base based on the campus environment had both scientific basis and practical test and realized the integration of theory and practice.

The establishment of the practical teaching base of landscape architecture majors in our campus aimed at cultivating students’ practical innovation ability and improving teaching quality in a large area, while the “double-qualified” teachers training and teaching reform closely combined with the improvement of campus environmental quality, so as to the beneficial groups (including students, teachers, schools, etc.) were maximized with the construction of the practical teaching base.

As the service department of the university, the logistics office has many of the resources that can be combined with the practical training of the university specialty, such as campus greening, power supply, water supply, and drainage. However, it remains a question as to how to combine the logistics resources and students’ professional training effectively, so that the logistics resources can effectively serve the practical teaching of each major, and at the same time, each major makes full use of its own advantage to feed back in the logistics construction, which requires the joint efforts of multiple departments of the university. Under the overall planning of university leaders and the cooperation of various departments such as the secondary colleges, the student affairs office, the finance office, the equipment office, and the dean’s office, the campus practical teaching base can not only save costs for the university but also serve the practical

teaching of related majors, so as to achieve multiple integration and maximize the comprehensive benefits.

In future, the research on the campus practice teaching base can be conducted in depth from the aspects of the close degree of the combination of college majors and campus elements, students’ practice and management methods, and the adjustment of talent cultivating programs.

## Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

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## Retraction

# Retracted: Protection and Inheritance of Traditional Culture in Urbanization Construction Based on Genetic Algorithm under the Concept of Environmental Protection

### Journal of Environmental and Public Health

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- [1] L. Guo, "Protection and Inheritance of Traditional Culture in Urbanization Construction Based on Genetic Algorithm under the Concept of Environmental Protection," *Journal of Environmental and Public Health*, vol. 2022, Article ID 5844732, 10 pages, 2022.

## Research Article

# Protection and Inheritance of Traditional Culture in Urbanization Construction Based on Genetic Algorithm under the Concept of Environmental Protection

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Chinese traditional culture is a typical “moral culture,” and traditional morality is the core and essence of culture. However, in recent years, the phenomenon of following the trend of rural construction has been particularly serious, and many villages have lost their original features. To solve the above problems, the genetic algorithm can be used to further explore the traditional culture of urbanization construction. A genetic algorithm is a natural evolutionary process that imitates natural selection and genetic operation in nature to obtain optimal solution, in which genetic operation mainly includes the processes of gene replication, crossover, and mutation. This paper studies the traditional culture of urbanization construction based on the genetic algorithm under the concept of environmental protection. Among the accuracy of urban construction land expansion, in 2018, the accuracy of ant colony algorithm, data mining algorithm, and particle swarm optimization algorithm is 58%, 51.8%, and 56.7%, respectively. The accuracy of this genetic algorithm is as high as 58.8%. It can be seen that the genetic algorithm in this paper has the highest accuracy in the expansion of urban construction land. Therefore, in the process of large-scale urbanization based on the genetic algorithm, we should pay attention to not being separated from traditional culture, not letting farmers lose their regional culture, local culture, and grassroots culture, and protecting the cultural-ecological environment on which these cultures depend.

## 1. Introduction

The original meaning of “culture” is “rule of culture” and “enlightenment,” that is, to influence and restrict people with ethics and etiquette and music rules and regulations. Chinese traditional culture is a typical “virtue culture,” and traditional morality is the core and essence of culture. However, in recent years, the phenomenon of following the trend of rural construction is particularly serious. Many villages have lost their original characteristics. The history and culture of countryside have also been damaged or even destroyed to varying degrees. This blind demolition and construction and disorderly development and construction pose a serious threat to the rural pattern and the historical style inherited for thousands of years [1]. At the same time, with the emergence of the word “nostalgia,” the local history and culture have been paid continuously more attention. China’s urbanization construction is the core of the overall

development of urban and rural areas and the carrier of the further expansion of industrialization. Urbanization construction should establish the concept of people-oriented and spatial balance, innovate the development mode, reflect and highlight the regional cultural characteristics of cities and towns, and promote the healthy development of urbanization construction with the construction of cultural characteristics. In the process of new urbanization, the specific methods of protecting and utilizing traditional culture are realistic and typical in Tibetan areas across the country. Therefore, through analysis and research on the protection and utilization of traditional culture in the process of new urbanization, it is of great and far-reaching significance to carry forward Chinese traditional culture and enhance the due historical status of Tibetan traditional culture [2, 3].

Under the concept of environmental protection, this paper analyzes the protection of traditional culture in

urbanization construction and uses the optimization algorithm of the genetic algorithm to solve some problems of traditional culture in urbanization construction. A genetic algorithm is a natural evolutionary process that imitates natural selection and genetic operation in nature to obtain optimal solution. Among them, genetic operation mainly includes the process of gene replication, crossover, and mutation. Therefore, the operation process of the genetic algorithm is also the process of genetic variation of simulated genes and the calculation method of selecting excellent individuals through copying, crossover and mutation operations, and selection operations. As we all know, biological evolution is based on Darwin's biological evolution theory, and the next generation of biological groups is produced by the reproduction of the previous generation of biological groups. Therefore, the main content of the abstract genetic algorithm, which simulates the evolution process of organisms, is to simulate the evolution process of biological groups. In essence, the genetic algorithm is a direct search method that does not depend on specific problems. The genetic algorithm has been applied in pattern recognition, neural network, image processing, machine learning, industrial optimization control, adaptive control, biological science, social science, and so on. The main problem to be solved in the process of genetic algorithm operation is the chromosome coding method, which is the key problem of genetic algorithm implementation, the method of transforming optimal solution from solution space-to-gene space, and the gene expression of optimal solution [4]. The quality of solution transformation will affect the evolutionary efficiency and degree of optimization [5].

People in different regions and environments have gradually formed their own unique local culture and regional culture in the long-term production practice. The forms of expression include local drama, arts and crafts, folk stories, and handicrafts. Different regions have also shaped the cultural elements, such as the character and beliefs of the local people. Under the concept of environmental protection, the traditional culture of urbanization construction is studied based on the genetic algorithm. In the process of promoting the overall development of urban and rural areas, one of the policies and measures to implement industry-feeding agriculture and cities supporting rural areas is to promote industrialization and urbanization. Industrialization is an important part of economic development, and urbanization is the main carrier and driving force of economic development [6]. Through the genetic algorithm, the evaluation index system of urban renewal project transformation potential and the evaluation index system of urban renewal project transformation urgency under the concept of environmental protection are established, and then the location model of urban renewal priority transformation project is constructed from the perspectives of efficiency and fairness. With the help of the genetic algorithm, the location scheme meeting the actual needs is solved, which verifies the accuracy, scientificity, and operability of the model. It provides a practical basis for the transformation sequence of traditional cultural projects in urbanization construction. Urbanization itself is a process of

cultural convergence. Therefore, in the process of large-scale urbanization based on the genetic algorithm under the concept of environmental protection, we should pay attention not to be separated from traditional culture, let farmers lose their regional culture, local culture, and grassroots culture, and protect the cultural ecological environment on which these cultures depend. The innovations in this are as follows:

- (1) This paper constructs the traditional cultural structure model of urbanization. The solution process of this model is similar to the evolution process of biological natural selection, and it is a process of iterative evolution from generation to generation. The fitness of individuals is calculated by fitness function, and proportion is divided on the wheel according to the fitness. Each individual is like a sector in the wheel, and a pointer is placed on the wheel to randomly select. The greater the fitness, the greater the probability of being selected, and the smaller the fitness, the smaller the probability of being selected.
- (2) The trend of the urban construction land expansion rate was tested and analyzed. From the perspective of the expansion rate, the growth rate from 2016 to 2021 showed the characteristics of first increasing and then decreasing. From 2016 to 2019, the expansion rate of urban construction land under the genetic algorithm reached 12% at the fastest, followed by 10% under the particle swarm algorithm, while the ant colony algorithm and data mining algorithm were only about 7% and 1%, respectively. It can be seen that the genetic algorithm in this paper is important in the expansion rate of urban construction land.

The overall structure of this paper consists of five parts.

The first chapter introduces the background and significance of traditional culture in urbanization. The second chapter mainly describes the research status of traditional culture in urbanization at home and abroad. The third chapter describes the principle and model of the genetic algorithm and the content of traditional culture protection and inheritance in urbanization. In chapter 4, simulation verification and analysis are carried out. The fifth chapter is a summary of the full text.

## 2. Related Work

*2.1. Research Status at Home and Abroad.* Guo et al. proposed that in the process of traditional urbanization, due to the lack of restraint mechanism for the protection and development conditions of rural cultural resources and the lack of attention to the scientific development of rural culture, rural culture is distorted and distorted, and the value of rural culture is greatly reduced [7]. Cheung et al. proposed that in the process of improving the appearance of villages, urbanization and ecological civilization, national unity, follow-up industry cultivation, spiritual civilization construction of farmers and herdsmen, and improvement of

urban cultural connotation should be mutually promoted to reflect the characteristics [8]. Yang et al. proposed that the common development of urban and rural areas is an important premise and fundamental policy to narrow the economic and social gaps between urban and rural areas, and it is also the best choice to solve the contradictions and problems between urban and rural areas at present and in the future [9]. Liu et al. proposed that new urbanization has made a great change in the development of human society in Tibetan areas for thousands of years, so the protection and utilization of traditional culture is to inject new soul and add gorgeous color to it [10]. Li et al. pointed out that traditional culture is neglected in construction of urbanization, and there is a lack and dislocation of ideas for the construction of traditional culture [11]. Zhao et al. proposed that actively promoting the coordinated development of urban and rural areas is to establish a market system for the rational allocation of production factors between urban and rural areas, an effective system for the benign interaction of the urban and rural economy, and an operation mechanism for the common development of urban and rural social undertakings and infrastructure, and strive to eliminate the institutional obstacles to the coordinated development of urban and rural areas [12]. Zhang et al. proposed that market pursues the maximization of economic benefits. In the process of urbanization, it often pays too much attention to people's material prosperity, the development level of public cultural services is low, and even destructive development and utilization have caused irreparable losses to excellent traditional culture [13]. Li et al. proposed that rural urbanization should not blindly oppose the development strategy of big cities, or idealize the strategy of small towns, but should adopt diversified and low-cost development strategy to realize the all-round development of cities and towns, realize the low-cost of rural labor transfer to cities and towns, and the low cost of urban and urban construction, so as to facilitate the smooth transfer of a large number of rural labor [14]. Wang et al. proposed that the relevant elements with rural cultural resources as the core were not revitalized, resulting in the phenomenon of "foreign village" common, or the "one-time tourism consumption" of rural cultural products due to the rough utilization of relevant elements, which failed to extend the value chain of rural cultural resources [15]. Hakak et al. proposed that the overall protection and inheritance of traditional culture under the construction of new urbanization is based on the full excavation of regional material culture and intangible culture, so as to form a traditional cultural inheritance policy with clear protection direction and local characteristics through continuous efforts [16].

*2.2. Research Status of This Paper.* In this paper, the traditional culture of urbanization construction is studied based on the genetic algorithm under the concept of environmental protection. Traditional urbanization is not conducive to the protection, inheritance, and innovation of rural culture. In the process of new urbanization construction, the homesickness concept is used to guide the protection,

inheritance, and innovation of rural culture, hoping to find a way to realize that the protection and development of rural culture complement each other, and inheritance and innovation keep pace with each other. Compared with rural areas, urban areas are more efficient, so we think that urbanization should be efficient in all aspects, including land conservation, but our urbanization is constantly devouring our land. The ultimate goal of the overall planning of urban and rural areas through the genetic algorithm is the integration of urban and rural areas, which is the advanced stage of modernization and urbanization, and the process of mutual absorption of advanced and healthy factors, rejection of backward and morbid conditions, mutual integration, and two-way evolution between urban and rural areas. On the basis of digging and protecting local history and culture in the genetic algorithm, rural development develops regional characteristic environmental protection industry, which drives rural development. However, completely copying or letting it develop is not conducive to the further advancement of urbanization in China. Therefore, it is necessary to take functional cultivation as foundation, cultural characteristics as the fulcrum, industrialization as the driving force, regional urban cluster construction, coordinated development of the large, medium, and small cities and small towns as the basic mode to make a good plan, and take the urbanization road of sustainable development in accordance with the principles of gradual progress, land conservation, intensive development, and rational layout. For the protection and inheritance of rural history and culture, a feasible planning method is put forward in the genetic algorithm under the concept of environmental protection, so as to protect the development space of environmental protection concept of Chinese history and culture, enhance its vitality, and have very important practical significance for carrying forward local culture and protecting the integrity of the Chinese nation's historical context.

### 3. Research Method

*3.1. Principle and Model of the Genetic Algorithm.* Genetic algorithm is an adaptive probabilistic search method, and the search process is based on global search. Its algorithm idea is similar to natural selection evolution. It is a simulation of biological genetic evolution in nature. It has penetrated into various fields of research and engineering with its strong problem-solving ability and wide adaptability, and achieved good results [17]. Genetic algorithm is a random, iterative, and evolutionary search method based on natural selection and population genetics. All natural species survive by adapting to the environment, which is the main law of the genetic algorithm. In the genetic algorithm, genetic operation mainly includes selection, crossover, mutation, and other operations. Through the change of some gene segments, biological genetic operation, and survival of the fittest in nature are realized [18]. In the operation process, some operation parameters will be involved, and the design of these parameters is generally randomly generated. Firstly, we determine the first-generation population, set the population number, and code it; we determine fitness



function and calculate the fitness of population; optimal individuals are selected by the selection operator to form the next generation population, and individuals in the next generation population are cross-exchanged and mutated to form new individuals. When the number of iterations is completed, we search for the optimal individual output; otherwise, we continue the iteration. The flow of the genetic algorithm is shown in Figure 1.

3.1.1. ① *Choose*. When the population size is set, if the value is small, the diversity of population will be lost, resulting in premature convergence and failure to reach optimal solution. However, if the value is too large, the operation time of the genetic algorithm program will be prolonged, which will affect the operational efficiency.

3.1.2. ② *Crossover*. When the crossover probability is chosen, if the crossover probability is too large, it will affect the dominant gene inheritance of population itself, which is not conducive to the optimization of the whole population. However, if the crossover probability is too small, the generation speed of new individuals will slow down, and when the number of iterations reaches, optimal solution can still not be reached.

3.1.3. ③ *Variation*. When mutation probability is selected, if mutation probability is too large, it will lead to too many gene mutations, which will make the difference between the new individual and the parent individual too large, thus losing the adaptive advantage of the genetic algorithm, resulting in the search process of optimal solution having no direction, and becoming the random search for optimal solution. However, if the mutation probability is too small, it will be difficult to generate new individuals, resulting in the generation of local optimal solutions [11].

When the impact on the result is positive, the data standardization formula is as follows:

$$A = \frac{A_{ij} - A_{j\min}}{A_{j\max} - A_{j\min}} \quad (1)$$

When the impact on the result is negative, the data standardization formula is as follows:

$$A = \frac{A_{j\max} - A_{ij}}{A_{j\max} - A_{j\min}} \quad (2)$$

where  $A$  is the standardized value of the index,  $A_{ij}$  is the actual value of the  $j$  index in the  $i$  year,  $A_{j\min}$  is the minimum value of index  $j$ , and  $A_{j\max}$  is the maximum value of  $j$  index.

According to the judgment matrix, the eigenvector  $\omega$  corresponding to the maximum eigenvalue  $\lambda_{\max}$  of the judgment matrix can be further obtained. The formula is as follows:

$$A\omega = \lambda_{\max}\omega \quad (3)$$

Then, the feature vector is normalized. The result of normalization is the ranking of the importance of corresponding index factors, that is, weight,  $\omega = (\omega_1, \omega_2, \dots, \omega_n)^T$ .

The transformation potential of the renewal project is evaluated, and the formula expression is

$$S = \sum_{i=1}^n f_i \omega_i \quad (4)$$

In the genetic algorithm, it is realized through the selection operator. The probability of individuals with high fitness to be inherited to the next generation population is relatively large, and the probability of individuals with low fitness to be inherited to the next generation population is relatively small. Finally, they continue to approach optimal solution. At the beginning of the development of rural tangible and intangible cultural resources by the genetic algorithm, it is necessary to clarify the constraints on the protection and development of rural cultural resources, that is, to find the constraints affecting the protection and development of rural cultural resources [19]. The development of cultural resources in this area through the genetic algorithm only provides preconditions for the development of rural cultural resources. If rural cultural resources need to be developed, it is also necessary to improve the function of elements, sublimate the function of elements, transform and optimize elements, and optimize elements. The traditional cultural structure model of urbanization construction is constructed, as shown in Figure 2.

The transformation potential of the urban land parcel can comprehensively and objectively measure the importance of urban renewal projects. The greater the transformation potential, the less difficult the transformation of the urban land parcel and the greater the benefits. The potential of urban reconstruction plays an extremely important role in judging the site selection of priority reconstruction projects. The formula for calculating the potential of urban land parcel projects to be evaluated is as follows:

$$P_i = \sum_{j=1}^n a_j \text{Potential}_{ij} \quad (5)$$

where  $P_i$  is the potential value of the  $i$  plot to be evaluated,  $a_j$  is the index weight of the  $j$  index, and the standardized index value of the  $j$  index of the  $i$  plot.

A multi-factor comprehensive evaluation method is used to analyze and evaluate the urgency of renewal projects. The calculation formula of the urgency of the plot project to be evaluated is as follows:

$$u_i = \sum_{j=1}^n b_j \quad (6)$$

where  $u_i$  is the urgency of the  $i$  plot project to be evaluated,  $b_j$  is the index weight of the  $j$  index, and the standardized index value of the  $j$  index of the  $i$  plot project.

Due to limited renovation funds and other reasons, it is impossible to renovate all updated plots in a short period of

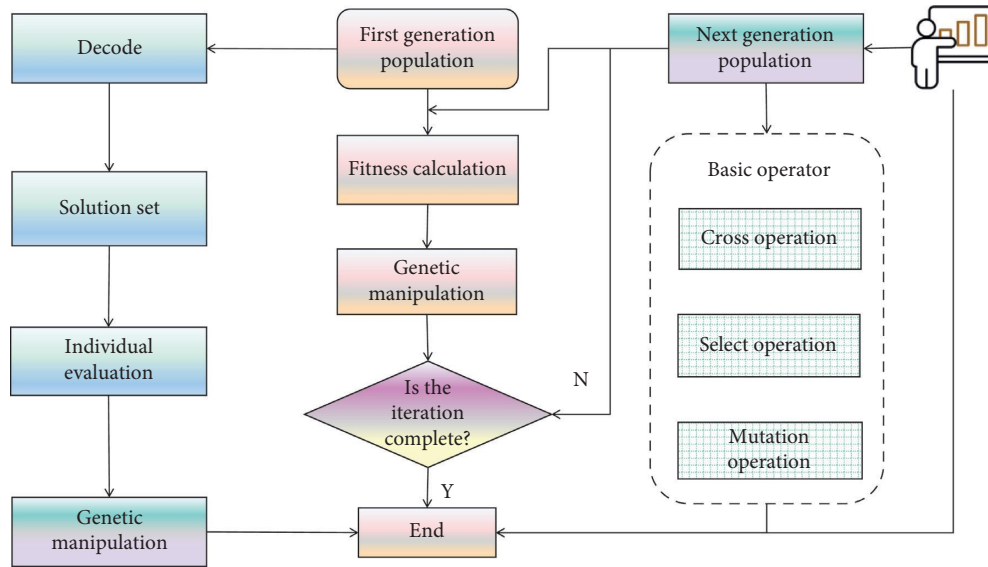


FIGURE 1: Flow chart of the genetic algorithm.

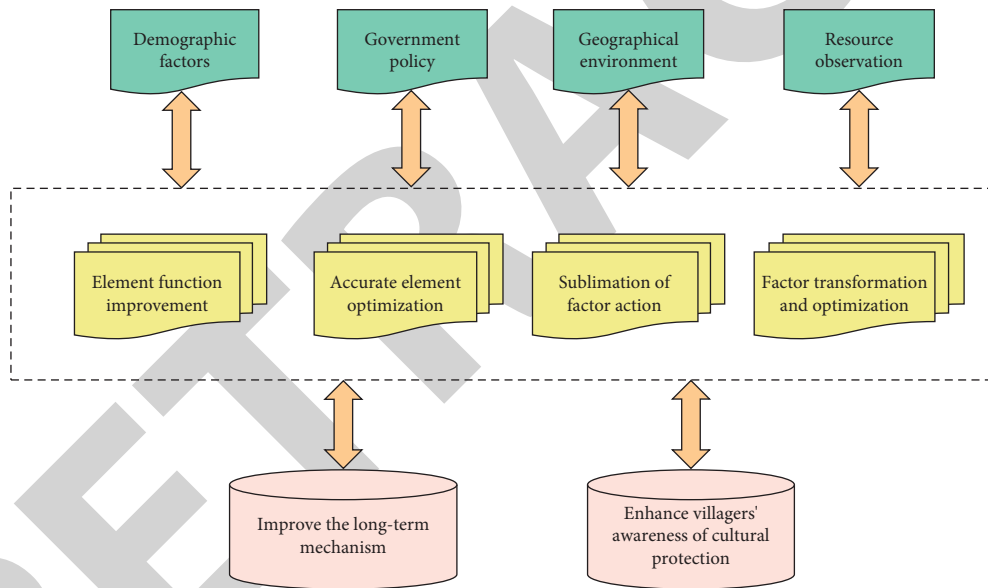


FIGURE 2: Model diagram of traditional cultural structure in urbanization construction.

time, so it is necessary to limit the total area of the plots that have priority for renovation, namely,

$$\sum_{i=1}^n x_i c_i \leq S, \tag{7}$$

where  $c_i$  ( $i = 1, 2, 3, \dots, n$ ) is the area of each plot and  $S$  is the priority transformation mode.

That is,  $S$  should meet the following conditions in quantity.

$$\sum_{i=1}^n x_i c_i \leq 1500. \tag{8}$$

In the genetic algorithm, it is very important to determine fitness function. Selection, also known as replication, is

the process of selecting excellent individuals in population to produce new population. The main body of biological evolution is population, and the calculation object of genetic calculation is also a set composed of individuals, that is, population. The operation and solution process of the genetic algorithm is very similar to the evolution process of biological natural selection. It is an iterative evolution process from generation to generation. We calculate the fitness of individuals through fitness function, and divide proportion on the roulette according to the fitness. Each individual is like a sector part of the disc. We put a pointer on the roulette for random selection. The greater the individual fitness, the greater the probability of being selected, and the smaller the fitness, the smaller the probability of being selected. Generally speaking, there are three common

methods to solve optimal solution: enumeration method, heuristic method, and search method. Because the types of problems are different and the scale of problems is also different, it is unrealistic and difficult to find a general method to solve all optimization problems. However, the genetic algorithm can provide us with a practical and effective way and a relatively general and universal model and create a global heuristic optimization search algorithm.

**3.2. Content of Protection and Inheritance of Traditional Culture in Urbanization.** China has a cultural awareness of advocating nature since ancient times. Influenced by Chinese traditional culture, it believes that the Earth is an organic natural body, of which human beings are only a part. Therefore, in rural site selection and the formation of rural texture under the concept of environmental protection, people are mostly integrated into nature and live with nature according to natural conditions. The coordinated development of new urbanization also requires the integration of nature and humanities, and the combination of modern elements and traditional culture. In new urbanization, we advocate the concept of environmental protection, respect for nature, and conform to nature, which embodies the concept of harmony between man and nature. In terms of landscape, relying on the unique natural scenery in rural areas at present, let new towns integrate into nature. Using the natural environment conditions, it can be roughly summarized into three types of site selection: along the river, by the mountain, and by the lake, so that the layout of the countryside is well integrated with the natural landscape, which has been passed down to this day by the long river of time. In the protection and inheritance of excellent traditional culture in rural areas, professionals should emancipate their minds and engage in this work in a way that keeps pace with the times. The reason why culture can still be preserved in the changes of the millennium depends on the spread of the spirit and core of the environmental protection concept, and some forms of changes will not destroy its intrinsic value. In order to realize the great development and prosperity of rural cultural undertakings and the sustainable development of rural cultural industries, it is necessary to develop various technologies and equipment dedicated to rural culture and art with various environmental protection concepts, so as to provide a technical and benefit platform for rural environmental protection cultural industries.

Excellent traditional culture is the embodiment of regional soft power and the basis of national identity, national cohesion, innovation, and development. We should pay attention to its influence and constantly explore the path of inheritance and development of traditional culture. The relevance between tradition and modernity makes the renewal process more natural and coherent, so as to better solve the inheritance of local history and culture and integration with modern society. In the process of renewal and development, the main context and constituent elements of rural texture should be organically renewed on the basis of respecting the original texture and structure, so as to maintain the original rural characteristics. It is worth noting

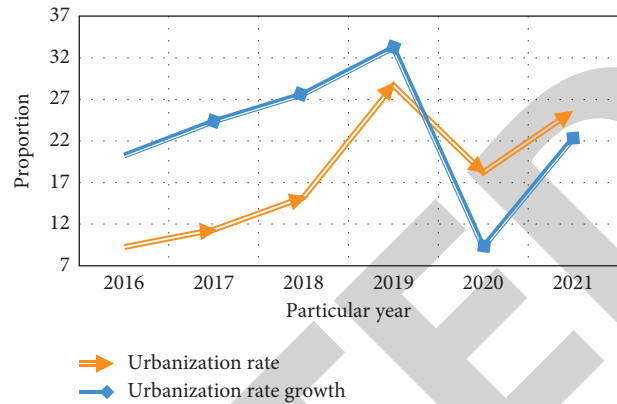


FIGURE 3: Changes in the urbanization rate and urbanization rate growth of a province from 2016 to 2021.

that we should pay attention to three principles in the inheritance of traditional culture under the concept of environmental protection. The protection and restoration of existing ancient relics and ancient buildings should pay attention to the authenticity, repair the old as the old, and try not to destroy the traditional cultural value contained therein. Integrity is to consider the overall environment as much as possible in the protection of historical buildings and traditional villages. Integration is the integration of nature and humanities, modernity and tradition in the protection, and inheritance of the overall traditional culture. The protection of important ancient buildings in rural areas, especially historical and cultural heritage, should be consistent with the local traditional context. For some important residential buildings and historical relics, specific environmental protection plans should be made to ensure reasonable implementation. On this basis, we should deeply explore the historical knowledge behind it, so as to create a local cultural card. Therefore, some innovative cultural protection behaviors should be supported as appropriate. For example, Kaifeng rural areas can also promote some tourism peripheral products through e-commerce platforms, and use group purchase, discount, etc. to promote the increase of tourist flow in the scenic spot. In the process of the era of the environmental protection concept, it is also necessary to pass on some ancient civilizations by “following the fashion”.

#### 4. Simulation and Analysis

Generally speaking, urbanization has been developing at a high speed since the reform and opening up. According to the official data released by a province from 2016 to 2021, this paper conducted an experiment on the urbanization rate and its growth rate. The experimental results are shown in Figure 3.

As can be seen from Figure 3, the urbanization rate of a province increased from 8.9% to 28% from 2016 to 2021, with an average annual increase of about 1.25 percentage points. The total urban population increased from 6.23 million in 2016 to 48.51 million in 2021, with an average annual growth of 998000. The per capita GDP increased from 324 yuan in the early stage of reform and opening up to 5958 yuan in 2021. A series of data show that the

TABLE 1: List of main economic indicators of a province in 2021.

Total index	Numerical value	GPer capita index growth rate	Per capita index	Numerical value	Growth rate
GDP	45241.75	10.8	Per capita GDP	47334	10.1
Added value of secondary industry	24016.12	11.6	Per capita local general budget revenue	3591.21	24.62
Added value of secondary industry	17370.88	11.2	Energy consumption per 10000 yuan GDP	0.85	-3.76
Total imports and exports	2359.91	24.8	Dependence on foreign trade	33.5	0.8

urbanization of the province has occupied a pivotal position in the economic construction of the whole society.

In 2021, the main economic indicators of a province were analyzed experimentally, as shown in Table 1.

It can be seen from Table 1 that the economy of a province continues to maintain a steady and rapid development rate, and the GDP of the province has reached 4524.175 billion yuan, an increase of 10.8 percentage points compared with 2018. The industrial structure was further optimized. In 2021, the proportion of three industrial structures in the province was 8.8:53.6:37.3.

A genetic algorithm is used to calculate the landscape pattern index of urban construction land in a municipal area from 2018 to 2021, so as to analyze the landscape pattern characteristics of urban construction land expansion in a municipal area. Among them, LPI represents the proportion of the largest patch area of urban construction land in the total area, Contag represents the spatial aggregation degree of urban construction land, and Shei represents the balance of urban construction land distribution. The landscape pattern index of urban construction land is shown in Table 2.

As can be seen from Table 2, the number of patches of urban construction land in a municipal area gradually increased from 2018 to 2021 and decreased from 2020 to 2021, indicating that in the rapid development stage of 2018–2020, the expansion of urban construction land in a municipal area is mostly regional development, resulting in an increasing number of patches. After 2020, the development mode was gradually adjusted, the urban spatial layout was optimized, the regional development was made more centralized and balanced, and the number of fragmented patches was reduced.

Three regions for experimental analysis were selected, namely Shandong, Guangdong, and Hebei, and carried out experiments on their urbanization rate from 2016 to 2021. The experimental results are shown in Figure 4.

It can be seen from Figure 4 that the urbanization rate of three regions showed an increasing trend from 2016 to 2021, with an average annual growth rate of 1.25%. In 2018, the population urbanization rate of Shandong Province reached 53.2%, exceeding the national average. With the increase of urbanization rate, the quality of urbanization development is also improving. The factors closely related to urbanization, such as population employment, economic development, urban construction, residents' life, social development, and ecological environment, have developed harmoniously in the process of urbanization, and urbanization has entered a stage of high-quality development.

TABLE 2: Landscape pattern index of urban construction land in a municipal district from 2016 to 2021.

Particular year	NP	LPI	Contag	Shei
2018	496	96.978	88.512	0.194
2019	527	96.835	88.104	0.203
2020	561	96.165	86.412	0.231
2021	473	96.016	85.887	0.241

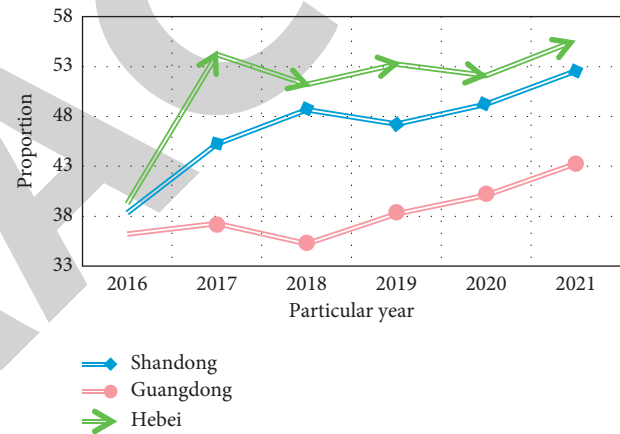


FIGURE 4: Urbanization rate trend in different regions from 2016 to 2021.

The simulation benchmark data selected in this study is the land use data of a municipal area in 2021. Taking the simulation from 2019 to 2021 as the benchmark, the initial weight is calculated to simulate the expansion of urban construction land in a municipal area from 2019 to 2021. The area statistics of various land use types in a municipal district in 2019, 2020, and 2021 are shown in Table 3.

As can be seen from Table 3, on the whole, more than 91% of the land in a municipal district is covered by cultivated land, woodland, and grassland, of which woodland occupies the largest area, and even after the rapid development in the 11th five-year plan and the 12th five-year plan, its proportion has remained stable at 35%, followed by grassland, which has remained stable at about 33.5%, making it a veritable forest city. After fifteen years of development, it gradually increased to nearly 5%. During the 12th five-year plan period, the area of urban construction land in a municipal district increased by about 25%, with an obvious growth rate and remarkable achievements in the development of new urbanization.

From 2016 to 2021, this experiment used ant colony algorithm, data mining algorithm, particle swarm

TABLE 3: Area statistics of land use types from 2019 to 2021.

Category	2019		2020		2021	
	Area	Proportion	Area	Proportion	Area	Proportion
Woodland	924.436	36.082	1308.427	36.094	1308.082	36.084
Urban construction land	109.133	3.012	114.262	3.151	137.308	3.787
Unused land	1.273	0.036	1.273	0.034	1.273	0.034

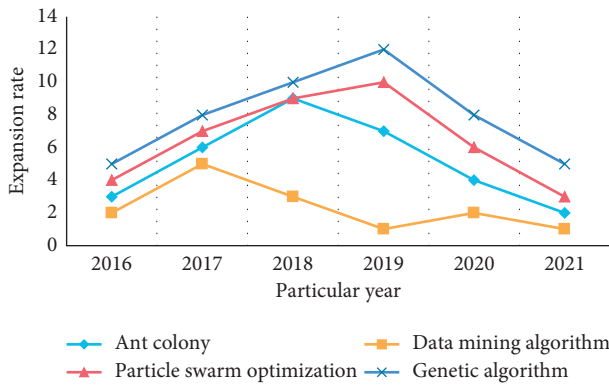


FIGURE 5: Trend of urban construction land expansion rate with different algorithms.

optimization algorithm, and genetic algorithm to study the expansion rate of urban construction land. The experimental results are shown in Figure 5.

As can be seen from Figure 5, from the perspective of expansion rate, the growth rate from 2016 to 2021 showed the characteristics of first increasing and then decreasing. From 2016 to 2019, the expansion rate of urban construction land under the genetic algorithm reached 12% at the fastest, followed by 10% under the particle swarm algorithm, while the ant colony algorithm and data mining algorithm were only about 7% and 1%, respectively. It can be seen that the genetic algorithm in this paper is important in the expansion rate of urban construction land.

From 2016 to 2021, the accuracy of urban construction land expansion was studied by ant colony algorithm, data mining algorithm, particle swarm optimization algorithm, and genetic algorithm. The experimental results are shown in Figure 6.

As can be seen from Figure 6, among the accuracy of urban construction land expansion, during 2018, the accuracy of the ant colony algorithm for urban construction land expansion was 58%, the accuracy of the data mining algorithm was 51.8%, the accuracy of the particle swarm optimization algorithm was 56.7%, and the accuracy of the genetic algorithm in this paper was as high as 58.8%. It can be seen that the accuracy of the genetic algorithm in urban construction land expansion is the highest.

This experiment is still in 2016–2021. Ant colony algorithm, data mining algorithm, particle swarm optimization algorithm, and genetic algorithm are used to study the growth rate of urban construction land expansion. The experimental results are shown in Figure 7.

As can be seen from Figure 7, in the growth rate of urban construction land expansion, during 2019, the growth rate of

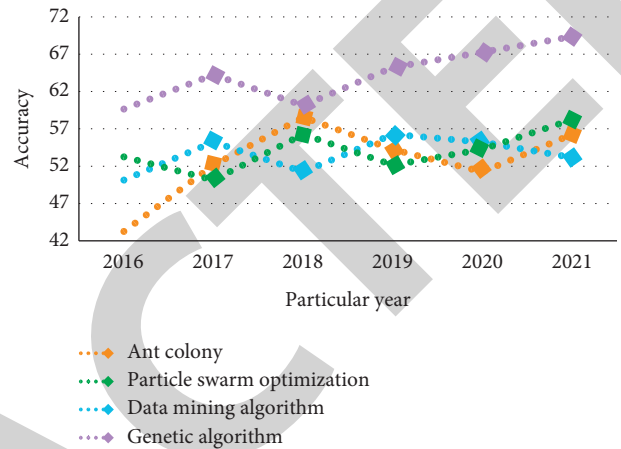


FIGURE 6: Accuracy of urban construction land expansion with different algorithms.

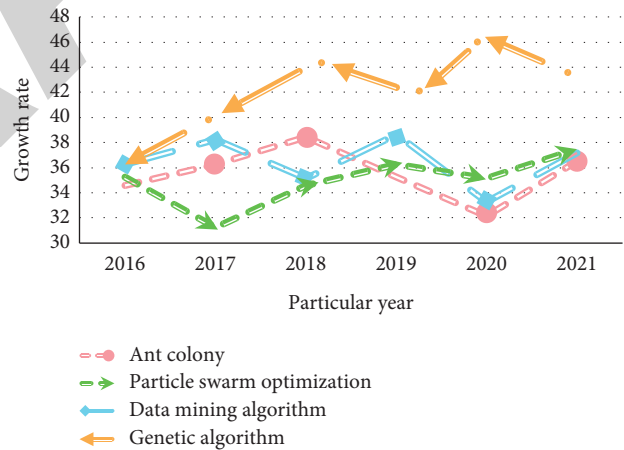


FIGURE 7: Growth rate of urban construction land expansion with different algorithms.

urban construction land expansion of the ant colony algorithm is 35.6%, the growth rate of the data mining algorithm is 35.2%, the growth rate of the particle swarm optimization algorithm is 36.2%, and the growth rate of the genetic algorithm in this paper is 42.1%. It can be seen that the growth rate of the genetic algorithm in urban construction land expansion is the highest and shows an increasing trend.

### 5. Conclusions

To sum up, this paper studies the traditional culture of urbanization construction based on the genetic algorithm under the concept of environmental protection. Among the

accuracy of urban construction land expansion, in 2018, the accuracy of the ant colony algorithm for urban construction land expansion was 58%, that of the data mining algorithm was 51.8%, that of the particle swarm optimization algorithm was 56.7%, and that of the genetic algorithm in this paper was as high as 58.8%. It can be seen that the genetic algorithm in this paper has the highest accuracy in the expansion of urban construction land. On the practical level, urbanization construction through the genetic algorithm should pay special attention to the concept of environmental protection, the inheritance and embodiment of cultural traditions, and advocate the establishment of a constructive development concept characterized by showing uniqueness with an open concept, so as to build a colorful world where constructive development and culture coexist harmoniously. In China, villages are earlier than cities, and their emergence and development have certain rules to follow, which endows them with profound historical accumulation. If we want to protect history and culture under the concept of environmental protection, we must clearly show it and let it continue to develop healthily, so as to achieve the purpose of protection. In the process of development, it should be noted that urban and rural areas are different spatial areas, which must have different characteristics and respective advantages. In order to realize the great development and prosperity of rural cultural undertakings and the sustainable development of rural cultural industries, it is necessary to develop various technologies and equipment dedicated to rural culture and art with various environmental protection concepts, so as to provide a technical and benefit platform for rural environmental protection cultural industries.

### Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

### Conflicts of Interest

The authors declare that they have no conflicts of interest.

### Acknowledgments

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## *Retraction*

# **Retracted: Multiple Influences of Intelligent Technology on Network Behavior of College Students in the Metaverse Age**

### **Journal of Environmental and Public Health**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] J. Ge, "Multiple Influences of Intelligent Technology on Network Behavior of College Students in the Metaverse Age," *Journal of Environmental and Public Health*, vol. 2022, Article ID 2750712, 7 pages, 2022.

## Research Article

# Multiple Influences of Intelligent Technology on Network Behavior of College Students in the Metaverse Age

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The advent of the metaverse age has gradually transformed digital survival from a fantasy in science fiction to a reality. Especially in recent years, the college students, as the objects of ideological and political education in universities, have been deeply embedded in their learning, social interaction, entertainment, and consumption behaviors, presenting new characteristics of the times. From the aspects of the background of intelligent technology on College Students' network behavior, the types of College Students' network behavior, the multiple effects of intelligent technology, the nature of College Students' network behavior, etc., provide some basis for ideological and political education.

## 1. Introduction

The term “meta universe” was first born in the science fiction avalanche published by the American writer Neil Stephenson in 1992. In the novel, a huge virtual network world parallel to the real world is constructed. Users communicate and entertain through their own “avatars,” and they live and work in the virtual network world. As a new form of the next generation Internet, meta universe is reshaping everyone's way of working, studying, shopping, traveling, socializing, and obtaining information.

In 2021, Facebook officially changed its name to “Meta,” which was derived from the “meta universe” (Metaverse). CEO Mark Zuckerberg said, “the next platform and medium will be a more immersive and embodied Internet, and you will be in the experience, not just as a bystander, which we call the metaverse.”

Negroponte describes in digital survival: “digital existence is a state of social existence in digital form; a way of existence, a new way of living in digital space, the sum of actions occurring in the digital environment and its experiences and feelings.” [1].

With the arrival of the metaverse age, digital survival has gradually changed from a fantasy in science fiction to a

reality. Especially in recent years, during the impact of the COVID-19 epidemic, college students rely on the Internet to study, socialize, enjoy entertain, and consume, during the special period, ensuring their basic learning and social needs. As the object of ideological and political education in colleges and universities, the college students, with the growth of the Internet, have become an urgent problem to explore the multiple influences of intelligent technology in the metaverse age on the network behavior of the college students.

## 2. Background Analysis of The Network Behavior of College Students in the Metaverse Age

*2.1. From Web Portals to the Era of Smart Media.* With the development of technology, the Internet has also experienced three eras, namely, portal era, search/social era, and intelligent Internet era. From Web 1.0, Web 2.0, Web 3.0, every era has a distinct technological development and era brand.

If the first generation of Internet is represented by PC Internet and the second generation of Internet is mobile Internet, then the third generation is the digital intelligent



Internet represented by VR glasses and other new wearable devices and technologies, which means that it will soon enter the metaverse age.

College students earliest contact is the Web 1.0 era, also called the portal age. At Sina, Sohu, and Netease, network communication is often one-way, for web information processing and editing and presented to network users for browsing and editing rights concentrated in the portal and mainstream media, and it can almost have little interaction.

The concept of “Web 2.0” began in 2004 in a brainstorming forum between press operators O’Reilly and Media Live International. This is also an era when college students have the most contact with the Internet. In the era of Web 2.0, social media emerged in an endless stream. The emergence of QQ, blog, RenRen, Weibo, WeChat, and other websites and apps makes the network communication change from one-way communication to two-way interaction. At the same time, the power of information collection and content release owned by professional news editors in the past has gradually weakened. With the advent of the era, everyone can have “microphone” and “voice.” As individual college students, they can also become the main body of content production. The institutionalized and organized centralized collection and editing of professional websites have been expanded into the content production with both the centralized gathering and editing of professional websites and the randomness and self-control of WeMedia. Grassroots power also began from this era and stepped on the stage. More and more online opinion leaders and online bloggers have millions of fans and have a voice that they did not have in real life.

The Web 3.0 era is a new era of big data, intelligent algorithms, represented by intelligence, openness, precision, and multidimensional characteristics. Nowadays, network carriers are not only limited to smart phones; smart glasses, watches, and other wearable devices have begun to put into the market and have a number of users. With the rapid development of smart devices, the real Internet of Things era will prevail. It is not difficult to imagine that, no matter which corner of the city, it will achieve intelligent interconnection through the Internet. Network becomes the user’s demand and provider, the network to the user, knowing what the user, wants and needs, resource screening, intelligent matching, and all-connected as college students, everyone’s received information is more accurate and personalized, gradually reaching “every individual, time networking, needed, real-time interaction” state.

*2.2. From Cyberg to Digital Survival.* The term cyberg (cyborg) originated in the 1960s, when Manfred Collins and Naesengram first proposed the concept in cyberg and Space.

“Cyberg” is often described in science fiction works such as “RoboCop” and “The Matrix” as various mechanical or biochemical people like humans. To sum up, Cyberg is actually a closely combined function of man and man. Nowadays, with the rapid development of medicine, biology, bionics, and other technologies, we are gradually realizing

the organic unity of human and artificial combination, such as mechanical prosthetic limbs.

Catherine Heller said in *Why We Are Later People*, “In the post-human opinion, there is no fundamentally different or absolute boundary between physical existence and computer simulation, between human structure and biological organization, and between robotics and human goals” [2]. “These devices existing in the human body promote the cyborgization of people, bringing enhanced human capabilities, including the connection between people, people and content, people and services, and human self-perception and environmental perception.” [2].

With the popularity of mobile and intelligent equipment, people with the help of intelligent equipment technology to strengthen their own functions, in a sense, have certain “berg” characteristics, especially as network indigenous college students, which are the mobile phone and all kinds of smart devices, such as smart headphones and smart watches. While these devices do not really combine with the human body, most people are already inseparable from these smart devices.

On the other hand, with the rapid development of technology, college students are also being “digitized” by equipment. Whether it is location information, personal preferences, purchase habits, consumption records, thumbs up, comments, expression patterns, etc., under the integration of big data of different dimensions, constitute the virtual digital identity of college students, reflecting the “virtual entity” of college students’ real life. The data of college students are easy to be leaked and controlled by technology. Therefore, as college students enhanced by intelligent device technology, in a sense, they are also constrained by these technologies and even carry out digital decomposition and deconstruction in different dimensions.

In the past, the digital information of college students still stayed in the symbol of simple communication on the network, but now, under the development of intelligent technology, the digital entities of college students are increasingly rich. All aspects of food, clothing, shelter, transportation, and life can be quickly solved through the network, and even the “second life” of the virtual world is realized in the network. It can be said that the “virtual entities” made of college students through digital mapping are gradually realizing the digital survival of individuals.

*2.3. From the “Internet+” to the Metaverse.* In the past, scholars discussed more about “Internet+,” such as “Internet + education” and “Internet + economy.” The Internet pointed more towards a platform and means, rather than forming an independent and complete virtual world. With the rapid development of information technology and the continuous upgrading of communication equipment, the line between the Internet and reality is also beginning to weaken. Through VR, AR, MR, and other media technology means, today college students can realize the original basic network functions such as online video, network broadcast, and network education, enjoy virtual reality, naked eye 3D, augmented reality, mixed reality, and other special

functions, equivalent to building a whole new virtual network world parallel to the real world, and make a connection between the virtual world and the real world, form a new human-computer interaction mode, greatly expanding the human sensory experience, enhanced to have the physical experience. The new technology not only changes the life of college students but also greatly changes their cognitive habits, lifestyle, and behavior patterns.

Facebook, Google, Microsoft, Apple, SONY, Tencent, Huawei, and other domestic and foreign technology giants have laid out the “metaverse.” The rapid development of science and technology has made many users feel the magic of the “metaverse” world. At present, in China, there are virtual students, metaverse campuses, and other real cases. In 2021, Tsinghua University became the first university in China to release original virtual students. As a research result of the Department of Computer Science of Tsinghua University, “Zhi bin Hua” was enrolled in the Department of Computer Science of Tsinghua University with a highly vivid image of young students and started his study and life in Tsinghua University. In January 2022, the Communication University of China cooperated with Baidu to create a virtual medium communication campus that was officially unveiled and open to the public. With the help of a street view map, 3D reconstruction, 3D engine, and other digital technologies, the virtual transmission campus vividly reproduces the real campus in the real world, realizing the accurate construction of the virtual campus.

### 3. Network Behavior Types and Characteristics of College Students in the Metaverse Age

*3.1. Type of Network Behavior of College Students in the Meta- Universe Era.* The arrival of the meta universe era has greatly enriched the types of college students’ network behavior. For college students’ network behavior research, due to the particularity of college students, they tend to involve in network entertainment, network social accord with their age, hobbies of network behavior, so the author thinks that these can according to the common purpose and motivation, divided into five main aspects, namely, network learning behavior, network social behavior, network entertainment, network consumption behavior, and network expression behavior. Through these five aspects, a relatively complete panorama of college students can be reflected. Among them, online learning behavior can be subdivided into online course learning, online information retrieval, and online work, online entertainment behavior can be subdivided into online audio and video and online games, online social behavior can be subdivided into online social platforms and online chat tools, online consumption behavior can be subdivided into online shopping and online payment, and online expression behavior can be subdivided into online speech.

According to the platform and content often browsed by college students, the five aspects of network behavior can be divided more carefully. For example, in Table 1, the specific content of college students’ network behavior is subdivided.

*3.2. Network Behavior Characteristics of College Students in the Meta- Universe Era.* According to the network behavior classification and behavior content of the college students of the “online generation” divided by the above table, it can be found that the college students, as the Aboriginal people in the network era, with the development of intelligent technology, their network behavior is also developing and changing, with a deep brand of the times.

*3.2.1. “Touch the Net” Young Age, the Network Behavior Began Early.* Since 2000, mobile network devices such as laptops, tablet computers, and smart phones have developed rapidly; basic communication equipment has also been constantly upgraded, mobile communication system from 2000, from 3G to 4G, and then to 5G, with continuous upgrading iteration. With the upgrading and rapid development of technology and equipment, most of the college students have had the habit of network contact since childhood. They touch the Internet early, are especially familiar with the Internet, and have their own relatively stable network social circle and entertainment positions. Many students have owned their own social media accounts, such as QQ and Weibo, since primary school. Since childhood, they have been used to expressing their views through WeMedia, influenced by various online shopping platforms, accustomed to spending through convenient mobile payment means, accustomed to chasing stars through the Internet, discuss hot topics, express opinions, accustomed to watching dramas, games, and making friends through the Internet, accustomed to using the network to record their own mood and life drip. They go along with the development of technology; the degree of network participation is also growing. Network behavior has also gradually diversified from the beginning of the single. The web became their “second living space.” Even some college students are addicted to the Internet. The Internet replaces the real world and becomes their home life.

*3.2.2. Intelligent and Diversified Network Equipment.* While the development of smart technology has greatly improved the penetration rate of smart phones, the development and promotion of wearable devices such as smart watches, smart headphones, smart glasses, and so on have further intelligently diversified the network equipment of contemporary college students, which also brings intelligent network behavior. For example, in the past, college students could only conduct online entertainment in simple web games. However, now, with the help of intelligent devices, virtual reality, space interaction in the meta universe, and other more intelligent online entertainment behaviors can be realized. In online learning, it could only rely on desktop computers or laptop computers for traditional video viewing. Now, with the help of diversified intelligent devices, diversified online learning forms such as live broadcast courses, online virtual course interaction, and immersive virtual experience courses can be realized. And the behavior of network communication, network consumption behavior, and network expression behavior also have new

TABLE 1: Specific content subdivision of college students' network behavior.

Level 1 composition	Grade II composition	Concrete content
Network learning	Network course	Meta classroom, rain classroom, wisdom tree, and other online course platforms
	Network information retrieval	Knowledge net, Wan Fang, Dou Ding net, etc
	Network homework	Network answer questions, network microvideo works, etc
Network consumption	Shopping online	Baidu Xishan Soil Blue Universe, Taobao, Jing dong, Pin duo duo, etc
	Internet payment	Metacom cryptocurrency, living payment, knowledge payment, etc
Network entertainment	Network audio and video	iQiyi, Tencent, Youku, Mango TV, TikTok, netease Cloud Music, etc
	Cyber games	Virtual 3D games, client side and online games, etc
	Network novel	WeChat reading, Himalayan reading, etc
Social networking	Online social platform	Weibo, Soul, Xiao hong shu, Metaverse Community Space, etc
	Network chat tool	WeChat, QQ, and other instant messaging tools
Network expression	Network speech	Internet post bar, forum, Weibo dynamic, Zhi hu, Dou ban, and Bilibili

characteristics of the times with the support of intelligent equipment.

### 3.2.3. Diversifying the Nature of Network Behaviors.

From the beginning of the Internet portal era, people only carry out Internet information browsing and other network behaviors with the help of the Internet, to now develop into the intelligent era, under the background of the meta universe, college students' network behavior is more diverse. A college student often has a same day: online courses through various learning platforms, immersive experience through metaverse virtual campus, information retrieval through search software, and homework through network equipment. In my spare time, I contacted my friends through WeChat, QQ, and online social media platforms, made video calls, and posted my life status. Online games, binge-watching TV series, and watching all kinds of short videos have become the necessary daily relaxation programs. Various kinds of shopping APP have become the main shopping channels for college students, while taking out food and running errands have become their main ways to get food, and WeChat Pay and Alipay have become their main payment models. Using a hot search, posting, and participating in the latest hot topics is the main channel for them to express their views and attitudes. Their shelters cannot leave the network, especially under the background of the outbreak; the traditional classroom was replaced by the network classroom. College students have become the norm of contemporary college students from simple online entertainment, online consumption, and online social networking to diversified online behaviors such as learning, communication, entertainment, and life with the help of online platforms.

## 4. Multiple Effects of Intelligent Technology on College Students' Network Behavior in the Era of Meta Universe

In the meta universe era of digital survival, people's lives have been completely wrapped by the Internet. In addition to oneself in real life, once connected to the Internet, individuals will have another digital virtual subject identity. IP is the ID card of the digital world. With the identity of digital

virtual subject, they enjoy a "second life" on the information highway.

Intelligent technology is a double-edged sword. It not only affects the cognitive mode of college students' network behavior but also affects the virtual and real boundary of college students' network behavior and also subverts the traditional network consumption habits. It not only brings a positive role but also has a certain negative impact.

### 4.1. Cognitive Reconstruction: Intelligent Technology Reshapes College Students' Cognitive Model of Network Behavior.

When college students are in the digital age and surrounded by various digital technologies, their thoughts and behaviors will naturally change. Different from the traditional Internet, intelligent technology has built an immersive network mimicry environment, which makes college students' perception of themselves, others, and even the world come more and more from the virtual world, and their way of thinking and cognitive model are also being reconstructed by intelligent technology. This is especially reflected in college students' online learning and online entertainment behavior.

On the one hand, intelligent technology has brought a new upgrade to college students' network behavior cognitive model, which has a certain positive effect. In the era of intelligent media, the development of intelligent technology continues to affect college students' cognitive habits. As the scholar Negroponte predicted in his book "Digital Survival," everyone has his own "daily newspaper," and the information you need is summarized and sorted in categories on the intelligent interface tailored for yourself for browsing. College Students' access to information will be more efficient and targeted, and their access to information will be faster and more efficient. They will no longer search aimlessly in the massive information of the network as before. Relying on intelligent technology, we can quickly realize the "private customization" of information, which greatly improves students' learning efficiency and work efficiency.

On the one hand, the capital, algorithm, and other logic behind intelligent technology will also have a certain negative impact on college students' network behavior cognitive model. First, intelligent technology is easy to cause cognitive bias. The capital logic behind intelligent technology makes

the major platforms take chasing traffic as the code of conduct in order to make capital profits, which makes the content of the platform vulgar and entertaining, and some of them are filled with bad network information such as network rumors, title party, and making rumors, which seriously deviates from the orientation of main stream values. Marcuse mentioned in his book “one-way man” that “when technology becomes a universal form of material production, it restricts the whole culture; it designs a historical whole—a “world.” [3] When college students study and entertain through the network, the information retrieved and entertainment content received are often “tailored” behind the capital to please users. Intelligent technology relies on capital to develop and design accurate push. In order to chase traffic and please users, serious mainstream value information is difficult to be recommended preferentially by the algorithm. Once individual content is marked as “disliked” by ordinary users, it will even be completely isolated from the recommendation mechanism, resulting in the isolation of mainstream value information from users. Some content is rough, but eye-catching content is preferred. In the package of various good and bad traffic information, it is very easy to cause the value deviation of college students, and then affect their outlook on life, world outlook, and values.

Second, intelligent technology is easy to cause media dependence. The massive amount of information on the Internet can easily lead to “information overload” in the brain of college students. When people are inundated with more and more information, they are also more inclined to believe the information that supports them. This phenomenon is called “confirmation bias” in psychology. The social media takes advantage of this phenomenon and further uses algorithm technology to accurately push according to everyone’s interests and browsing records, so that people can only see the information they are interested in, thus forming the “echo room effect” and “information cocoon room,” which will affect people’s cognition and judgment. The formation of public opinion fields such as network hot search will further amplify the opinions of some opinion leaders, and some people who lack the ability of independent judgment will be affected, so as to become unconscious followers and affect the trend of public opinion.

With the support of intelligent technology, various subculture circles popular among college students are becoming more and more “self-sprouting,” and the barriers between circles are becoming stronger under the influence of big data such as intelligent recommendation and “guess what you like,” which is easy to form an “information isolation area,” isolate people outside the circle, and further aggravate the differentiation and solidification of different network circles.

Third, intelligent technology is easy to cause shallow cognition. In entertainment to death, Neil Postman proposed that different media ages represent different cultures, accompanied by different epistemology. For example, in the culture ruled by printing, the public often see the orderly type content, which is highly logical and has clear views. Therefore, the culture and epistemology in the era of the

printing press rule also tend to be rigorous and meticulous. The birth of television overturned the previous epistemology and culture, followed by an overwhelming trend of entertainment. As a native of the Internet, college students’ cognitive model is already in an immature state. It is very vulnerable to the influence of the Internet and is easily wrapped by the complex information of the Internet. The fragmented reading model also disintegrates college students’ deep thinking and understanding ability.

They habitually rely on the recommendation of intelligent technology and are also used to straightforward and simple network content, all kinds of strange pictures, or video stimulation. They lose patience and interest in traditional classical paper books and cultural classics, gradually indulge in the mathematical model and mechanism of intelligent algorithms, and gradually lose their independent thinking ability and correct judgment under the subtle “manipulation” of algorithms and big data, and their cognitive ability is weakened.

*4.2. Virtual Reality Interaction: Intelligent Technology Reshapes College Students’ Online Social Interaction and Expression.* With the advent of the digital age, great changes are taking place in individual thinking modes and behavior habits.

On the one hand, different from the traditional Internet, with the rapid development of information technology, with the help of VR, AR, big data, cloud computing, artificial intelligence, blockchain, and other emerging new digital technologies, the boundary between the virtual world and the real world is becoming more and more blurred, gradually forming a new world of virtual real interaction. The network behavior of college students is essentially carried out by the “virtual avatar” composed of different dimensions of data information. With the help of bidirectional transmission of brain computer interface and the accurate docking and integration of virtual and real information that meets people’s needs on this basis, the network behavior of college students has completely broken the barriers between the real world and the virtual world and broken the “two kinds of virtual and real conflicts between reality and virtual control or virtual erosion of reality” with information as the medium [4]. Relying on intelligent technology and intelligent devices, they roam in the virtual world and enjoy technological convenience. Virtual reality technology is based on the perception of vision and touch. This multiperception technology processing system can make college students more immersive and experience when they socialize and express online. At the same time, it is also more conducive to their online friends and free expression.

On the other hand, this virtual reality interaction technology will also make college students derail from reality. Some college students will even have different performances in the two spaces of virtual world and real world. When they conduct online social networking and network expression, they will use intelligent technology to package and beautify their virtual identity.

First, college students will also involuntarily beautify their digital avatars when they conduct normal network behaviors such as online social networking, such as beautifying their images through beautiful photos; decorating their circle of friends by publishing some beautified pictures; enhancing their online appeal by making up their identity; and so on.

Erving Goffman, an American sociologist, put forward the “pseudo drama theory.” He believes that society and life are a big stage, and social members are very concerned about how to shape an acceptable image in front of a large audience (i.e., others participating in interaction). In order to perform, people may distinguish between the front desk and the backstage. At the front desk, people present an image that can be accepted by others and society. The backstage is relative to the front desk. It is to prepare for the front desk performance and cover up the things that cannot be performed at the front desk. People will hide the unacceptable or unacceptable images of others and society in the backstage [5].

Sometimes the real self is often hidden. The “front desk” in real life often shows an image of abiding by various rules and regulations, while the “back desk” in the network virtual society will release the real self and express the real thoughts of the heart in a way of the “virtual avatar.” Some students will regard the self-expression in the network society as the “front desk” and beautify and package it through technical means, create a completely different “virtual avatar” from real life, and have their own “second life” in the network.

Second, because the network has the characteristics of concealment, virtuality, and symbolic interaction, especially with the support of intelligent technology, the network trace is more difficult to track, the network camouflage technology is more changeable, and the network immersion experience is more addictive. Therefore, college students sometimes break away from the constraints of existing social rules when carrying out network activities such as browsing bad network information, indulging in virtual online games, spreading false network information, and other network anomie behaviors, which are more serious and even further evolve into network illegal behaviors such as network fraud and network hackers.

With the development of intelligent technology and the era of the universe, all kinds of realistic network experience give people the illusion of “immersive.” However, it is this illusion that gives people behind the network more opportunities to beautify and package themselves. For example, the beauty in the webcast is actually a middle-aged man disguised through technical means, and the sweet voice behind the Internet phone is also made up by technology. Various network screenshots with pictures and the truth are likely to be pieced together and forged by various marketing numbers and jokes using technology, as well as the controversial intelligent AI face-changing technology, which makes it difficult for ordinary people to distinguish the truth from the false. In the era of intelligent technology, “what you see cannot be true, and what you hear may not be true.” In the face of the virtual and real interactive network world, it is

difficult for college students to distinguish between the true and the false, and it is very easy to lose themselves in the middle.

*4.3. Consumption Reform: Meta Universe Reshapes College Students' Online Consumption Mode.* On March 30, 2022, the “blue universe” marketing space under blue cursor was officially launched and settled in Baidu Xirang, becoming the first “meta universe marketing space” in China. 5g networks, artificial intelligence, big data, and cryptocurrency will build a new consumption ecosystem.

On the one hand, with the advent of the meta universe era and the support of intelligent technology, the online consumption mode of college students will change greatly. In the past, college students were more inclined to carry out online shopping rather than consumption in offline physical stores. Traditional online shopping platforms such as Taobao, jd.com, Netease koala, and Pinduoduo can no longer meet the needs of postcollege students who have diversified consumption and pay attention to experience. With the advent of the meta universe era, by building an immersive cyberpunk business district, it can not only meet the needs of immersive experience that college students can feel in offline physical stores but also meet their proposition of fast shopping without leaving home and also experience all kinds of fresh and interesting interactive activities brought by the meta universe world at the same time of shopping, which will be a major change in the future online consumption mode.

On the other hand, a more convenient and rich online virtual shopping experience may lead some college students with insufficient self-control to fall into the trap of consumerism, indulge in online consumption, and even go astray such as advanced consumption and online loan consumption.

## 5. Summary and Reflection

Facing the opportunities and challenges brought by intelligent technology in the meta universe era, to study the multiple effects of intelligent technology on college students' network behavior, in the final analysis, we should do a good job in the education and guidance of college students, innovate the ideas and methods of ideological and political education on the basis of understanding the types, characteristics, influencing factors, and essence of college students' network behavior, and adhere to creating a clean and positive cyberspace, in order to truly implement the fundamental task of building morality and cultivating people.

*5.1. Explore the Essence: The Real Self Who has been “Present”.* In essence, the behavior of college students on the Internet is also a kind of performance behavior in the foreground and background. However, no matter the “front desk” or “back stage,” or the behavior in real life or the behavior in network society, the essence of real and virtual subjects is the real “people” behind the identity. Even in the network society, the individual replaces the real self with a “digital identity” and only digitizes himself from the technical level, but the

## Retraction

# Retracted: Benefit Modeling and Analysis of Wind Power Generation under Social Energy Economy and Public Health

### Journal of Environmental and Public Health

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

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## Research Article

# Benefit Modeling and Analysis of Wind Power Generation under Social Energy Economy and Public Health

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Wind is a renewable energy source. Overall, using wind to produce energy has fewer effects on the environment than many other energy sources. Wind and solar energy provide public health and environmental benefits to the social. Wind turbines may also reduce the amount of electricity generation from fossil fuels, which results in lower total air pollution and carbon dioxide emissions. In order to better optimize the effect of social energy economic management and facilitate the multiobjective decision making of coordinated development of energy and socioeconomic environment, a modeling and analysis method of economic benefits of wind power generation based on deep learning is proposed. In this paper, based on the principle of deep learning, the evaluation indicators of wind power economic benefits are excavated, a scientific and reasonable economic benefit evaluation system is constructed, a wind power economic benefit analysis model supported by public management is constructed, and the steps of wind power economic benefit analysis are simplified. It is concluded that the modeling and analysis method of wind power economic benefits based on deep learning has high practicability in the actual application process, which is convenient for the prediction and analysis of energy demand for social and economic development.

## 1. Introduction

The economic benefit modeling and analysis method of wind power generation is bound to become the main form of energy development in the future. However, at present, the concept, physical framework, and related models of economic benefit modeling and analysis methods of wind power generation have been deeply studied at home and abroad, but most of the existing studies are based on a specific/assumed regional energy economic data, which is not universal, especially in the current economic benefit modeling and analysis methods of wind power generation. All kinds of physical equipment and their mathematical models have not been combed and summarized, and the theoretical system suitable for the economic benefit evaluation of comprehensive wind power generation has not been established. The analysis of the economic, environmental, and social benefits that energy development and

management can bring is still in the conceptual stage. Therefore, based on the relevant research and exploration at home and abroad, this paper optimizes the economic benefit modeling and analysis method of wind power generation based on the deep learning method. Deep learning is the internal law and representation level of learning sample data [1–3]. The information obtained in the learning process is very helpful to the solution of data such as words, images, and sounds. Deep learning is a complex machine learning algorithm. Its effect in speech and image is far better than that of previous related technologies. Deep learning has achieved a lot in data mining, machine learning, translation, natural language, multimedia learning, speech, recommendation, and personal related fields. Deep learning enables machines to imitate human activities such as audiovisual and thinking, identify difficult problems, and make great progress in artificial intelligence-related technologies. In terms of its basic framework, model, and comprehensive

benefit evaluation system, this paper summarizes and analyzes the research status and theoretical results at home and abroad, combs the shortcomings of the current research, and looks forward to the key research directions and key problems of wind power generation economic benefit modeling and analysis method modeling and comprehensive benefit evaluation in the future.

## 2. Modeling and Analysis Method of Economic Benefits of Wind Power Generation

Wind power projects aim at the efficient use of wind energy as a new energy. As a clean and renewable energy, wind energy is of great significance to energy conservation and pollution reduction in our society. One of the important features of wind power projects is their significant social benefits. From this perspective, wind energy is a clean and renewable energy source, and also a new type of energy resource that needs to be further developed in the country. The development and utilization of wind energy resources are an effective way to optimize the country's energy structure and implement sustainable energy development, and are also conducive to ecological conservation and environmental protection. After the completion of the wind farm, the wind turbine can provide renewable power generation for the power grid every year, which can help reduce the country's consumption of other energy sources such as standard coal and, in turn, reduce the emissions of a variety of harmful gases and exhausts such as sulfur dioxide, carbon dioxide emissions, soot emissions, carbon monoxide and hydrocarbons, nitrogen oxide, and suspended particulate matter. At the same time, wind power projects can also bring huge social benefits and boost employment. According to statistics, every 1 mW of installed capacity will directly increase employment by 5 people and 20 indirectly. Therefore, besides economic evaluation and social benefit evaluation, it is also necessary to conduct a comprehensive evaluation of wind power construction projects. The content of the index system for social benefit evaluation of wind power construction projects is divided into 3 parts: natural environment impact, social economic impact, and social environmental impact. Using the deep learning-based modeling and analysis method for wind power economic benefits, this paper demonstrates that the cost and benefit of wind power generation are positively correlated with the reliability level, so it can maximize the overall economic and environmental benefits of the wind power generation model, and contribute to social and economic development. It provides an important reference for forecasting and analysis of energy demand.

Wind power construction projects belong to infrastructure construction and are also profitable projects. Compared with other construction projects, wind power construction projects have their own characteristics:

- (1) From the perspective of construction methods and project operation methods, wind power construction projects are projects that are completed have also been developed and utilized at the same time as

primary energy development and construction. Compared with hydropower, thermal power, and nuclear power projects, wind power projects do not involve troubles like the coal mining and transportation required by thermal power, or the investment required by oil. Compared with hydropower, thermal power, and nuclear power projects, the construction period is short, the investment is flexible, the automatic control level is high, and the operation and management personnel are less. After the project is completed, the operation cycle is relatively long.

- (2) The cost and benefit of wind power construction projects are both very important in the form of financial microscopic cost-effectiveness and national economic macroscopic cost-effectiveness. Wind power construction projects are first and foremost profitable projects, considering their microeconomic benefits. Moreover, wind power projects themselves have significant social benefits. One of the prominent reasons for carrying out wind power construction projects is that this clean energy is renewable and pollution-free energy, and the wind power industry can promote the development of such industries as machinery manufacturing. Therefore, in the process of project construction and evaluation, it is necessary to fully consider the cost-effectiveness of both micro and macro aspects.
- (3) Wind power construction projects have strict requirements on the construction period. Completion on time is critical to the success or failure of wind power projects. For owners and developers, the importance of timely completion even outweighs the basic goal of making a profit as soon as possible. In many wind power projects, owners and developers are bound by commercial operation deadlines, subject to power purchase agreements or financing agreements. In addition, if the production tax credit policy is applicable to the location of the project, the new project must be put into use before the production tax credit expires. Improperly scheduled engineering schedules can increase recurring expenses. Many factors will cause the project to be delayed in completion, in order to avoid that the project must have a strong ability to resist risks, and have a strict plan for the use of funds and the survival of the project.
- (4) From the perspective of the benefits and costs of wind power construction projects, due to the limitation of independent manufacturing of wind power equipment in the country, the profitability of such projects is low and the investment recovery period is long. At present, after the completion of the project, the cost of power generation is high and the profit is low, and there is still a profitability gap compared with thermal power projects. At present, the cost of wind power generation in domestic enterprises is significantly higher than that of water and thermal















## *Retraction*

# **Retracted: Ant Colony Algorithm-Based Audit Supervision to Promote the Optimization of New Infrastructure Investment Environment**

### **Journal of Environmental and Public Health**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] F. Yuan, "Ant Colony Algorithm-Based Audit Supervision to Promote the Optimization of New Infrastructure Investment Environment," *Journal of Environmental and Public Health*, vol. 2022, Article ID 7454982, 7 pages, 2022.





general, by strengthening investment in infrastructure and technological innovation in infrastructure, the upgrading of the industrial structure has been promoted, and a new growth point has been provided for the development of the national economy [9]. Other researchers believe that the establishment and use of infrastructure in a developing country have a very critical significance in promoting the long-term sustainable development of its economy and society. At the same time, capital construction investment not only directly promotes the development of the national economy, but also has a far greater impact on the national economy than the investment itself. Expanding construction investment can cause an exponential increase in the income level of residents and a multiplier effect of investment. Coupled with the global economic crisis and the accelerated coordination of the world's industrial economic structure, the level of progress in infrastructure construction will have a more significant impact on our country's macroeconomic structure, and this will be for Chinese companies to participate in global production and actively participate in global economic competition to overcome constraints on population issues and poverty reduction: optimizing industrial structure, reducing production costs, enhancing corporate profitability, improving the investment environment, attracting foreign investment, increasing employment opportunities, improving social welfare, and the basic subsistence security level of the people. The final result will be reflected in the GDP growth rate. Therefore, infrastructure construction has always been an issue that governments around the world are paying more and more attention to [10]. In summary, although there are more studies on capital construction investment, there are fewer studies on investment optimization. The purpose of investment optimization is to achieve the best investment effect with the same investment. Its main objectives include reasonable investment structure; the most effective use of resources; forming the largest production capacity with the fastest construction speed; promoting technological progress to the greatest extent; and maximizing the total social products and national income.

In this paper, the audit supervision of ant colony algorithm promotes the optimization of new infrastructure investment environment. Based on the literature data, it analyzes the status quo of our country's infrastructure investment and the characteristics and theories of large-scale infrastructure project investment decision-making and then analyzes the characteristics and theories based on ant colony algorithm. The audit supervision promotes the construction of a new infrastructure investment environment optimization model, tests the constructed model, and draws relevant conclusions through the test results.

## 2. Infrastructure Investment Research

*2.1. The Status Quo of Our Country's Infrastructure Investment.* The first mode of infrastructure investment in my country is the centralized decision-making mode, which is determined by the state and it is difficult to exert the influence of enterprises [11]. Considering the lack of

funds for infrastructure construction and the financial burden of local governments trying to change infrastructure units and infrastructure construction financing mechanisms, it is necessary to gradually open the market, increase assets, release reserve purchases, and gradually introduce nonprofit organizations in the field of infrastructure investment. Although the rate of return on infrastructure investment is not high, the rate of return on cash flow is stable and the rate of return on income is low, so the innovative billing mechanism can further increase the rate of return on capital. From the perspective of decision-making process, a macroeconomic decision-making is not a scheme produced in an instant. It is a systematic project involving a large amount of economy, management, humanities, and information technology. From the proposal of problems, the formulation of plans to the evaluation, implementation, and tracking feedback of plans, there are many uncertain factors from the internal and external management system, which are more complex and difficult to grasp than ever before.

There are still many problems and difficulties in my country's infrastructure [12]. First, the scale of infrastructure investment is relatively insufficient. The process of urbanization is advancing rapidly, the level of infrastructure enjoyed by ordinary people has declined, and infrastructure investment is still insufficient. Second, the structure of infrastructure funds is unreasonable. The use of foreign capital, social, and public funds is relatively low, and the construction of infrastructure in many fields is monopolized by state-owned enterprises. Third, there are relatively few infrastructure financing methods. Many cities use IPOs, BOTs, TOTs, PPPs, ADRs, and ABSs and other infrastructure investment and financing processes, but the lack of financing methods and current systems and regulations has increased. Fourth, the structure of infrastructure investment is unreasonable. The structure of the infrastructure investment fund is absurd, focusing on projects, neglecting supporting facilities and rebuilding and neglecting maintenance. The regional structure of my country's infrastructure stock is unbalanced, and infrastructure investment in some states is far below the national average. In addition, due to the lagging behind construction of related systems, the imperfect government supervision and supervision system, the imperfect social credit rating system, the unclear tax reform goals, and uncertainties, the structural risks of investment still exist.

The infrastructure investment decision-making mechanism is a group decision-making process carried out by a limited number of rational decision-makers in a fuzzy and multifunctional environment. Infrastructure investment decisions are group decisions. Decision-making options have multiple characteristics. The decision-making environment is fuzzy, the decision-making behavior is bounded rationality, and the decision maker is a person with bounded rationality (see Figure 1). Infrastructure construction has the so-called "multiplier effect"; that is, it can bring total social demand and national income several times the amount of investment. Whether a country or region's infrastructure is perfect is an important foundation for its long-term, sustainable, and stable economic development.

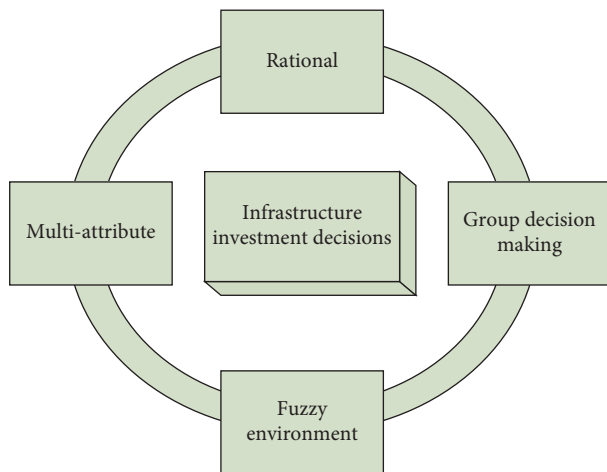


FIGURE 1: Infrastructure investment decision-making mechanism.

## 2.2. Characteristics and Theories of Investment Decision-Making for Large-Scale Infrastructure Projects

**2.2.1. The Complexity of the Investment Decision-Making System for Large-Scale Infrastructure Projects.** The decision-making process of large-scale infrastructure construction projects is a complex system, involving many interconnected and cross-related subsystems, and the relationship between the different components of each subsystem is very complicated. At the same time, because of the uncertainty and dynamics of the decision-making environment of large-scale infrastructure projects, and the long-term engineering decision-making cycle, for example, it took more than ten years from the Beijing-Shanghai high-speed rail to its completion and commissioning. From preliminary research to final approval, it is an arduous and tedious argumentation process. From the engineering perspective, the decision-making problem of major national infrastructure construction projects is itself a problem of poor structure, faced with huge ambiguities and risk factors in the decision-making process, that is, incomplete and incorrect information. A well-structured problem is often an intuitive, familiar, and easy-to-understand problem, and it is often very consistent with completely reasonable assumptions. For example, these problems are also included in the decision-making process of national key highway construction projects. Because the constructed high-speed railway system is more systematic than other transportation methods such as road transportation, the overall layout of the road network must be made at the national level in order to make a strategic, scientific, and reasonable design of the railway network. Similarly to the design of the stations along the route and the choice of routes, including a large number of demolition projects, the construction scale of the project is quite large, but it also produced a lot of funding and financial problems, and there are many coordination problems with the management project. There are different types of decision-making problems, and the usual decision-making methods are also different. Usually, procedural decisions are taken for structured issues, while nonprocedural decisions are taken for problems that constitute undesirable problems. The key step of procedural decision-making is to obtain accurate, timely, and

sufficient information. Accurate information is the most basic condition of procedural decision-making. Information error is worse than no information, which makes the direction of decision-making go to the opposite. Timely information determines the timeliness of decision-making. Modern market changes thousands of times, and time is benefit. Outdated information will inevitably make decision-making passive and eventually lead to decision-making failure.

**2.2.2. The Multiagent Nature of Investment Decisions for Large Infrastructure Projects.** The complexity of decision-making for large-scale infrastructure construction projects fundamentally determines that individuals cannot participate in decision-making. In investment decision-making, the coordination of the rights and interests of all parties requires concentrated wisdom and in-depth discussions. From the perspective of decision-making units, experts and scholars in the development environment, technology, market, capital, and ecological environment of the industry are required to actively participate in investment decisions, so it may be necessary to establish a project expert group to make decisions. The decision-making of large-scale infrastructure project investment decision-making group has typical characteristics.

Group decision-making also brings uncertainty to decision-making. Making the decision to invest in a large infrastructure project brings multiple benefits. When decision-making and decision-making options are selected by different decision-makers, they inevitably have specific positions and interests, subjective tendency is large, group decision-making is difficult to coordinate the interests of all parties, and decision-making power is low. In addition, the interdisciplinary nature of decision-making obscures everyone's responsibility for project decision-making. When errors occur, everyone is evading responsibility. There are very important stages in the decision-making process—feasibility demonstration. One of the objects of feasibility demonstration is the research of decision-making procedure. Whether the methods and methods used in the demonstration procedure are logical and scientific, there are two main methods of feasibility demonstration: one is functional demonstration—that is, the “black box” method is adopted, and a large number of experiments are often used to demonstrate the feasibility of decision-making in practical demonstration—the other method is structural argumentation—that is, the degree of direct argumentation is overall, and the decisive decision-making often adopts two methods to demonstrate.

**2.2.3. Large-Scale Infrastructure Investment Is a Multipurpose Investment Decision.** For traditional financing projects or financing projects involving the public, monetary benefits are usually regarded as the ultimate goal or the main goal of the project, while other benefits are regarded as the realization of constraints or subsidiary goals. However, the target system of major infrastructure projects is rarely unified, and the main target system of large and medium-sized infrastructure projects is generally to achieve the optimization of economic, ecological, and social benefits. In these big goal

systems, each big goal is composed of multiple small goals, and these small goals not only are related to each other, but also mutually restrict each other. Therefore, WBS (Target Decomposition) is generally used to subdivide the target system of large and medium-sized infrastructure into execution levels in decision-making. In this way, a multipurpose system with hierarchical structure is composed of applications, large uses, small applications, subuses, and reference levels. In decision-making, low-level goals must follow high-level goals. In this way, different levels of goals or goals at the same level are not only related to each other, but also have opportunities to compete with each other.

**2.3. Application of Artificial Ant Colony Algorithm.** In the process of optimizing the route problem, the artificial ant colony algorithm requires parameter preparation, ant movement between cities, local pheromone update, and global pheromone update. The process is described as follows: first, only  $m$  ants are placed in  $n$  cities according to certain rules. Secondly, the ant traverses  $n$  cities according to the probability of transitioning to the specified state, so the ant prefers to choose the closest city on the path with strong pheromone content. When each ant moves from a certain city to another, it will notify all the pheromone on the path according to a certain partial pheromone update rule. At the same time, pheromone evaporates continuously over time to prevent premature pheromone concentration in certain routes. Third, each Hamilton ring is the shortest path of time that an ant is looking for. When all the ants return to the original city, a Hamilton cycle is formed. By comparing the best solution of each ant, finding and recording this section of the route to  $v$  are done through all the cycles. When each ant has traversed all cities and reached the starting point, the solution of the optimal path will be selected as a feasible solution, and the pheromone will be updated within a certain range according to the selected feasible solution. Finally, run multiple loop iterations and record the shortest path created after each iteration until the condition to stop the iteration is met.

There are many methods of path optimization, which can be divided into two categories: exact algorithm and heuristic algorithm. Precise algorithm refers to the algorithm that can find its optimal solution, mainly including cutting plane method, branch and bound method, and dynamic programming method. Because the amount of calculation of the accurate algorithm generally increases exponentially with the increase of the problem scale, its application range is very limited in practice.

### 3. Audit Supervision Based on Ant Colony Algorithm Promotes the Optimization Model of New Infrastructure Investment Environment

**3.1. Research Purpose.** The level of urban public infrastructure construction directly affects the degree of urban development. Establishing a sound financing system and scientific and reasonable allocation of investment funds are

inevitable requirements for promoting urban public infrastructure construction. However, in the past, the single-purpose or standard optimization model of urban infrastructure investment income optimization models was more common, but multipurpose, multistandard, or multipurpose return on investment and multistandard model optimization are rarely included. This article focuses on the application of ant colony algorithm decision-making in the optimization model of urban public infrastructure investment and discusses the public infrastructure systems of six major cities (power supply, water supply and drainage, sewage, post, and installation).

Ants find the shortest path thanks to pheromones and environment. The intelligent behavior of ants benefits from its simple behavior rules, which make them have diversity and positive feedback. When foraging, diversity makes ants not walk into a dead end and cycle indefinitely, which is an innovative ability; positive feedback keeps good information, which is a kind of learning and strengthening ability. The ingenious combination of the two makes intelligent behavior emerge.

#### 3.2. The Algorithm Principle of Portfolio Optimization

**3.2.1. Pheromone.** Similar to the Seller-Traveler problem, this article introduces pheromone as a state variable in the portfolio problem, but it is different from the pheromone in the Seller-Traveler problem. First, this article defines pheromone as a constant parameter in the portfolio problem. As the ants look for the best, the pheromone will update. The information rules are as follows:

$$\tau_{ij}(t+1) = \rho\tau_{ij}(t) + \Delta\tau_{ij}(t). \quad (1)$$

Here,  $\tau_{ij}(t)$  is the stock of pheromone on the path at time  $t$  (initial time, that is, when  $t=0$ ,  $\tau_{ij}(t) = \tau(0) = 0.2$ );  $\tau_{ij}(t+1)$  is the stock of pheromone on the path at time  $(t+1)$ ;  $\Delta\tau_{ij}(t)$  is the increment of pheromone on the path at time  $t$ .

There are obstacles: other ants and pheromones in the environment where ants live. Pheromones include food pheromones (left by ants who find food) and nest pheromones (left by ants who find nest). Pheromones disappear at a certain rate. Ants look for food within the range of perception. If they perceive it, they will pass. Otherwise, if you go to a place with more pheromones, each ant will make mistakes with a small probability, and not all move in the direction with the most pheromones. Ants have similar rules for finding nests and only respond to nest pheromones.

$$\eta_{ij} = (\bar{r}_j - \bar{r}_i) - (\sigma_j^2 - \sigma_i^2) + 0.1. \quad (2)$$

Among them,  $\eta_{ij}$  is the heuristic function between portfolio investments  $i$  and  $j$ , and  $\bar{r}_i, \bar{r}_j$  is used to indicate the heuristic degree of investors investing  $i$  and  $j$ .  $r$  represents the previous rate of return.  $j$  and  $i$  are added to prevent the formation of negative numbers, and 0.1 is added to make the value of the heuristic function positive.

According to the set movement rules, the ant moves in the direction with the most pheromones. When there is no pheromone guidance around, it will move inertia according

to the original movement direction and will remember the point passed recently to prevent turning in place. When the ant has obstacles in the direction to be moved, it will randomly choose other directions. When there is pheromone guidance, it will move according to the foraging rules.

#### 4. Case Analysis

**4.1. Investment Decision Analysis.** The article selects the financial data of the top ten domestic investment companies in China, such as Beijing Capital Construction Investment Company, Tianjin Urban Infrastructure Construction Investment Company, Shanghai Municipal Infrastructure Investment Development Co., Ltd., and Beijing Zhongqing Urban Construction. In order to obtain the data, this article selects the listed urban investment subsidiary Beijing China Investment (Group) Co., Ltd., to obtain the data. This article selects the listed urban investment subsidiary Beijing China Investment Jintai Co., Ltd., as the analysis object (Code: 600683), Tianjin Capital Environmental Protection Group Co., Ltd. (Code: 600874), Shanghai Urban Investment Holdings Co., Ltd. (Code: 600649), and Chongqing Development Co., Ltd. (Code: 000514). Because the investment and construction area of the four urban investment enterprises in the shortlist is quite broad, they not only invest in local construction, but also invest in construction in other provinces and cities in China. Therefore, the article will select the most representative urban public facilities and analyze the annual average level of public building construction in Beijing, Tianjin, Shanghai, and Chongqing from 2015 to 2018 and its impact on the investment of urban investment companies. For these data, a simulation program based on ant colony calculation was established, and the simulation was run on Matlab 8.0 platform. The settings of each parameter are as follows: the group size is 1000, the maximum number of iterations is 300, the learning coefficient is 1.4964, the inertia weight range is (0.8, 1.2), and the calculation results are shown in Table 1.

It can be seen from Figure 2 that, from 2015 to 2018, investors mainly focused on investment in Beijing, followed by Shanghai, Chongqing, and Tianjin to maximize overall returns.

#### 4.2. Model Checking

**4.2.1. Stationarity Test.** Integration testing usually needs to measure two or more variables at the same time and produce the same single integrated sequence. Therefore, the ADF test first performs a unit root test on the sequence to see if the sequence is stable, so as to judge the integer sequence of the variable. The test conclusions are given in Table 2.

It can be seen from Figure 3 that the first-order average values are all transient series, which are fixed after first-order difference, and have the same single integration order, which meets the requirements of the test.

**4.2.2. Comprehensive Judgment of Criteria Such As AIC and SC.** From the above ADF test results, it can be known that the first-order difference (DLNY, DLNX) of the original

TABLE 1: Investment decision analysis results.

	600683	600874	600649
$t = 1$	0.29	0.25	0.25
$t = 2$	0.30	0.26	0.24
$t = 3$	0.32	0.25	0.24
$t = 4$	0.34	0.19	0.29
$t = 5$	0.36	0.17	0.29
$t = 6$	0.38	0.16	0.19
$t = 7$	0.65	0.06	0.18

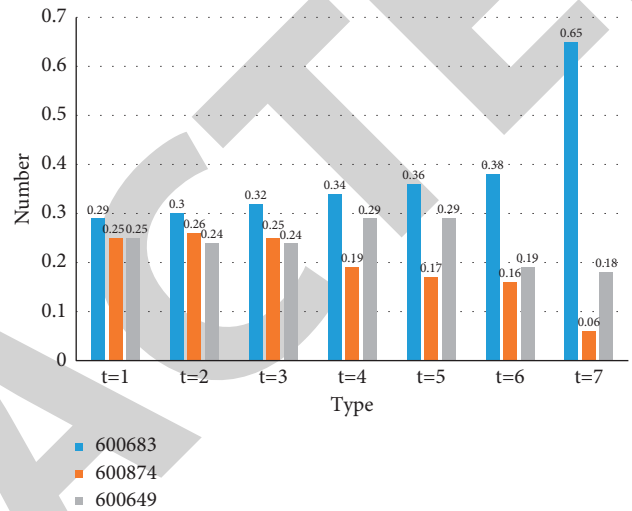


FIGURE 2: Investment decision analysis results.

TABLE 2: Stationarity test result.

	1% level	5% level	10% level
LN <sub>X</sub>	-3.73	-2.99	-2.64
DLN <sub>X</sub>	-4.34	-3.59	-3.23
LN <sub>Y</sub>	-3.69	-2.98	-2.63
DLN <sub>Y</sub>	-4.34	-3.59	-3.23

sequence is a constant variable, and the VAR series established with fixed variables is a fixed system. First, from the comprehensive evaluation of the lag order of AIC, SC, and other standards, the lag order of the VAR model is selected as 1. The test results are shown in Table 3.

From Figure 4, it can be found that the statistics of AIC, SC, etc., from the first row to the third row are considered to be somewhat nonautocorrelated, and all sources of unit periods are different. The model is also robust, able to analyze and perform impulse response function analysis and variance analysis.

**4.2.3. Granger Causality Test.** The cointegration test shows that there is a dynamic equilibrium relationship between total infrastructure investment and GDP, even if it cannot explain the potential relationship between the two. In essence, infrastructure investment has a positive impact on economic growth. As the economic level increases, the demand for infrastructure will increase, which will inevitably

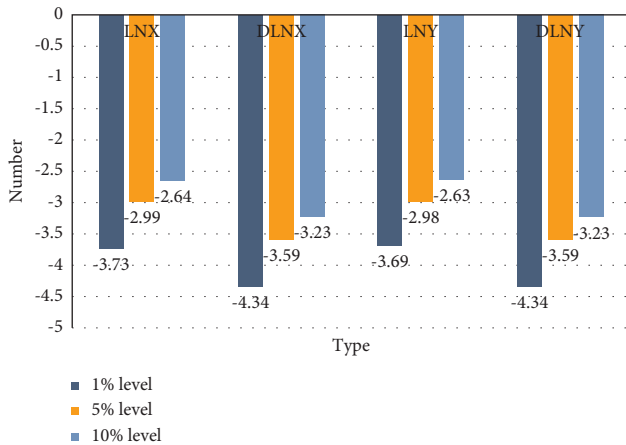


FIGURE 3: Stationarity test result.

TABLE 3: Comprehensive judgment results of AIC and SC criteria.

	AIC	SC	HQ
0	-4.87	4.77	-4.85
1	-5.02	-4.73	-4.95
2	-4.86	-4.37	-4.73
3	-4.71	-4.02	-4.52

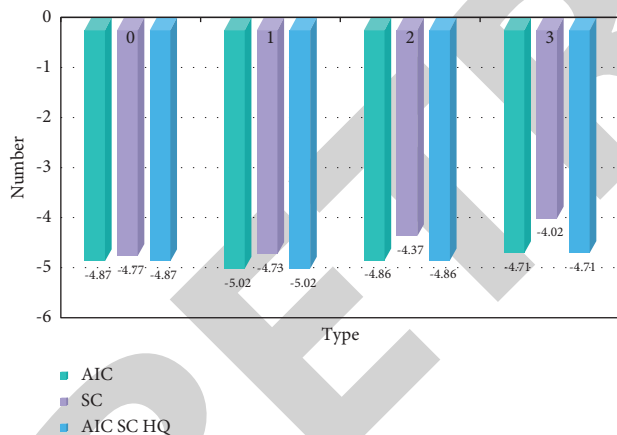


FIGURE 4: Comprehensive judgment results of AIC and SC criteria.

increase infrastructure investment. Granger causality test can be used to show the relationship between the two.

It can be seen from Table 4 that, in addition to the basic LNX hypothesis, there is no LNY in the second period, and the hypothesis from the third period, namely, infrastructure investment, was rejected at a significant level of 5%. Calculating GDP growth can also see the infrastructure in the investment economy; all 2--5 periods have accepted the null hypothesis that LNY is not relevant, and GDP growth has not improved infrastructure. In the future, inflationary investment should increase moderately along with infrastructure financing.

TABLE 4: Granger causality test.

Lag period	F-statistic	P value
2	2.58	0.099
	1.15	0.337
3	0.44	0.728
	3.44	0.038
4	0.45	0.773
	4.03	0.019
5	0.84	0.549
	4.12	0.019

### 5. Conclusions

In this paper, the audit supervision of ant colony algorithm has promoted the optimization of the new infrastructure investment environment. After analyzing the relevant theories, the audit supervision based on the ant colony algorithm has promoted the construction of a new infrastructure investment environment optimization model. The case analysis was carried out, and the model was tested. According to the experimental conclusions, the statistics from the first row to the third row of AIC, SC, etc. are considered to be somewhat nonautocorrelated, and all sources of unit cycles are different. The model is also very robust, able to analyze and perform impulse response function analysis and variance analysis.

### Data Availability

The experimental data used to support the findings of this study are available from the author upon request.

### Conflicts of Interest

The author declares that there are no conflicts of interest to report regarding the present study.

### Acknowledgments

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