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Intensive Evaluation and High-Quality Redevelopment of Enterprise Land Use: A Case Study in China

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Abstract: The reuse of existing industrial spatial resources in China's major urban agglomerations is still very unbalanced and needs more in-depth research. This study used intensive evaluation technology for industrial land in Beijing, Tianjin, and Hebei to evaluate Tianjin and Hebei development zones, and took the Dingzhou Economic Development Zone as an example to evaluate and analyze the intensive use of enterprise land; it suggests the influencing factors for the intensive use of development zones and the measures that can take advantage of the potential of enterprise stock land so as to provide a basis for the rationale behind upgrading industrial land structures and the efficient use of industrial land in Beijing, Tianjin, and Hebei. The results show that the typical enterprise land use in the typical economic development zone is extensive, which suggests that the intensive use of land in the Dingzhou economic development zone is low and that there is still potential for land redevelopment. According to the classification system developed for available land, there is ample opportunity for land-use redevelopment in the development zone, especially in the area of approved but not supplied land and extended enterprise land. Therefore, the redevelopment of enterprise land could also provide a better land guarantee for industrial transfer projects in the equipment manufacturing industry. This study also offers strategies to redevelop available industrial land.

Keywords: enterprise land use; intensive evaluation; economic development zone; high-quality development

Citation: Yang, Z.; Li, S.; Sun, D.; Li, C.; Wu, J. Intensive Evaluation and High-Quality Redevelopment of Enterprise Land Use: A Case Study in China. *Land* **2022**, *11*, 432. https://doi.org/10.3390/land11030432

Academic Editors: Baojie He, Ayyoob Sharifi, Chi Feng and Jun Yang

Received: 1 March 2022
Accepted: 15 March 2022
Published: 16 March 2022

1. Introduction

High quality is the best advantage of meeting the use needs at low cost and obtaining the maximum return in the exchange process [1]. High-quality development is a development mode, element structure and dynamic state that can better meet people's real needs [2]. The high-quality development stage is not simply the pursuit of the high speed of economic development, but the pursuit of higher efficiency, more effective supply, higher structure, and greener, sustainable and more harmonious growth. It can even forgo the pursuit of economic growth speed to achieve higher quality development. Entering the stage of high-quality development, we need to build supporting elements, including the development of strategic transformation, construction of a modern industrial system, deepening of the market system, adjustment of the distribution structure, optimization of the spatial layout structure, and compensation mechanism of the ecological environment and global economy based on domestic demand. Improving the quality of development promotes the well-rounded and coordinated development of economy, politics, society

and ecological environment [3]. Industrial development should be distributed evenly across the land; the land supply for different industrial uses has also directly affected the direction of economic development [4]. According to the results of the second China land survey, the proportion of the output value of secondary and tertiary industries created based on industrial land in the gross national economic product was 89.8%, which showed that industrial land was in an essential position for economic development [5,6]. China's economy has shifted from a stage of rapid growth to a stage of high-quality development.

After the large-scale expansion of urban construction in the early stages, all major cities have been faced with varying degrees of land resource shortages. At the same time, the proportion of the output value of the secondary industries in the cities of Beijing, Shanghai, and Guangzhou in total output value has decreased year over year, forming an industrial structure dominated by the tertiary sectors. Urban development has gradually transformed from the industrial age to the post-industrial age, and a large number of industrial lands are facing opportunities for redevelopment [7–10]. Land-use-change research methods that integrate the time scale and historical background of social and environmental changes are essential in global land planning [11]. Land-use transformation refers to the process of the adaptation of regional land use corresponding to the transformation of economic and social development during a specific period, driven by economic and social changes [3]. As an expression of human activities, industrial land reflects the differences in the behavior and intensity of human industrial production. It is an important research focus in land-use transformation. In recent years, the utilization of industrial land in China has shown characteristics of heavy expansion, including light tapping potential, high stock occupation, and significant increments [12,13]. It is urgently required to optimize the pattern of spatial land development and improve the utilization efficiency of land [14]. The essence of land-intensive use refers to the amount of labor and capital invested in the unit stock land area [4]. The level of land-intensive use can be measured by indicators, such as capital intensity, population intensity, land intensity and land output rate [5,6]. The rational evaluation of land intensive use in the development zone can understand the land intensive use in the development zone, identify the main limiting factors affecting land-intensive use, and provide a practical basis for formulating land-intensive use policies and measures.

In the early days of the founding of the People's Republic of China, to balance the economic development among regions, the government proposed to "change a consumer city into a production city". By the early 1980s, more than 40 cities became key industrial focuses for national construction [15]. These cities represented the most advanced production levels of domestic industrialization and were the pillars of the country's industrial production. At this time, industrial renewal theory focused on the traffic and environmental problems brought on by the development of traditional industry in the layout, adjustment, and construction of the material space [16,17]. From the 1980s to the late 20th century, driven by the promotion of reform, opening up, and new industrialization, China entered a stage of rapid urbanization, and the theory of industrial land renewal focused on discussing the guidance of national policies in the transformation of the old industrial zones [18–28]. Since the 21st century, China has entered the second half of its middle period of industrialization. With improved marketization, the effect of poor land use has become increasingly apparent. Many industrial enterprises have gradually lost competitiveness due to automation, investment, and other problems and were forced to move out of city centers, leaving behind idle industrial spaces. At this time, the adjustment of the industrial structure had become an essential part of the national economic development strategy. The dynamic automation research based on market demands and the exploration of interest relations became the focus of industrial land-transformation theory.

China's urbanization has entered a period of rapid development since the turn of the last century. By the end of 2020, the national urbanization rate reached 63.89%, and the urbanization rate of the central cities in economically developed areas exceeded 80%. The "establishment and sound economic system for green, low-carbon, and circular development" proposed in the report to the 19th CPC National Congress shows that China's

economy shifted from high-speed location growth to a stage of high-quality development [29]. Within this context, "stock optimization and integration" has been promoted as the leading strategy of urban development, and the reuse of "stock industrial land" has become an essential resource for the sustainable development of cities [30]. However, in the practice of urban and rural spatial governance, the transformation and upgrading of existing industrial lands still face many problems. The reuse of existing industrial spatial resources in China's major urban agglomerations is still very unbalanced and needs more in-depth research.

With the rapid development of urbanization, the Beijing–Tianjin–Hebei urban agglomeration has become one of the emerging economic clusters in China [31]. Diversified industrial land distribution, unreasonable structure, extensive utilization, and regional imbalance require an industrial structure adjustment. Therefore, the Beijing–Tianjin–Hebei urban agglomeration is an excellent sample in which to study the transfer of the manufacturing industry and industrial land transformation. The intensive evaluation and regulation of enterprise land use under the concept of high-quality development requires a deep understanding of the reasons for industrial land utilization and conversion and could guide industrial transformation and the upgrading of enterprises so as to optimize the layout of the industrial land, and it is a vital reference to guide the governance policies and measures of industrial land reuse after industrial upgrading. The research objectives of this paper include the following:

- According to different industrial types, this study constructed an industrial land-intensive evaluation index system, calculated the degree of industrial land-intensive utilization by standardizing the index and using a multifactor comprehensive evaluation model, and completed the industrial land-intensive evaluation in Beijing, Tianjin, and Hebei so as to provide corresponding theoretical and technical support for land regulation and control in Beijing, Tianjin, and Hebei.
- This study used intensive evaluation technology for industrial land in Beijing, Tianjin, and Hebei to evaluate the Tianjin and Hebei development zones, and took the Dingzhou economic development zone as an example to evaluate and analyze the intensive use of enterprise land; it suggests the influencing factors for the intensive use of development zones and the measures that can take advantage of the potential of enterprise stock land so as to provide a basis for the rationale behind upgrading industrial land structures and the efficient use of industrial land in Beijing, Tianjin, and Hebei.

The remainder of the paper is organized as follows. Section 2 provides a literature review on the redevelopment methods for industrial and enterprise lands. Section 3 describes the research materials including the research context and data sources. Section 4 outlines the intensive evaluation method and redevelopment process for enterprise land. Section 5 provides the empirical results of the research in the Beijing–Tianjin–Hebei urban agglomeration. Section 6 concludes this research.

2. Literature Review

In the second half of the 20th century, the world economic pattern developed, and the manufacturing industries moved to low-cost labor countries. In developed countries, the tertiary industries gradually replaced the pillar positions of the secondary sector. Many cities that relied on manufacturing industries began to show structural decline, resulting in a large number of idle and abandoned lands. The United Kingdom, Germany, the United States, and other countries have spared no effort to update and renovate industrial lands [32].

Research into the transformation of urban industrial land began in light of the changes in urban industrial zones. Industrial zone-planning research paid attention to the adjustment and change of the industrial area itself. In the early stage of urban industrial land-transformation research, more attention was paid to material transformations and adjustments, such as functional zoning [33], or on technical means, such as industrial

heritage protections [34] and industrial-site landscape designs [35], and the exploration of transformation gradually focused on the guidance of the dynamic mechanism of industrial land transformation and the coordination of interest relations. In industrial zones in the United States, the government has been guided by market demand to implement renewal plans and prevent construction that could damage the public interests of the city through reasonable intervention. In the 1980s, the economic and social impacts on urban development was a pertinent issue, for example, the impact of government policy on the transformation of industrial land. In the 1990s, the United States proposed the "brownfield" concept and noted that urban renewal should be addressed jointly by public and private institutions [36]. It was suggested that traditional material planning does not apply to the development of industrial enterprises and is of great significance for the research of property rights in industrial land transformation [37]. Government policy has played a crucial role in the sustainability of the industrial zone reconstruction and paid attention to property rights in land development [38].

At present, the research of foreign industrial land transformation is focused on the implementation of industrial land-adjustment policies [39,40]. Theoretical methods have been used to analyze the concept of space productivity in regional science and the significance of industrial land as a factor of production as well as clarifying and explaining the regional differences in spatial productivity in Dutch industrial parks, for example. It was also proposed that space productivity was affected by the urbanization rate and manufacturing employment rate in industrial parks and industrial land development policies [41,42]. The role of industrial land policy was analyzed, and its "spatial effectiveness" and "economic benefits" were discussed based on the statistical analyses of seven countries [43]. It was argued that the impact of industrial land development on economic growth depends mainly on the actual situation of the involved regions and that the economic benefits of industrial land policy need to be adjusted in the Netherlands and the nearby suburbs of most cities. The index of industrial land vulnerability on the issue of whether planners should develop industrial land protection policies when dealing with the issue of urban industrial land was proposed [34]. The possibility of converting industrial land to other uses was analyzed, and it described how various industrial protection policies effectively restricted modification. The research ideas in this paper provide a reference for our constructed industrial land-intensive evaluation index system.

In research regarding the transformation of urban industrial land, China has paid more attention to the renewal planning and reconstruction strategies of material spaces in old industrial areas. The background of the renewal and adjustment of industrial land in Yangpu's Old Industrial Zone was elaborated [44]. Based on the specific analysis of the current situation of Yangpu's old industrial zone, the researcher proposed that the industrial land adjustment must serve the functional development strategy of the central urban area of Shanghai, and it should be committed to improving the transformation of the urban functions from "Industrial Yangpu" to "Knowledge Yangpu". Taking Wuhan as the research object, the problems of economic system reform in the adjustment and transformation of Wuhan's old industrial base were analyzed and summarized, including the enterprise behavior of industrial relocation and the lack of urban business concepts as well as other mechanisms, and the study explored the general law of urban transformation of an old industrial base during the transformation period [45]. From urban industrial development, urban development, and system policy factors, Ref. [46] discussed the evolution of urban industrial land, spatial location distribution, and spatial layout evolution in terms of three aspects: the amount of urban industrial land, its spatial distribution, and the spatial layout, specifically of Nanning. According to the scale and transformation path of industrial land, it was divided into two categories: industrial construction and small-scale industrial land transformation as well as the overall transformation of the industrial zone [47,48]. The Hongkou District of the Shanghai downtown area was selected as a case study to clarify the urban center industrial land transformation issues and core problems, and the mechanisms behind the choice were analyzed. Based on the choice of urban form, a reasonable choice

of mechanism systems was provided, according to the structural characteristics of each property itself and the planning selection.

Based on the above analysis, the traditional transformation research of industrial land utilization appeared to focus on the intensity and evaluation of industrial land and utilization efficiency. Although quantitative analysis methods, such as intensive-use evaluation, have provided a new way to evaluate the utilization levels of industrial land, the existing industrial land intensity and utilization efficiency evaluation measurement indicators and different spatial scales have impacted the research results. At present, the research indicators of the transformation of industrial land utilization are mainly focused on the scale of industrial land, industrial land intensification, and industrial land efficiency, and insufficient research has been conducted on the aspects of its business model, land-use nature, and social and economic functions.

3. Research Materials

3.1. Research Context

The Dingzhou economic development zone, located in the Beijing–Tianjin–Hebei urban agglomeration, belongs to the provincial development zone, with 30 km^2. The development zone has a superior geographical location, and by road, local travelers can reach the Beijing, Tianjin, and Hebei International Airport within two hours (Figure 1). Founded in December 2008, the development zone is one of the first industrial clusters and one of the 14 industrial focus areas of more than USD 15 billion.

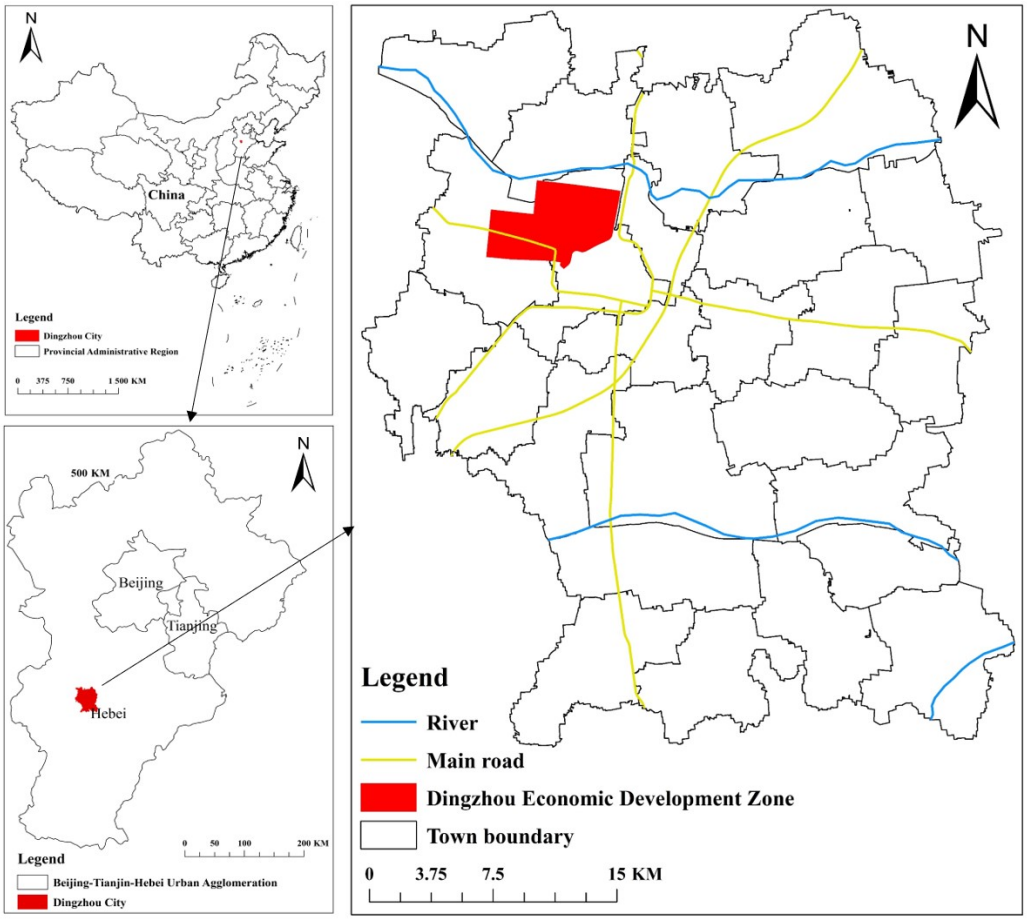

Figure 1. Location of Dingzhou economic development zone.

The leading industry of the Dingzhou economic development zone in Hebei Province is a high-end equipment manufacturing industry, with a basically ideal infrastructure, and is engaged in the production and sales of microvehicles, light vehicles, new energy

vehicles, and critical parts. Typical enterprises in the development zone were selected as representatives for the intensive evaluation of enterprise land use (Figure 2 and Table 1).

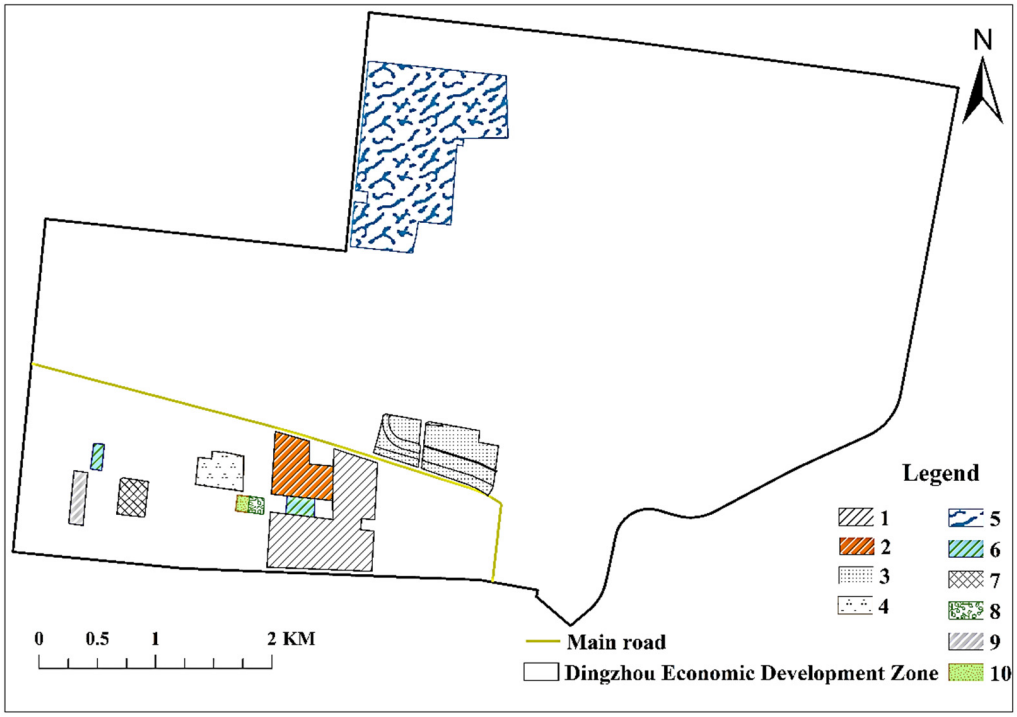

Figure 2. Typical enterprise distribution in the Dingzhou economic development zone (1: Hebei Changan Automobile Co., Ltd.; 2: Baoding Changan Bus Manufacturing Co., Ltd.; 3: Hebei Xuyang Coking Co., Ltd.; 4: Dingzhou Jiabitong Auto Parts Co., Ltd.; 5: Hebei Dongxu Chemical Co., Ltd.; 6: Lingyun Industrial Co., Ltd. Dingzhou Branch; 7: Hebei Shuangcheng Machinery Manufacturing Co., Ltd.; 8: Dingzhou Zhixin Machinery Manufactur-ing Co., Ltd.; 9: Dingzhou Hongyuan Machinery Co., Ltd.; 10: Hebei Hyde Auto Parts Co., Ltd.).

Table 1. Classification of typical enterprise type in Dingzhou economic development zone.

Number	Enterprise Name	Enterprise Type
1	Hebei Changan Automobile Co., Ltd.	Equipment manufacturing industry
2	Baoding Changan Bus Manufacturing Co., Ltd.	Equipment manufacturing industry
3	Hebei Xuyang Coking Co., Ltd.	Equipment manufacturing industry
4	Dingzhou Jiabitong Auto Parts Co., Ltd.	Equipment manufacturing industry
5	Hebei Dongxu Chemical Co., Ltd.	Equipment manufacturing industry
6	Lingyun Industrial Co., Ltd. Dingzhou Branch	Equipment manufacturing industry
7	Hebei Shuangcheng Machinery Manufacturing Co., Ltd.	Equipment manufacturing industry
8	Dingzhou Zhixin Machinery Manufacturing Co., Ltd.	Equipment manufacturing industry
9	Dingzhou Hongyuan Machinery Co., Ltd.	Equipment manufacturing industry
10	Hebei Hyde Auto Parts Co., Ltd.	Equipment manufacturing industry

3.2. Data Collection

The socioeconomic data came from Dingzhou's statistical yearbook in 2018. In addition, land-use information was collected from the land-use status survey database of Dingzhou City, in order to analyze the spatial industrial land utilization in the Dingzhou economic development zone.

4. Methods

4.1. Basic Idea

The research design was divided into three steps:

First, we examined the current status of land-intensive use and industrial land use at home and abroad among the research of domestic and foreign researchers, combined the current situation of the Dingzhou economic development zone land, and selected key influence factors to build an intensive evaluation system of enterprise land. Based on the above analysis, we identified the main influencing factors of enterprise intensive land use evaluation.

Second, the enterprises in the Dingzhou economic development zone were divided into industrial types, and then we determined the practical and precision principles, selected key influence factors, built an intensive evaluation system of enterprise land use, and then used subjective and objective comprehensive methods to determine the weight to obtain the total score of enterprise intensive land use.

Third, through the Dingzhou economic development zone enterprise land intensive evaluation research, we established enterprise land intensive potential values through the intensive scores and highly intensive enterprise-land values to acquire the potential of the enterprise land and Dingzhou enterprise land according to the stock division and on the stock land regulation policy to improve the efficiency of land use.

4.2. Classification of Industrial Types

According to the types of leading industries, the enterprises were divided into the equipment manufacturing industry, raw material industry, high-tech industry, and modern service industry [38] (Table 2).

Table 2. Industry classification standard.

Industry Type	Definition	Specific Industries
Equipment manufacturing industry	To meet the needs of the development of various sectors of the national economy and security and manufacturing all kinds of technical equipment industry.	Including automobile manufacturing, engineering machinery, electrical engineering, machine tools, petrochemical general machinery, heavy mining machinery, instrumentation, agricultural machinery, and other industries.
Raw material industry	A collection of activities of protection, recovery, regeneration, renewal, value-added, and accumulation of natural resources and reproduction through government and social input.	Including metallurgy, chemical industry, non-metallic materials, gold, petroleum, and other industries.
High tech industry	Research and development play a key role in the production and service industries.	It includes electronic information, biology, medicine, and public security industries.
Modern service industry	A new service industry with modern characteristics that is mainly based on the tertiary industries.	Including logistics, tourism, business services, cultural and creative industries, and technology services.

4.3. Evaluation Method of Enterprise Land-Intensive Use

After the enterprises were divided into industrial types according to the standard table, a comprehensive evaluation was carried out for each kind of enterprise land-use industry, including selecting the evaluation indicators, determining the ideal value and setting weight, and measuring their intensive degree and potential.

In this paper, the multi-factor comprehensive evaluation model was used for the intensive evaluation of the enterprise land. The overall degree of land use was comprehensively reflected by simple, intuitive, qualitative, and quantitative methods.

(1) The calculation formula of each sub-objective score of land-use intensity is as follows:

$$G_{ij} = \sum_{k=1}^{n} \left(x_{ijk} \times f_{ijk} \right) \quad (1)$$

where G_{ij} is the intensive degree score of sub-target j in target i, x_{ijk} is the standard value of index k in sub-target j of target I, and f_{ijk} is the weight value of index k in sub-target j of target i relative to sub-target j.

(2) The calculation formula of the land-use intensive target score is as follows:

$$G_i = \sum_{j=1}^{n} (G_{ij} \times f_{ij}) \quad (2)$$

where G_i is the intensive score of goal I, G_{ij} is the intensity score of sub-target j in target i, and f_{ij} is the weight value of sub-targets j in target i relative to mark i.

(3) The total score of the land-use intensity is calculated as follows:

$$G = \sum_{i=1}^{n} (G_i \times f_i) \quad (3)$$

where G is the score for the degree of intensity, G_i is the intensity degree score for target i, f_i is the weight value of goal i, and n is the number of targets.

4.3.1. Building Evaluation Index System for Enterprise Land-Intensive Use

Based on the index specified in the China manual for the evaluation of urban construction land conservation and intensive use, this study chose an evaluation index to understand the land-use status and land-use benefit of enterprises and combined the influencing factors and the methods of obtaining the indicators [45]. In this paper, five kinds of evaluation factors with economical attributes, i.e., land input (a), land output (b), land intensity (c), land structure (d), and land-use intensity (E), were preliminarily selected to establish an evaluation index system for enterprise land-intensive use (Table 3).

Table 3. Evaluation index system of enterprise land-use intensity.

Criterion Layer	Index Layer	Unit	Index Explanation	Index Influence
land input (A)	Investment intensity of fixed assets (A1)	10^4 USD/hm^2	The ratio of the total accumulated fixed-asset investments of the enterprise to the land area of the Development Zone	positive
	Labor input intensity (A2)	person/hm^2	The ratio of the number of employees to the land area of the Development Zone	positive
land output (B)	Average industrial output value (B1)	10^4 USD/hm^2	The ratio of industrial output value of enterprises to the land area of Development Zone	positive
land intensity (C)	Comprehensive plot ratio of industrial land (C2)	/	Ratio of the total construction area of industrial land to the occupied area of industrial land	positive
	Building coefficient of industrial land (C2)	%	The ratio of the sum of the base area of buildings and structures, the area of open storage yard and open operation site to the area of industrial land	positive
land structure (D)	Industrial land use rate (D1)	%	Ratio of industrial land area of enterprises to built-up land area in Development Zone	positive
	Green space rate (D2)	%	Ratio of green area of enterprise to land area of Development Zone	negative
use intensity (E)	Land supply rate (E1)	%	The ratio of the land area approved for construction supply to the land area approved for construction in the enterprise	negative
	Rate of unused land (E2)	%	The ratio of idle land of enterprises to the area of state-owned construction land supplied	negative

4.3.2. Dimensionless Evaluation Index Data of Enterprise Land-Intensive Use

In this study, the ideal value of the dimensionless method was used to analyze the original data.

(a) We determined the ideal value of land-intensive evaluation for the equipment manufacturing industry, raw material industry, high-tech industry, and modern service industry. For the positive and negative indicators, according to the principle of intensive land use, the ideal value was determined by the quarter-point method and the experience reference method [41].
(b) Dimensionless indicators. Due to the characteristic differences of the selected indicators, it is necessary to make them dimensionless in order to simplify the experiment or calculation. Therefore, the ideal value standardization method was used to standardize the evaluation indicators.
(c) For the initial value of the positive indicator, the following formula was used.

$$X_{i0} = \frac{a_i}{A_i} \times 100 \tag{4}$$

For the initial value of the negative indicator, the following formula was used.

$$X_{i0} = \frac{A_i}{a_i} \times 100 \tag{5}$$

where X_{i0} refers to the initial dimensionless value of the sub-indicator i; a_i refers to the actual value of the sub-indicator i; and Ai refers to the standard ideal weight of the sub-indicator i.

According to the characteristic differences of relevant indices and corresponding ideal values with the dimensionless input of each index, the initial value X_{i0} of dimensionless was processed according to the following principles, and the dimensionless value X_i of the final indexes was obtained. The principles of treatment are as follows:

- X_i belongs to the closed interval (0100).
- If $X_{i0} \geq 100 \geq 100$, $X_i = 100$, indicating that the actual value has reached the ideal state.
- Indicator with an excellent value of 0, $X_i = (1 - a_i) \times 100$.

In this study, the optimal combination weight method was used. The subjective and objective weighting methods were combined organically, and the weights were determined by the AHP (analytic hierarchy process) and entropy method.

Set the weight coefficient of each index obtained by AHP (subjective method) to p:

$$p_j = (p_1, p_2, \ldots, p_n)^T \tag{6}$$

Set the weight coefficient of each index obtained by entropy method (objective method) to q:

$$q_j = (q_1, q_2, \ldots, q_n)^T \tag{7}$$

Set the optimal combination weight coefficient to f:

$$F = (f_1, f_2, \ldots, f_n)^T \tag{8}$$

where $F_j = m_1 p_j + m_2 q_j$ $(j = 1, 2, \ldots, n)$, m_1 and m_2 are the linear representation coefficients of the combined weight coefficient vector. Set $m_1, m_2 \gg 0$, and unitized constraints $m_1^2 + m_2^2 = 1$.

Calculation m_1 and m_2.

According to the simple linear weighting method, the total evaluation value of the object i is G, that is,

$$G_i = \sum_{j=1}^{n} x_{ij} f_j, i = 1, 2, \ldots, m \tag{9}$$

where the greater the G_i, the better the intensity. If the selected m_1 and m_2 are not correct, the mutual difference of the multi-index total evaluation values among evaluation objects will be slight and not conducive to ranking. Therefore, to reflect the final evaluation results, G_i needs to be as dispersed as possible, and the following constraints need to be met: $m_1,\ m_2 \geq 0$, $m_1^2 + m_2^2 = 1$ make the value of $\sum_{i=1}^{m} G_i^2 = \sum_{i=1}^{m} (\sum_{j=1}^{n} (m_1 p_1 + m_2 q_2) x_{ij})^2$ maximum.

Then the following optimization problems are solved equivalently:

$$\begin{cases} \max H(m_1, m_2) = \sum_{i=1}^{m} G_i^2 = \sum_{i=1}^{m} \left(\sum_{j=1}^{n} (m_1 p_1 + m_2 q_2) x_{ij} \right)^2 \\ m_1^2 + m_2^2 = 1 \\ m_1,\ m_2 \geq 0 \end{cases} \tag{10}$$

4.3.3. Calculation of the Total Potential of Enterprise Land

In this study, combined with the national economic and social development planning objectives, the overall land-use planning, urban planning, industrial land-use standards, and the total score of land-use-intensive evaluation in developed areas, the evaluation standard for the land-use-intensity degree for enterprise land was divided into four levels, which are highly intensive, intensive, less extensive, and extensive (Table 4).

Table 4. Intensive degree of enterprise land.

Intensive Degree of Enterprise Land	Industry Type	Intensive Score	Description
Highly intensive	Equipment manufacturing industry	$G \in (90.00, 100]$	The potential of intensive land use is very small, and the land is intensive and tense.
	Raw material industry	$G \in (90.00, 100]$	
	High-tech industry	$G \in (95.00, 100]$	
	Modern service industry	$G \in (95.00, 100]$	
Intensive	Equipment manufacturing industry	$G \in (80.00, 90.00]$	The potential of land intensive use is small, and the level of land use is intensive and moderate.
	Raw material industry	$G \in (80.00, 90.00]$	
	High-tech industry	$G \in (80.00, 95.00]$	
	Modern service industry	$G \in (80.00, 95.00]$	
Less extensive	Equipment manufacturing industry	$G \in (60.00, 80.00]$	The potential of intensive land use is large, and the land use mode is extensive.
	Raw material industry	$G \in (60.00, 80.00]$	
	High-tech industry	$G \in (60.00, 80.00]$	
	Modern service industry	$G \in (60.00, 80.00]$	
Extensive	Equipment manufacturing industry	$G \in [0, 60.00]$	The potential of intensive land use is large, and the land use mode is extensive.
	Raw material industry	$G \in [0, 60.00]$	
	High-tech industry	$G \in [0, 60.00]$	
	Modern service industry	$G \in [0, 60.00]$	

We set the highly intensive values in Table 4 as the ideal values of the equipment manufacturing industry, raw material industry, high-tech industry, and modern service industry, respectively. The overall land-use potential of an enterprise is the difference between the intensive degree of each enterprise and the excellent value:

$$P_i = \left(\frac{G - G_i}{G} \right) \times S_i \tag{11}$$

where P_i refers to the potential value of enterprise intensive land use; G refers to the highly intensive value of equipment manufacturing, raw material industry, high-tech industry, and modern service industry; G_i refers to the score of the land-intensity degree for enterprise i; and S_i refers to the area of enterprise land.

5. Results

5.1. Intensive Evaluation of Enterprise Land Use and Its Potential Results

According to the intensive evaluation of enterprise land use and the calculation of enterprise land-use potential, the evaluation results are shown in Table 5. The results showed that the typical enterprise land in the Dingzhou economic development zone was widely used. The distinct enterprises in the development zone were all in the equipment manufacturing industry, and the excellent value of intensive land use was 90 points. Hebei ShuangTian Machinery Manufacturing Co., Ltd., with the highest intensive degree, has only 74.50 points, while Baoding Changan Bus Manufacturing Co., Ltd. has the lowest, with less than 50 points. These enterprises have a significant difference, as compared to the average intensive land use, so they could still further expand their potential.

Table 5. Intensive evaluation and possible results of enterprise land use.

Enterprise Name	Intensive Evaluation Results	Intensive Evaluation Level	Area (hm^2)	Potential Measurement Results (hm^2)
Hebei Changan Automobile Co., Ltd.	57.19	Extensive	81.10	26.61
Baoding Changan Bus Manufacturing Co., Ltd.	49.33	Extensive	50.00	20.34
Hebei Xuyang Coking Co., Ltd.	68.59	Less extensive	193.39	41.40
Dingzhou Jiabitong Auto Parts Co., Ltd.	67.93	Less extensive	9.93	2.19
Hebei Dongxu Chemical Co., Ltd.	58.49	Extensive	6.03	1.90
Lingyun Industrial Co., Ltd. Dingzhou Branch	72.26	Less extensive	3.48	0.62
Hebei Shuangcheng Machinery Manufacturing Co., Ltd.	74.50	Less extensive	7.93	1.23
Dingzhou Zhixin Machinery Manufacturing Co., Ltd.	70.71	Less extensive	1.21	0.23
Dingzhou Hongyuan Machinery Co., Ltd.	53.06	Extensive	3.79	1.40
Hebei Hyde Auto Parts Co., Ltd.	76.14	Less extensive	1.07	0.15

5.2. Redevelopment of Enterprise Land

5.2.1. Redevelopment Process

This study selected the Dingzhou economic development zone as the research object of land-use regulation. It carried out the redevelopment of enterprise land by focusing on the route of "identifying the stock of enterprise land," "determining the stock of enterprise land," and "redeveloping the stock of enterprise land" (Figure 3).

5.2.2. Classification of Stock Enterprise Land

According to the urgency of carrying out focused investigations on urban construction land use in China, Huang et al. [42] researched the potential of urban construction land in Chizhou's economic and technological development zone of Anhui Province, and Liu et al. [43] researched the connotation, definition, and type division of available urban construction land. The classification of available urban construction land was divided into unused land, approved but not supplied land, and extensive land.

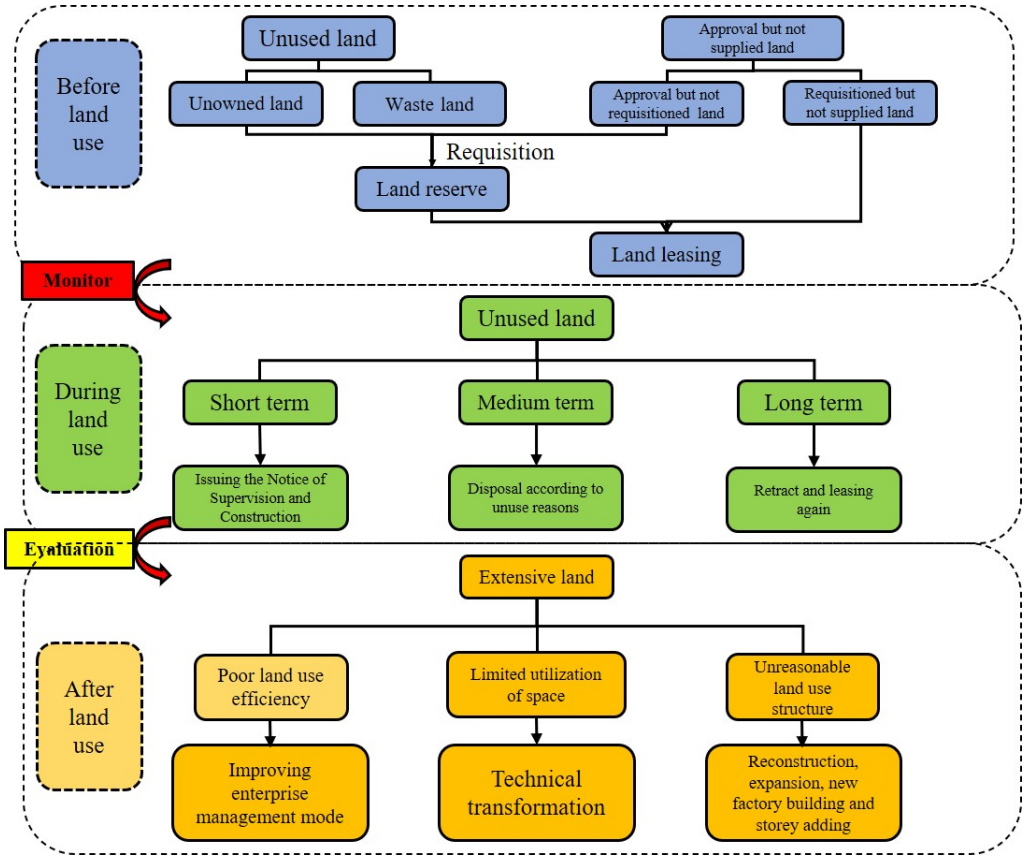

Figure 3. Flow chart of enterprise land redevelopment.

5.2.3. Determining the Availability of Enterprise Land

(a) Unused enterprise land

Unused land was divided into short-term new, medium-term new, and long-term new by the start time and development degree of enterprises. The evaluation conditions are shown in Table 6.

Table 6. Criteria for unused land.

Type	Criteria
short-term	$t \in \left[\frac{1}{2}, 1\right), s = 0;\ t \geq 1, s < 1/3$
medium-term	$t \in [1,\ 2),\ s = 0;$ or $t \geq 2, s < 1/2$
long-term	$t \geq 2, s = 0;$ or $t \geq 3, s < 1$

Note: t is the starting time of the enterprise, unit: years refers to the proportion of the development and construction area to be completed, unit: dimensionless.

(b) Approved but not supplied land

Approved but not supplied land refers to the land that was not provided after being approved by the State Council or provincial people's government for land requisition or farmland conversion according to China's Land Management Law. It was divided into approved but not requisitioned land and requisitioned but not supplied land [38].

According to the report of the intensive economy evaluation of the Development Zone, there were many unfulfilled land requisitions in the Dingzhou economic development zone. The land granted but not collected was 1378.45 hm^2, and the land not supplied was 165.48 hm^2; the distribution is shown in Figure 4.

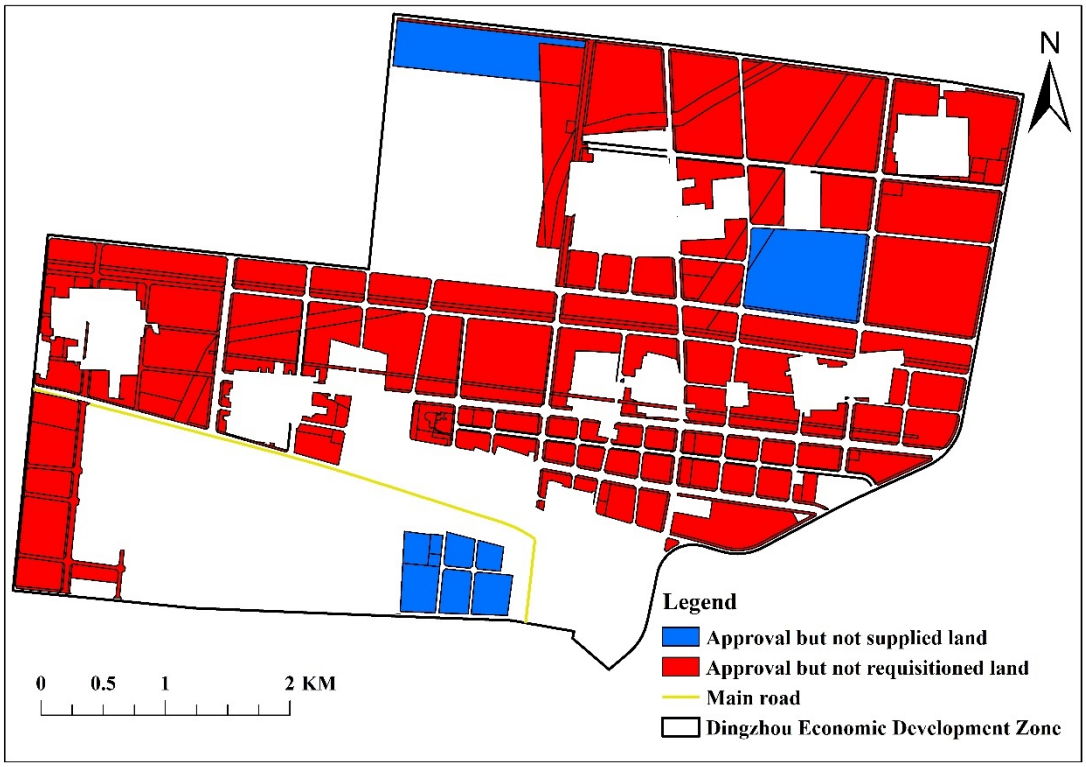

Figure 4. Approval but not supplied or requisitioned land.

(c) Extensive enterprise land

According to the results of the intensive evaluation of enterprise land use, it was concluded that the selected typical enterprises had extensive land use. According to the causes of comprehensive land use, comprehensive land use was divided into three categories: the impact of land-use efficiency on enterprises, the impact of land-use intensity on enterprises, and the impact of land-use structures on enterprises [45]. The goal was to compare each item of the criteria layer of the enterprise land-intensive evaluation index vertically. If the score of this item was lower than the enterprise land-intensive evaluation index, the average score of each layer would be regarded as the influencing factor for extensive land use (Table 7).

Table 7. Hierarchical score of enterprise land-intensive evaluation criteria.

Enterprise Name \ Criterion Layer	Land-Use Efficiency	Land-Use Intensity	Land-Use Structure
Hebei Changan Automobile Co., Ltd.	35.53	7.76	13.90
Baoding Changan Bus Manufacturing Co., Ltd.	28.44	9.70	11.19
Hebei Xuyang Coking Co., Ltd.	30.68	20.38	17.53
Dingzhou Jiabitong Auto Parts Co., Ltd.	24.17	25.55	18.21
Hebei Dongxu Chemical Co., Ltd.	38.53	12.94	7.02
Lingyun Industrial Co., Ltd. Dingzhou Branch	38.53	23.61	10.12
Hebei Shuangcheng Machinery Manufacturing Co., Ltd.	36.62	23.29	14.59
Dingzhou Zhixin Machinery Manufacturing Co., Ltd.	38.53	17.47	14.71
Dingzhou Hongyuan Machinery Co., Ltd.	16.57	20.70	15.78
Hebei Hyde Auto Parts Co., Ltd.	38.53	20.70	16.91
Average value	32.61	18.21	13.85

From Table 7, it was concluded that there are four enterprises mainly affected by land-use efficiency, namely Baoding Chang'an Bus Manufacturing Co., Ltd., Hebei Xuyang Coking Co., Ltd., Dingzhou Jiabao Tiantong Auto Parts Co., Ltd., and Dingzhou Hongyuan

Machinery Co., Ltd. The low land-use efficiency of these enterprises was mainly affected by the financing environment of the enterprises. The difficulty of financing and the severe shortage of funds restricted the funds needed for technical transformation.

There are four enterprises mainly affected by land-use intensity, namely Hebei Chang'an Automobile Co., Ltd., Baoding Chang'an Bus Manufacturing Co., Ltd., Hebei Dongxu Chemical Co., Ltd., and Dingzhou Zhixin Machinery Manufacturing Co., Ltd. The utilization intensity is mainly reflected in the floor area ratio, 0.24, 0.3, 0.4, and 0.54, respectively. There is a large difference noted from the ideal value of 1, and these typical enterprises have not reached the standard of perfect weight.

There are three enterprises mainly affected by the land-use structures, namely Baoding Chang'an Bus Manufacturing Co., Ltd., Hebei Dongxu Chemical Co., Ltd., and the Dingzhou branch of Lingyun Industrial Co., Ltd. The land-use structures are mainly composed of production land, office land, green space, and other land. The proportion of production land was somewhat high, which indicated that the more reasonable the structure, the higher the intensity level. Among the three enterprises, the proportion of production land was 44.00%, 27.03%, and 34.48%, respectively, none of which accounts for 50%, while the other enterprises accounted for more than 50% of the production land.

5.2.4. Redevelopment of Available Enterprises Land

(a) Unused enterprise land

According to different types of unused enterprise land, the measures to dispose of new land are shown in Table 8.

Table 8. Disposal measures of unused land.

Type	Measures
short-term	The local departments in charge of land and resources at all levels shall issue notices to the land users to supervise and urge construction
medium-term	Government-caused unused land: (1) Replacement of equivalent idle land for land users (2) According to the actual amount of payment for the enterprise to supply the corresponding land.
	Enterprise causes land unused: (1) Due to the difficulty of the project, the enterprise is unable to start the project at present, and requests to postpone the construction, but the delay time should not exceed one year. (2) If the enterprise wants to change the land use, the land department shall re-evaluate the economic capacity and actual land demand of the construction unit and handle the land-use change procedures to meet the requirements. (3) Because the enterprise itself cannot continue to invest in the construction of the land, the government does a good job of coordination, and takes measures to recover and transfer the land to new users. (4) Without special reasons, enterprises need to pay the corresponding unused land fees.
Long-term	It should be returned to the market free of charge

(b) Approved but not supplied land

Approved but not requisitioned land should complete the land acquisition according to the land acquisition procedures and then place it into the land reserve and transfer it to the market. Requisitioned but not supplied land should speed up the supply of land.

(c) Extensive enterprise land

Given the major impact of land-use efficiency, enterprises should improve their enterprise management mode; enhance their employee competitiveness through salary and

welfare, personnel training, and improved working conditions; and mobilize the initiative, enthusiasm, and creativity of employees in a well-rounded way. Given the major impact of land-use intensity, enterprises should, on the one hand, cooperate with new enterprises by using the land and plants as financing capital. On the other hand, obtaining capital for upgrading and technological transformation, adopting new technologies and processes, and using the latest equipment to reduce energy consumption could also improve their efficiency and intensity. Given the major impact of the land-use structure, enterprises should upgrade the production equipment, rebuild, expand, and build new production land as well as adding floors to the plant.

6. Conclusions

Using the Dingzhou economic development zone as a case study, this paper discussed the factors influencing of enterprise intensive land use. We constructed the evaluation system and method of enterprise intensive land use. On this basis, the results suggested the redevelopment of available industrial land as well as the supply of industrial land. The results showed that the typical enterprise land use in the economic development zone is extensive, which makes the intensive use of land in the Dingzhou economic development zone low; there remains opportunities for land redevelopment. According to the stock classification, there is ample space for redevelopment in the development zone, especially in the category of approved but not supplied land and extended enterprise land. Therefore, the redevelopment of this kind of land would also provide a better land guarantee for industrial transfer projects in the equipment manufacturing industry. Hebei is a platform for Beijing's ambitions. Extensive land use is typical in industrial parks, and there is still ample space for redevelopment. According to the causes of comprehensive land use, when combined with the practical orientation of the industrial park, the threshold for enterprises to enter the park is set from the aspects of the enterprise input–output benefit, plot ratio, energy consumption, production land proportion, etc., to effectively and reasonably transfer the industries in Beijing.

The contribution of this research is the redevelopment of enterprise land to provide better land guarantee for industrial transfer projects in the equipment manufacturing industry. This study also offered strategies to redevelop available industrial land.

There remain some limitations in the current research. The determination of the ideal value involved in the index system cannot remain unchanged, and it would also be appropriate to follow the changes in the government's industrial policy. According to the data availability, the only indicators related to land-use structure in the determination of intensive evaluation indicators are the industrial land-use rate and green-space rate. Optimizing a reasonable land-use structure is the premise of evaluating land-intensive use. In the future, more data indicators of land-use structures should be obtained through field investigation.

Author Contributions: Conceptualization, Z.Y. and J.W.; methodology, Z.Y.; software, J.W.; validation, C.L., J.W. and S.L.; formal analysis, Z.Y. and J.W.; investigation, C.L. and Z.Y.; resources, C.L. and J.W.; data curation, Z.Y., C.L. and J.W.; writing—original draft preparation, Z.Y., C.L. and J.W.; writing—review and editing, Z.Y., C.L. and J.W.; visualization, Z.Y. and D.S.; supervision, Z.Y. and C.L.; project administration, Z.Y. and C.L.; funding acquisition, Z.Y. and C.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the National Natural Science Fund Youth Project of China (Grant No. 41501606); National Natural Science Fund General Project of Shandong (Grant No. ZR2020MD012); Youth Innovation Team of colleges and universities of Shandong Province (Grant No. 2019RWG016); the Foundation of Key R&D plan of Shandong (soft science project) (2021RZB06026); Joint Project of Major Theoretical and Practical Problems in the Social Sciences of Shaanxi Province (Grant nos.20ST-98); Social Science Fund of Shaanxi Province (Grant No. 2020R051) and Independent Research and Development project of State Key Laboratory of Green Building in Western China (LSZZ202215).

Data Availability Statement: The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to privacy.

Acknowledgments: The authors sincerely thank the anonymous reviewers for their valuable comments and suggestions to improve the quality of this paper.

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

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