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Evaluating and Analyzing Urban Renewal and Transformation Potential Based on AET Models: A Case Study of Shenzhen City

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Abstract: With the development of the urban economy and population growth, the demand for urban construction land continues to rise. Addressing the challenges of land protection and ecological security calls for the exploration of new approaches. This study emphasizes a sustainable solution by emphasizing in-depth exploration of existing land resources, moving away from the traditional "expanding the pie" model of urban development. Specifically, we selected land parcels in Shenzhen city from 2010 to 2020 that met the criteria for urban renewal and transformation as evaluation units, further categorized into residential, industrial, and commercial land for transformation. From multiple perspectives, including geological conditions, building conditions, agglomeration, social factors, and the degree of completeness of public facilities, we constructed an evaluation system comprising 23 indicators to quantify the potential for urban renewal of these units. Through the AET (AHP-EWM-TOPSIS) model analysis for assessing the potential of urban renewal and transformation, we classified the transformation parcels into different potential levels based on the optimized solutions from the model. Finally, we validated the results using the planned land units implemented in Shenzhen from 2010 to 2020, achieving an accuracy of 81% in matching the spatial distribution of potential levels with the actual situation. The comprehensive evaluation results from the model provide a basis for optimizing and enhancing sustainable urban renewal. This research contributes to the formulation of informed decisions and strategic urban development planning, enabling a more cautious and resource-efficient approach to address the challenges of urban expansion.

Keywords: urban renewal and transformation; potential measurement; TOPSIS; entropy weight method; AHP

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Citation: Yao, K.; Lu, Y.; Li, X.; Ruan, H.; Gao, F.; Shao, S.; Sun, Y.; Liu, Y.; Li, J. Evaluating and Analyzing Urban Renewal and Transformation Potential Based on AET Models: A Case Study of Shenzhen City. *Sustainability* **2023**, *15*, 13528. https://doi.org/10.3390/su151813528

Academic Editor: Thomas A. Clark

Received: 30 July 2023
Revised: 5 September 2023
Accepted: 8 September 2023
Published: 10 September 2023

1. Introduction

The "14th Five-Year Plan and Long-Term Goals for 2035 of the People's Republic of China's National Economic and Social Development" puts forward the concept of "implementing urban renewal actions" at the national level. The previous model of urban expansion through large-scale demolition and relocation is no longer feasible. Instead, we need to enter an era of refined management, focusing on high-quality transformation within limited space [1].

By the end of 2018, approximately 35 large and medium-sized cities in China had entered the stage of urbanization. According to data released by the National Bureau of Statistics on 17 January 2020, the overall urbanization rate in China reached 60.60%, surpassing the 60% mark for the first time [2]. According to the "Urban Blue Book: China Urban Development Report No. 12" published by the Institute of Urban Development and Environmental Studies of the Chinese Academy of Social Sciences on 29 October 2019, the urbanization rate in China is predicted to reach 70% by 2030, but the growth rate of urbanization may slow or stagnate. The rapid growth of the Chinese real estate market over the past 20 years has been driven by a rapid urbanization process [3]. As China enters the middle and later stages of urbanization, the era of large-scale expansion in the real estate industry will come to an end, gradually transitioning into an era of stock development with a focus on large-scale asset management and operations known as urban renewal.

In the practice of urban renewal, China faces serious issues and challenges. A shortage of funds for urban construction has become a common phenomenon. At the same time, urban renewal projects are dispersed and numerous. Therefore, prioritizing funding for important and urgent projects in urban renewal can greatly accelerate the process, create greater socio-economic benefits, and serve as a demonstration for other potential projects, resulting in significant efficiency gains. The selection of priority redevelopment projects aims to maximize the comprehensive benefits of urban renewal. This process considers factors such as land-use status, social factors, economic factors, ecological environment factors, policy factors, current development driving forces, planning development pulling forces, and regional equity. Therefore, the problem of selecting priority redevelopment project sites can essentially be classified as a multi-objective factor spatial optimization problem. The present study aims to establish potential evaluation indicators and methods based on urban renewal and multi-objective factor optimization site selection. This research assesses and explores the potential for internal urban renewal and provides a scientific decision-making basis for the formulation of relevant policies and the determination of planning objectives, timing, and strategies.

In this endeavor, our study delves deeply into the intricate dimensions of the "potential" concept within urban renewal. "Potential" embodies the innate capability of a specific area to undergo impactful and sustainable transformations. We shall expound upon how our evaluation of potential engrosses a comprehensive analysis of diverse factors, encompassing economic, social, and environmental facets, steering away from a sole emphasis on heightened input-output efficiency. A higher potential suggests that the area has favorable conditions for successful revitalization, such as its geographic location, existing infrastructure, economic prospects, and community needs. This concerted effort is directed at fostering a more lucid comprehension of the nuanced connotations encapsulated within the realm of "potential". Urban renewal is an activity that involves the demolition, reconstruction, investment, and construction of a declining area within a city, aiming to enhance the connotation of urban development, achieve structural succession in spatial terms, and restructure and reorganize the urban functional system [4]. Originating from large-scale urban redevelopment activities in Western countries after World War II, the terms associated with urban renewal in foreign contexts often correspond to "Urban Renewal" [5–7], "Urban Reconstruction" [8–10], "Urban Regeneration" [11–13], and similar expressions. In China, urban renewal has traditionally been referred to as "old city transformation" or "old city reconstruction". In response, Wu Liangyong [14] proposed the following: "In the field of urban planning in China, there is a popular term 'old city reconstruction', which is inaccurate and has been misunderstood by society as requiring large-scale demolition and construction to adapt to modern life, with unsatisfactory results". Therefore, it is necessary to rectify this terminology and replace it with "urban renewal".

Currently, research on urban renewal in China is primarily focused on case studies of first-tier cities such as Beijing, Shanghai, and Guangzhou. Research topics mainly revolve around the current state of urban renewal, renewal models, driving mechanisms, policy regulations, reflections on problems, and introductions to foreign urban renewal experiences. Li Shaoying et al. [15] explored the spatiotemporal patterns and evolutionary rules of residential plot ratios in Guangzhou at multiple scales, including the neighborhood, street, and district levels, based on spatiotemporal real estate data. Cao Kexin et al. [16] conducted research and analysis on the spatiotemporal evolution paths and driving mechanisms of sustainable urban renewal by applying a macroeconomic model. Zhang Jiali et al. [17] utilized policy text mining and content analysis to construct a PMC (Policy Modeling Consistency) index model for urban renewal policies in the Beijing–Tianjin–Hebei region. The authors selected nine primary variables and 37 secondary variables to analyze the strengths and weaknesses of various policies from multiple dimensions and provided suggestions for urban policy development. Jihad Awad [18] employed the Analytic Hierarchy Process (AHP) to conduct expert brainstorming, extract sustainable urban renewal planning elements in Dubai, and determine the ranking of tasks for the urban environment, economy, and social/cultural sectors through experiments. Benedetto Manganelli [19] established a policy model to support urban renewal through a case analysis of a residential area in Matera, Italy, and sought optimal solutions that balance different effects for each stakeholder. Jerson Alexis Pinzon Amorocho [20] employed the TOPSIS method to compare different pairs of implementation plans for a five-story building in Spain, providing a comprehensive decision-making approach for the proposed renovation plans.

Most studies in this field often focus on entire administrative regions, rather than specific land parcels, making it difficult to develop a systematic theory that can guide practical implementation. Due to the widespread shortage of urban construction funds and the dispersed and multivalent nature of urban renewal projects, determining which areas should be prioritized for renewal is a fundamental issue in urban planning. This paper aims to establish a set of indicators to address this problem. Subsequently, a multi-criteria evaluation method is employed to calculate the potential value, thereby providing a scientific basis for government land management and serving as a reference for future urban renewal plans.

2. Study Area and Data

2.1. Study Area

The study area selected for this research is Shenzhen City. With a total area of 1997.27 km^2, Shenzhen is the first Special Economic Zone established in the People's Republic of China and is currently experiencing rapid and intensive urbanization. The resident urban population and built-up area have increased from 8.91 million people and 813.23 km^2 in 2010 to 12.90 million people and 923.25 km^2 in 2020. The built-up area now accounts for 46.22% of the administrative region, and the availability of land for new constructions is extremely limited. Urban renewal has become an important means for Shenzhen to mitigate conflicts between population and land resources. After surpassing the supply of new construction land for the first time in 2012 (with stock land indicators accounting for 56% of the total supply indicators), the proportion of stock land has increased annually, reaching 85% by 2016 and far exceeding the scale of new land supply. From 2016 to 2020, the Shenzhen municipal government set the goal of developing 30 km^2 of various types of renewal land. Among them, the scale of demolition and reconstruction, mainly focusing on urban villages and old industrial areas, totaled 12.5 km^2, achieving an average annual land supply of 2.5 km^2. The scale of non-demolition and reconstruction (comprehensive renovation, functional changes, etc.) was 17.5 km^2 [21].

Shenzhen has entered a transitional period in its urban spatial development model, shifting from "rapid expansion" to "stock exploration". This period reflects the various complex issues involved in urban renewal and transformation [22]. By using open-source big data-based evaluation, the potential of Shenzhen's renewal and transformation can be better reflected, thus providing a theoretical basis for decision-makers involved in urban renewal and transformation in the city. This measure also provides a methodological reference for delineating the potential levels of urban renewal and transformation across the country. A DEM map of Shenzhen City is shown in Figure 1.

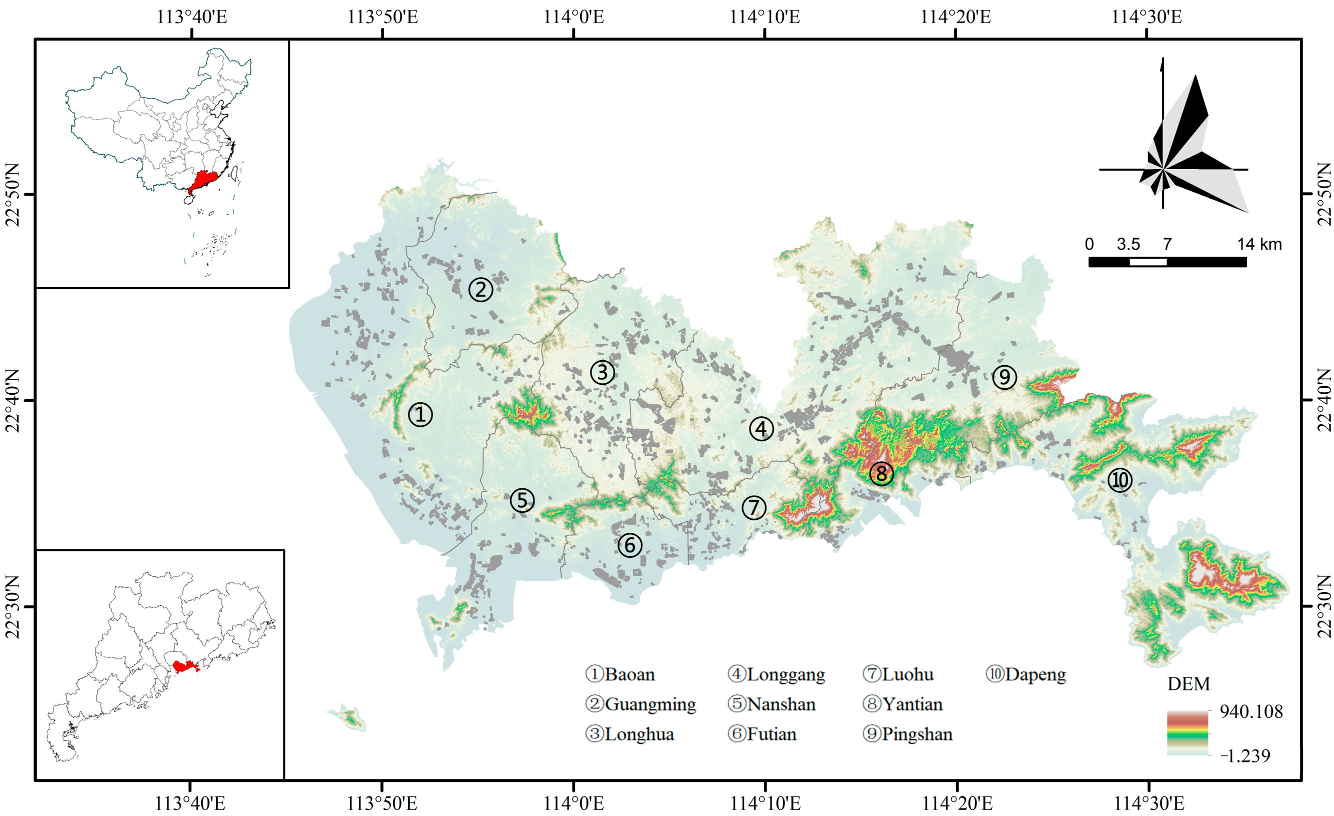

Figure 1. DEM Map of Shenzhen City.

2.2. Study Data

The collected research data and data sources are listed in Table 1, mainly including the following three types of data:

Table 1. Data summary table of the beach area.

Type	Name	Period (Year)	Source
Vector data	Supply of Urban Renewal Sites in Shenzhen City	2010–2020	Shenzhen Planning and Natural Resources Bureau
	Land use status data in Shenzhen	2020	Shenzhen Planning and Natural Resources Bureau
	Shenzhen road network system (primary, secondary arterial roads, branch roads)	2020	Shenzhen Planning and Natural Resources Bureau
	Base land price data	2020	Shenzhen Planning and Natural Resources Bureau
	Administrative divisions of Shenzhen	2020	Shenzhen Land Planning Commission
	Land Title Confirmation Data (Parcel Data)	2020	Shenzhen Land and Resources Bureau
	Building census data	2020	Building Census
	Air quality	2020	Shenzhen Ecology and Environment Bureau
	Green coverage	2020	Shenzhen Ecology and Environment Bureau
The Internet opens up big data	population density	2020	Unicom mobile signaling platform
	Shenzhen culture, sports, parks, squares, life service facilities	2020	Map of Geode
	Data on educational facilities in Shenzhen	2020	Map of Geode
	Data on educational facilities in Shenzhen	2020	Map of Geode
	Data on medical facilities in Shenzhen	2020	Map of Geode
	Data of municipal supporting facilities in Shenzhen	2020	Map of Geode
DEM data	DEM30 m elevation data	2020	Geospatial data cloud

3. Construction of Evaluation Index System

3.1. Indicator Selection

The present study classified the land types involved in urban renewal and redevelopment, including residential, industrial, and commercial land. To elucidate this classification, our methodology will draw upon a comprehensive referencing of relevant urban planning guidelines, historical developmental trajectories, and the distinctive attributes intrinsic to the study area. In order to evaluate the potential for urban renewal and redevelopment, we referred to previous research findings on land consolidation, renovation, redevelopment, and improvement conducted by scholars. Furthermore, we considered the requirements for enhancing urban functions (economic, social, cultural, and ecological) to adapt to urban social development. Through a literature review, field investigations, comprehensive comparisons, and expert group discussions, the following indicators were selected as factors to evaluate the potential for urban renewal and redevelopment (Table 2). The direction of influence of each indicator on urban potential was also determined [23,24]:

Table 2. Evaluation index system of urban renewal and transformation potential.

Target Level	Guideline Level	Index Layer	Characteristic
A_1 Natural conditions	B_1 Geological conditions	C_1 Elevation	Inverse indicators
		C_2 slope	Inverse indicators
	B_2 Landscape pattern factors	C_3 Landscape patch fragmentation	Inverse indicators
		C_4 Average plaque area	Inverse indicators
		C_5 Landscape shape index	Inverse indicators
	B_3 Landscape environment	C_6 Green coverage	Positive indicators
		C_7 Air quality	Inverse indicators
A_2 Social factors	B_4 Public amenities factor	C_8 Complete educational facilities	Positive indicators
		C_9 Complete facilities for life services	Positive indicators
		C_{10} Complete cultural and sports facilities	Positive indicators
		C_{11} Complete medical facilities	Positive indicators
		C_{12} Park Plaza Completeness	Positive indicators
	B_5 Regional demographic status	C_{13} population density	Positive indicators
		C_{14} GDP per capita	Positive indicators
A_3 Location factors	B_6 Degree of aggregation	C_{15} The degree of commercial distribution agglomeration	Positive indicators
		C_{16} Industrial distribution agglomeration	Positive indicators
		C_{17} Residential distribution agglomeration	Positive indicators
	B_7 Traffic conditions	C_{18} Road accessibility	Positive indicators
		C_{19} Accessibility of public transportation	Positive indicators
A_4 Parcel conditions	B_8 Building condition	C_{20} Base land price	Inverse indicators
		C_{21} Parcel tenure type	Inverse indicators
	B_9 Building development intensity	C_{22} Plot ratio	Positive indicators
		C_{23} Building density	Positive indicators

3.2. Index Interpretation and Quantitative Method

COHESION: Fragstats4.2 software can assess the fragmentation level of landscapes, thereby reflecting the complexity of spatial structures. A low fragmentation degree indicates a more regular distribution of land patches, resulting in more significant agglomeration effects generated by urban renewal. Simultaneously, this low fragmentation degree implies a lower level of intensive land use and relatively lower regional economic development [25]. Consequently, a smaller fragmentation degree suggests a greater potential for urban renewal and transformation.

The factors considered in this study include architectural style, life services, municipal facilities, parks and squares, and the completeness of medical facilities. The collected data were first processed and organized using data cleansing techniques and then merged into a GIS spatial database. ArcGIS was used to extract different attributes of points of interest (POI) in the spatial domain, match location information, and convert coordinate systems. Subsequently, the Euclidean distance function was applied with the Shenzhen city boundary as a mask to perform reclassification based on distance levels, and the level values were extracted into cadastral units using the tabulate area function. Higher values of these indicators indicate stronger economic vitality within urban renewal units, increasing the likelihood of investment and the development of new real estate projects, thus suggesting higher potential for urban renewal.

Road transportation accessibility: The assessment of road accessibility includes both existing and planned roads. The planned roads were extracted from the "2010–2020 Shenzhen Master Plan". Based on the accessibility model outlined in the "Regulations on Urban Land Grading," the effective radii for arterial roads, sub-arterial roads, and local roads were determined to be 0.5 km, 0.3 km, and 0.1 km, respectively. The quantification formula for road accessibility, as specified in the grading regulations, was used to calculate the attenuation index for road accessibility [26]. The equation is as follows:

$$F_{ij} = I_i\left(1 - d_{ij}/D\right) \tag{1}$$

where F_{ij} represents the accessibility impact score of roads i on point j; I_i represents a road score of road i; and d_{ij} represents the distance from spatial point i to road j. A lower accessibility score indicates a stronger willingness toward resident transformation and a greater potential for urban redevelopment.

Population Density: In this study, we extracted a one-week online count from the Unicom Smart Footprint mobile signaling platform to represent the average number of active users as an indicator of the resident population. Using ArcGIS, the filtered and organized population data were overlaid with cadastral data. The population of the cadastral units was derived using the Point-in-Polygon function, and values were assigned based on reclassification into different density levels. Higher population density can often signify increased demand for resources, services, and infrastructure, potentially driving the need for urban renewal and redevelopment. It can also lead to intensified land use and higher property values, which incentivize redevelopment efforts.

Transportation Accessibility: Information points such as subway stations, high-speed railway stations, bus stops, airports, parking lots, and bicycle rental stations were extracted from the A map Points of Interest (POI) dataset and imported into ArcGIS. The cleaned, filtered, and organized POIs were matched with location information and transformed into the desired coordinate system. Kernel density analysis was performed to derive density values, which were then extracted to cadastral units. The transportation accessibility was represented by the aggregation level of different transportation facility points within a certain range. Improved transportation infrastructure, such as well-connected roads, public transit systems, and pedestrian-friendly pathways, can significantly enhance an area's attractiveness for both residents and businesses. Higher transportation accessibility often leads to increased economic activity, higher property values, and greater demand for commercial and residential spaces.

The most crucial task in the data processing workflow is establishing a database. Since the factors influencing the evaluation of urban renewal potential have spatial characteristics, GIS was utilized to extract and convert data formats. Subsequently, the data were imported into PostgreSQL, enabling data and spatial analysis of evaluation units and facilitating the evaluation of urban renewal potential. This process allowed for the creation of thematic maps illustrating potential levels.

3.3. Index Standardization

Data standardization involves homogenization and dimensionless processing. The evaluation factors in this study have multiple attributes, with different units, physical meanings, and variation degrees. Therefore, a unified approach is necessary to normalize the data. Considering the presence of both positive and negative indicators in the index system [27], the Min–Max normalization method is employed for standardization.

The formula for positive indicators is as follows:

$$Z_{ij} = \frac{x_{ij} - min_{1 \le i \le n} x_{ij}}{max_{1 \le i \le n} x_{ij} - min_{1 \le i \le n} x_{ij}}, \tag{2}$$

And the formula for negative indicators is as follows:

$$Z_{ij} = \frac{min_{1 \le i \le n} x_{ij} - x_{ij}}{max_{1 \le i \le n} x_{ij} - min_{1 \le i \le n} x_{ij}} \tag{3}$$

where Z_{ij} represents the standardized value, i denotes the index number ranging from 1 to n, and j refers to the unit number being studied, ranging from 1 to m. Additionally, x_{ij} represents the original value, and $max_{1 \le i \le n} x_{ij}$ and $min_{1 \le i \le n} x_{ij}$ represent the maximum and minimum values of the i-th index, respectively. Through the aforementioned process, the original data are transformed into dimensionless and homogeneous evaluation values, where all the index values are on the same scale, enabling comprehensive evaluation and analysis.

4. Research Methods

4.1. Weight Determination Method

4.1.1. Determination of Subjective Weight via AHP

The Analytic Hierarchy Process (AHP) serves as a comprehensive decision-making approach, effectively integrating both quantitative and qualitative analyses to facilitate multi-criteria decision-making. Within our study, a hierarchical structure was established, encompassing the goal, factor, and criterion levels, to effectively evaluate urban renewal potential.

The process of determining the significance of criteria involved a thoughtfully designed questionnaire aimed at obtaining expert evaluations within the pertinent research domain. Experts were tasked with assigning values to the importance of criteria at the factor level, employing a scale of 1, 3, 5, 7, and 9. The same approach was employed for scoring criteria at each factor level. Adhering to the principles of AHP analysis, pairwise comparison matrices were sequentially formulated. To ensure methodological rigor, specialized AHP software (Yaahp version 12.7) was employed to undertake hierarchical single sorting and overall ranking. Furthermore, a consistency assessment was executed, thus culminating in the computation of weights for potential evaluation criteria factors for residential, industrial, and commercial land categories [28–31].

The determination of the subjective weights in AHP was achieved through a meticulous harmonization of expert opinions and findings derived from literature investigations. This integration fortified the coherence between these two influential components and thereby ensured the robustness of our weight-determination process. Our approach, drawing from both expert insights and established research outcomes, enabled the establishment of an accurate and reliable framework for evaluating the urban renewal potential decision-making. (1) First, we construct the pairwise comparison matrices. The importance of each potential evaluation criterion is compared in pairs, representing the degree of preference between the two criteria. Here, a numerical scale of 1 to 9 is used, where 1 indicates equal importance, 5 indicates moderate importance, and 9 indicates extreme importance. The values 2, 4, 6, and 8 represent midpoint judgments between the adjacent values mentioned above. If the judgment of criterion i compared to criterion j is denoted as a_{ij}, then the judgment of criterion j compared to criterion i will be $a_{ji} = 1/a_{ij}$:

$$W_n = \begin{array}{ccccccc} & C1 & C2 & C3 & Ci & \ldots & Cn \\ C1 & 1 & a_{12} & a_{13} & a_{1i} & \ldots & a_{1n} \\ C2 & 1/a_{21} & 1 & a_{23} & a_{2i} & \ldots & a_{2n} \\ C3 & 1/a_{31} & a_{32} & 1 & a_{3i} & \ldots & a_{3n} \\ Cj & 1/a_{j1} & a_{j2} & a_{j3} & 1 & \ldots & a_{jn} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ Cn & 1/a_{n1} & a_{n2} & a_{n3} & a_{ni} & \ldots & 1 \end{array}$$

(2) Normalization of the judgment matrix proceeds as follows:

$$\overline{a_{ij}} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{k_j}},\ i,j = 1,2,\ldots \tag{4}$$

Accumulate the judgment matrix for each column after normalization:

$$\overline{w_i} = \sum_{j=1}^{n} \overline{a_{ij}},\ j = 1,2,\ldots,\text{n}. \tag{5}$$

Normalized vector $\overline{w} = [\overline{w}_1, \overline{w_2}, \ldots, \overline{w}_n]^T$:

$$w = \frac{\overline{w_i}}{\sum_{j=1}^{n} \overline{w_j}},\ i = 1,\ 2\ldots,\ \text{n}. \tag{6}$$

(3) After performing the consistency check, the obtained vector $\overline{w} = [\overline{w}_1, \overline{w_2}, \ldots, \overline{w}_n]^T$. represents the desired weights. The consistency of the judgment matrix is further evaluated based on the maximum eigenvalue λ_{max} using the following consistency check formula:

$$CI = \frac{\lambda_{max} - n}{n-1},\ \lambda_{max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}. \tag{7}$$

In general, $CI > 0$, where a smaller value of CI indicates better consistency. $CI = 0$ signifies complete consistency with the judgment matrix, where the matrix has a maximum eigenvalue of n.

4.1.2. Determination of Objective Weight by EWM

The entropy weighting method (EWM) is an objective weighting method that determines weights based on the information content of each indicator, resulting in an objective outcome. The core of this method is information entropy, which reflects the variability of indicators [32]. Suppose there are i evaluation objects and j evaluation indicators. The main steps of the entropy weighting method are as follows:

(1) Calculate the information entropy of the indicator:

$$E_j = -[ln(n)]^{-1} \times \sum_{i=1}^{n} \left[P_{ij} \times ln\left(P_{ij}\right)\right] \tag{8}$$

where E_j is information entropy, n is the number of evaluation indicators, and P_{ij} is the proportion of the index value of the j-th indicator of the i-th evaluation object. If $P_{ij} = 0$, then $\lim\limits_{P_{ij} \to 0} P_{ij} \times ln\left(P_{ij}\right) = 0$.

(2) Calculate the weight of the indicators based on entropy weight:

$$w_j = \left(1 - E_j\right) / \sum_{j=1}^{m} \left(1 - E_j\right) \tag{9}$$

where w_j represents the weight of indicator j, E_j represents the information entropy, and m represents the number of evaluation objects.

4.1.3. Combined Weight

Subjective weights, pivotal in our assessment framework, are garnered through the robust Analytic Hierarchy Process (AHP), while objective weights are thoughtfully derived via the entropy weight method. To seamlessly integrate these two dimensions, a linear weighted synthesis approach is harnessed, guided by the following formulation:

$$W_i = aW^i_{AHP} + (1-a)W^i_{IEw}. \quad (10)$$

Here, W_i represents the combined weighting factor, a signifies the weighting coefficient for subjective weights, W_{AHP} corresponds to the subjective weights obtained through AHP, and W_{EWH} represents the objective weights derived using the entropy weight method.

The value of coefficient a is crucial as it determines the balance between subjective and objective weights. Its range is $0 \leq a \leq 1$, and the specific value is subjectively determined by researchers. In our study, the selection of coefficient a was a comprehensive process. We referenced literature [33–36] and engaged in consultations with 12 experts. The experts provided diverse suggestions for a: 6 recommended a = 0.6, 3 suggested a = 0.7, 2 advised a = 0.5, and 1 advocated a = 0.4. Taking into consideration the consensus among experts and the insights drawn from existing research, we determined the value of a to be 0.6.

This approach guarantees that both the expert opinions and empirical findings are harmonized, leading to a well-balanced and accurate weighting system. The selection of a is pivotal in reflecting the importance attributed to subjective judgments and objective data, ensuring the robustness and credibility of our urban renewal potential assessment methodology.

The weighted results for residential land, industrial land, and commercial land combinations are provided below in Table 3:

Table 3. Determination of index weight.

	Residential land			**Industrial Land**			**Commercial Land**		
	AHP Weights	**EWM Weights**	**Combined Weight**	**AHP Weights**	**EWM Weight**	**Combined Weight**	**AHP Weights**	**EWM Weights**	**Combined Weight**
C_1	0.014	0.0458	0.02672	0.068	0.0746	0.07064	0.0121	0.0694	0.03502
C_2	0.032	0.0282	0.03048	0.0389	0.0304	0.0355	0.0404	0.0335	0.03764
C_3	0.009	0.0173	0.01232	0.004	0.0311	0.01484	0.0065	0.0149	0.00986
C_4	0.034	0.041	0.0368	0.0083	0.0079	0.00814	0.0036	0.0121	0.0070
C_5	0.005	0.0037	0.00448	0.0043	0.0141	0.00822	0.0046	0.0088	0.00628
C_6	0.0354	0.0412	0.03772	0.013	0.021	0.0162	0.0168	0.0211	0.01852
C_7	0.036	0.0356	0.03584	0.0272	0.0298	0.02824	0.0165	0.0146	0.01574
C_8	0.153	0.0644	0.11756	0.0016	0.0014	0.00152	0.0368	0.0257	0.03236
C_9	0.075	0.0312	0.05748	0.0025	0.0019	0.00226	0.0596	0.0452	0.05384
C_{10}	0.018	0.0248	0.02072	0.0011	0.0013	0.00118	0.0112	0.0101	0.01076
C_{11}	0.067	0.0349	0.05416	0.0021	0.0019	0.00202	0.0351	0.0214	0.02962
C_{12}	0.0169	0.0159	0.0165	0.0013	0.0011	0.00122	0.0112	0.0198	0.01464
C_{13}	0.0268	0.0268	0.0268	0.0659	0.0452	0.05762	0.0986	0.1125	0.10416
C_{14}	0.0314	0.0422	0.03572	0.0758	0.0526	0.06652	0.0982	0.0799	0.09088
C_{15}	0.0329	0.0313	0.03226	0.0629	0.0492	0.05742	0.1573	0.1495	0.15418
C_{16}	0.0136	0.0169	0.01492	0.0664	0.0931	0.07708	0.0129	0.0121	0.01258
C_{17}	0.038	0.0411	0.03924	0.0853	0.0522	0.07206	0.0583	0.0597	0.05886
C_{18}	0.136	0.0601	0.10564	0.0952	0.1115	0.10172	0.1138	0.1264	0.11884
C_{19}	0.025	0.0653	0.04112	0.0639	0.0752	0.06842	0.0798	0.0495	0.06768
C_{20}	0.019	0.0671	0.03824	0.0668	0.0658	0.0664	0.0585	0.0622	0.05998
C_{21}	0.048	0.152	0.0896	0.1191	0.107	0.11426	0.0186	0.0154	0.01732
C_{22}	0.067	0.0283	0.05152	0.0307	0.0421	0.03526	0.0248	0.0216	0.02352
C_{23}	0.067	0.0849	0.07416	0.0957	0.0896	0.09326	0.0248	0.0146	0.02072

4.2. Comprehensive Evaluation of Urban Renewal Potential

The TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method is a multi-criteria decision-making technique, also known as the approximate ideal solution ranking method. This method is based on a normalized matrix of the original data and aims to identify a solution that is closest to the ideal solution and farthest from the negative ideal solution. This solution is considered the most satisfactory option among the set of alternatives [10,37]. The specific operational steps used in this study are as follows. The decision problem involves m objectives that need to be considered simultaneously: $f_j(j = 1.2, \ldots, m)$. There are n feasible solutions available for the decision problem: $z_i = (z_{i1}, Z_{i2}, \cdots, Z_{im})(i = 1, 2, \cdots n)$. Let z^* be the ideal solution for the normalized weighted objectives of the problem.

(1) Data normalization.

In the previous section, the range normalization method was applied to perform data normalization analysis on the valuation indicators. As a result, a standardized decision matrix, denoted as Z'_{ij}, was obtained using the range-normalized data.

(2) Determining the weights of the indicators and constructing a weighted decision matrix.

The weights of the indicators W_i were determined using a combination of the Mean Square Error method and Analytic Hierarchy Process (AHP). The weighted normalized decision matrix $Z_{ij} = \left(Z'_{ij}w_{\mathrm{i}}\right)m \times n$ was then constructed, where each element Z_{ij} was obtained by multiplying each row of matrix R with its corresponding weight W_i. Here, i ranges from 1 to n, and j ranges from 1 to m:

$$Z_{ij} = \begin{matrix} Z'_{11}w_1 & Z'_{12}w_2 & \ldots & Z'_{1m}w_m \\ Z'_{21}w_1 & Z'_{22}w_2 & \ldots & Z'_{2m}w_m \\ \ldots & \ldots & \ldots & \ldots \\ Z'_{n1}w_1 & Z'_{n2}w_2 & \ldots & Z'_{nm}w_m \end{matrix}.$$

(3) Determine ideal and negative ideal solutions.

If the elements Z_{ij} in the decision matrix Z have larger values, then the corresponding solutions are superior:

$$Z^+ = \left(Z_1^+, Z_2^+, \ldots, Z_m^+\right) = \left\{ maxZ_{ij} \middle| j = 1.2, \cdots, m \right\} \tag{11}$$

$$Z^- = \left(Z_1^-, Z_2^-, \ldots, Z_m^-\right) = \left\{ minZ_{ij} \middle| j = 1, 2, \cdots, m \right\} \tag{12}$$

(4) Calculate the distance.

Calculate the distance from each evaluation unit to the positive ideal solution and the distance from the negative ideal solution using the Euclidean norm as the measure of distance. Then, from any feasible solution Z^-, the distance from i to Z^+ is:

$$S_i^+ = \sqrt{\sum_{j=1}^{m} \left(Z_{ij} - Z_j^+\right)^2} i = 1, \cdots, n \tag{13}$$

where z_{ij} represents the normalized weighted value of the j-th objective for the j-th solution.

Similarly, let $Z^- = \left(Z_1^-, Z_2^-, \cdots, Z_m^-\right)^T$ be the negative ideal solution of the normalized weighted objectives in the problem. The distance between any feasible solution Z_i and the negative ideal solution Z^- can be calculated as follows:

$$S_i^- = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - z_j^-\right)^2} \mathrm{i} = 1, 2, \cdots, n. \tag{14}$$

Therefore, if Z_i is an ideal solution, the corresponding value of $C_i = 1$. If Z_i is a negative ideal solution, the corresponding value of $C_i = 0$. As Z_i approaches the ideal solution, C_i approaches 1, it indicates a higher potential for urban renewal and transformation. Conversely, as Z_i approaches the negative ideal solution, C_i approaches 0, indicating a lower potential for urban renewal and transformation [38].

5. Result Analysis

5.1. Overall Analysis

Using the reclassification method, the urban renewal potential of residential, industrial, and commercial land types in various districts of Shenzhen City is classified into different levels: Level I (highest potential), Level II (comparatively high potential), Level III (moderate potential), Level IV (lower potential), and Level V (lowest potential). Based on the evaluation results, the evaluation units with the top three potential levels are selected as the priority for government planning and arrangements in urban renewal decision-making. In Shenzhen, the quantities, proportions of land transformation across various districts, the distribution of potential grade quantities are provided below in Tables 4 and 5, and the comprehensive distribution in the form of bar charts are illustrated in Figure 2.

Table 4. Distribution and proportion of land transformation grades in various regions of Shenzhen.

Administrative Region	Residential Land	Proportion	Industrial Land	Proportion	Commercial Land	Proportion
Yantian District	115	59.90%	22	11.46%	55	28.65%
Guangming District	96	46.60%	54	26.21%	56	27.18%
Nanshan District	233	48.54%	117	24.38%	130	27.08%
Futian District	264	56.77%	64	13.76%	137	29.46%
Pingshan District	94	50.81%	53	28.65%	38	20.54%
Dapeng New District	96	57.83%	29	17.47%	41	24.70%
Longhua District	316	51.30%	154	25.00%	146	23.70%
Baoan District	325	41.83%	266	34.23%	186	23.94%
Longgang District	647	52.26%	282	22.78%	309	24.96%
Luohu District	198	50.00%	73	18.43%	125	31.57%

Table 5. Quantity distribution and proportion of regional potential grades in Shenzhen.

Administrative Region	I	Proportion	II	Proportion	III	Proportion	IV	Proportion	V	Proportion
Yantian District	36	20.34%	30	16.95%	33	18.64%	37	20.90%	41	23.16%
Guangming District	34	18.09%	29	15.43%	49	26.06%	37	19.68%	39	20.74%
Nanshan District	94	20.13%	86	18.42%	93	19.91%	100	21.41%	94	20.13%
Futian District	99	22.45%	92	20.86%	101	22.90%	75	17.01%	74	16.78%
Pingshan District	31	19.25%	32	19.88%	31	19.25%	41	25.47%	26	16.15%
Dapeng New District	35	22.44%	28	17.95%	29	18.59%	29	18.59%	35	22.44%
Longhua District	96	16.87%	106	18.63%	104	18.28%	121	21.27%	142	24.96%
Baoan District	122	16.92%	155	21.50%	117	16.23%	152	21.08%	175	24.27%
Longgang District	198	17.73%	212	18.98%	206	18.44%	208	18.62%	293	26.23%
Luohu District	80	21.16%	70	18.52%	79	20.90%	80	21.16%	69	18.25%

Based on the evaluation results, the urban renewal potential of Shenzhen City can be classified into different levels. From 2010 to 2020, a total of 4375 units met the criteria for urban renewal planning, including 2834 units for residential renewal, 1114 units for industrial renewal, and 1223 units for commercial renewal, with a total area of 100.9716475 km^2. Level I potential units accounted for 18.86% of all units, with 825 units. Level II potential units accounted for 19.20%, with 840 units. Level III potential units accounted for 19.25%, with 842 units. Level IV potential units accounted for 20.11%, with 880 units. Level V potential units accounted for 22.58%, with 988 units.

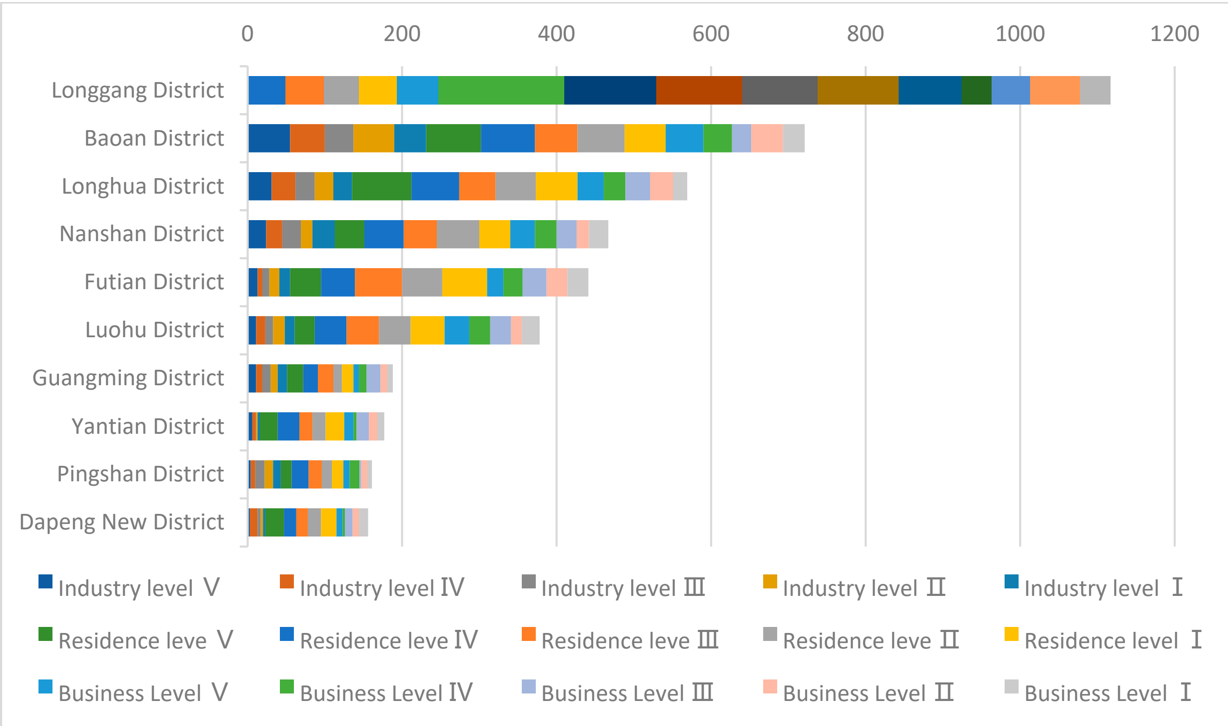

Figure 2. Column chart of the number of potential units in Shenzhen.

From the perspective of unit parcel redevelopment area distribution, within the context of commercial land renewal planning, the largest area is attributed to the land transformation of the Henggang Central Area in the Longgang District, with a planned land area of 345,730 m^2. The principal components of this revitalization encompass the Henggang commercial district and Zhijian Square. In terms of industrial land renewal planning, the most extensive parcel is located within the Pingshan Advanced Manufacturing Industrial Park of the National High-Tech Zone, serving as a pivotal hub for national-level new energy vehicle industries. The overarching goal is the establishment of a contemporary industrial ecosystem, with particular emphasis on intelligent connected vehicles, laser and additive manufacturing, as well as emerging materials clusters. The designated land area for this development covers 480,283 m^2. Within the realm of residential land renewal planning, the largest expanse falls under the Five and Hub Area of Bantian Street in the Longgang District, encompassing a total land area of 429,803 m^2 (inclusive of 239,000 m^2 dedicated to affordable housing initiatives).

In terms of quantity distribution among districts, Longgang District had the highest number of units that met the urban renewal criteria, but the majority of renewal potential was concentrated in Level V, accounting for 26.23% of the planned renewal units in Longhua District. Dapeng New District had the fewest renewal units, accounting for 3.52%. However, this district also had the highest proportion of Level I potential land at 23.44%. In terms of the proportion of potential values in each district, Futian District had the highest proportion of Level I values, with Level I, II, and III values accounting for 66.21% of the total.

5.2. Potential Analysis of Each District

Bao'an District is an important industrial base and manufacturing center in Shenzhen and also one of the areas with the highest proportion of publicly announced urban renewal projects. The proportion of industrial land renewal in Bao'an District is the highest among the administrative districts, reaching 34.23%. Among them, 56.8% of the industrial potential levels are $\leq$III. The potential of Bao'an District is predominantly manifested through the upgrading of the manufacturing sector and the advancement of new urbanization, with particular emphasis on the substantial renewal potential within the industrial zones of

Shajing, Xixiang, and Xin'an Streets. The Shajing region boasts expansive industrial land, and its logistics park is slated for an upgrade, introducing intelligent logistics facilities and advanced warehousing technologies to meet the burgeoning logistical demands. The construction of the Xixiang Science and Innovation Park aims to position the area as a vital hub for technological innovation, attracting high-tech enterprises while providing innovative support and research and development resources to drive industrial upgrading and innovative growth. In the realm of Xin'an, a comprehensive revitalization of the commercial center is in the works, ushering in modern business facilities and services to shape the region into a central commercial core of Bao'an District. Over the past few decades, the industrial zones of Shajing, Xixiang, and Xin'an Streets have amassed a robust industrial foundation, housing multiple industry clusters, thus furnishing a robust industrial bedrock for subsequent rejuvenation efforts. Bao'an District also needs to renew some old residential and commercial buildings to improve the quality of residents' lives. In the context of scarce land resources, Bao'an District will fully leverage the advantages of "old" areas, revitalize land resources, and provide spatial support for urban upgrading.

Futian District is one of the most prosperous commercial centers in Shenzhen, with a favorable geographic location, convenient transportation, and high population density. This district has fewer old industrial areas, mainly consisting of old towns and villages, which are primarily located in the Meilin Street area. The proportion of commercial land renewal in Futian District is 29.46%, which is relatively high compared to that of other administrative districts, mainly due to its geographic location and population density. Although the area of renewal patches is relatively small, the building density and floor area ratio are high. The focal points encompass a comprehensive transformation scheme for the Huaqiangbei area and the revitalization project for the northern sector of Futian Central Business District (CBD). The plan entails the infusion of contemporary commercial office buildings to cater to the ever-expanding business requisites. These structures are anticipated to align with green building standards, thereby providing a superior quality office environment. In the realm of residential land transformation, particular emphasis is placed on the redevelopment plan for the Shangmeilin Village area. This region boasts a high residential renewal potential owing to its proximity to the commercial nucleus. Additionally, it is surrounded by an abundance of medical and educational resources, such as hospitals and institutions. Notably, the area benefits from excellent transportation accessibility, featuring multiple subway stations and bus stops that further enhance its appeal. However, due to its economic prosperity, Futian District features a high concentration of residential, industrial, and commercial activities along with relatively well-developed public facilities.

Guangming District is mainly focused on updates and transformations in industrial land, with the areas of greatest potential located in the central and western areas. The western region is distributed on both sides of Nanhuan Avenue and Donghuan Avenue. The industrial zones are widespread in this region, primarily necessitating the transformation of industrial land. The substantial renewal potential in this area is chiefly attributed to factors such as limited transportation accessibility, aging industrial facilities, inadequate municipal infrastructure, and a dearth of emerging industries. The revitalization efforts hold significant promise for enhancing the industrial functionality of this locale. One notable site of considerable potential is the Baihua district, marked by an extensive transformation of contiguous industrial land. This includes refurbishing factories, upgrading facilities, and establishing a hub for technological innovation. These initiatives are poised to inject fresh vigor into the regional economic landscape. In the central section of this area, specifically the northern precinct of the science park, the focus is on overhauling residential and commercial epicenters. While this zone boasts commendable road connectivity, its large population base has strained the adequacy of essential amenities. Educational, medical, and cultural facilities lag in per capita provisions. Consequently, the renewal strategy for this sector should emphasize elevating the supporting infrastructure. An exemplary representation of this approach is the redevelopment plan for the central district of Guangming in Shenzhen. Envisioned as a comprehensive service hub driving technological innovation in the Greater Bay Area, this area epitomizes high-quality development. It embraces a multifaceted integration of functions, spanning business, commercial services, research and development offices, tourism, residences, and supporting amenities, culminating in a sustainable, green, and livable new urban district.

Longgang District is the main battlefield for urban renewal in Shenzhen, accounting for 26.2% of the city's renewal area. This district is not only an important ecological, cultural, and tourist area in Shenzhen but also a region with a high population concentration. Despite the relatively low land prices and less obvious geographical advantages in Longgang District, Henggang Street is an area with great potential. Through urban renewal and transformation, this district aims to promote the transformation of existing urban functions, improve public supporting services, enhance the urban environment and quality, and address various issues in old village areas, such as multiple safety hazards, mixed functional layouts, and low land-utilization rates. Additionally, Longgang District offers abundant natural resources, such as the Dafen River and Kengzi Mountain. In the future, these natural resources could be integrated with urban renewal to create an ecological city.

Dapeng New District, which has a relatively small urban renewal area, is primarily concentrated in grade I potential sites, accounting for 23.44% of the total. grade III or lower potential areas are mainly located in the Kuichong Central area, Xichong area, and Dapeng Central area, with demolition and reconstruction or composite updates being the primary methods of transformation. Additionally, Dapeng New District is the only region in Shenzhen that boasts a pristine ecological coastline and holds the status of a national-level ecological protection area. To improve the living standards of its residents, Dapeng New District is accelerating its infrastructure construction and attracting more industrial resources.

Luohu District is situated in the central part of Shenzhen, adjacent to Hong Kong, and covers a total area of 78.36 km^2, with a built-up area of 33.72 km^2. It constitutes one of the earliest developed regions in Shenzhen. Notably, the proportion of commercial land transformation in Luohu District surpasses that in other administrative areas, reaching an impressive 31.57%. Within Luohu District, land parcels categorized under potential levels I, II, and III predominantly pertain to residential use, particularly emphasizing the transformation of informal settlements, highlighting the district's focus on addressing older residential areas. Luohu District's parcels with potential levels I and II are predominantly concentrated in the streets of Sungang, Qingshuihe, and Liantang. The Sungang and Qingshuihe areas epitomize the quintessential "backward and disorderly" attributes, characterized by an abundance of outdated warehouses and factories, narrow roads, and glaring deficiencies in basic infrastructure. The relatively homogeneous property ownership facilitates streamlined renewal and transformation efforts. Therefore, directing revitalization initiatives towards the Sungang and Qingshuihe areas holds greater potential for elevating the overall urban functionality. Furthermore, Liantang Street's renewal and transformation potential is notably influenced by several factors. The architectural plot ratio and density in the Liantang area are generally low, reflecting a sparse industrial agglomeration and limited per capita medical facility coverage. These factors collectively contribute to shaping the prospects for renewal and transformation in the Liantang precinct. Nanshan District is one of the economic centers and high-tech industrial clusters in Shenzhen. Nanshan is one of the regions with the highest proportion of grade I potential industrial land transformation, reaching 26.5%, which is among the highest in Shenzhen. In Nanshan District, areas with high industrial potential are mainly distributed in the Shekou community, on Nantou Street, and in other areas. There is a high concentration of grade I and II potential residential land located in the Xili and Shahe Street areas. This land is characterized by a significant number of "urban villages" and old neighborhoods that require renovation. These areas have low green coverage and building volume ratios, and the surrounding environment is relatively poor, thus offering significant potential for renovation and transformation.

Yantian District is a coastal urban area known for its beautiful natural environment and relatively good air quality, providing a comfortable living environment. Compared to other administrative districts, Yantian District has a relatively high proportion of residential land transformation, reaching 59.9%. This land transformation is mainly concentrated in the renovation of old neighborhoods in the Shatoujiao Street and Yantian Street areas. The areas with high potential include the Xiaomeisha area, Yantian Village 3 and 4, and Xishanxia Village urban village areas on Yantian Street. The proportion of industrial land transformation in Yantian District is relatively small, accounting for only 11.46% of the district's overall renewal and 1.92% of the city's industrial renewal. grade III or lower potential for industrial land transformation represents 0.31%, mainly concentrated in the renovation of old factories on Shatoujiao Street. Most blocks in Yantian District have relatively lagging functionality and inadequate supporting infrastructure that are unable to fully meet the needs of the local population. To achieve the goal of establishing an international shipping center in Shenzhen, Yantian District is focusing on the development of the shipping industry, the construction of a marine economy demonstration zone and cultural and creative industry base, and the development of new energy and high-end equipment manufacturing industries.

Pingshan District, as a new area in Shenzhen, is primarily characterized by traditional manufacturing industries with a high concentration of industrial clusters, mainly located in the Kengzi and Shi Jing streets. This region has tremendous potential for industrial land transformation, with the top three grades accounting for a significant proportion (76.7%). In comparison to other regions, Pingshan District has the lowest proportion of commercial transformation, only accounting for 20.54%; this type of transformation is mainly concentrated around the "Tianxin Avenue" commercial street on Longtian Street. However, Pingshan District faces challenges such as an insufficient overall road network scale, a shortage of public transportation services, relatively weak infrastructure, and incomplete development planning and layout, primarily concentrated in the central part of the district. Therefore, Pingshan District still needs to increase its commercial and cultural facilities to improve the quality of life for its residents.

Longhua District is an emerging economic zone and transportation hub within Shenzhen City. The urban renewal potential in Longhua New District is primarily concentrated in areas graded as Level III, IV, and V. These regions are mainly located in the northern and eastern parts of Guanlan, characterized by former industrial zones and buildings with poor construction quality (more than 50% of which are brick-and-mortar structures). The predominant focus of urban renewal in Longhua New District lies in the transformation of industrial land, with an area of 17.48 km^2 falling within grades I, II, and III potential levels, accounting for 61.1% of the total industrial land size in the district. The next significant category is residential land, covering 12.98 km^2, contributing to 36.63% of the overall urban renewal potential at grades I, II, and III in the wider Shenzhen area. The areas with significant urban renewal potential in Longhua New District follow a pattern of spreading along major roads and are distributed across multiple points. They tend to be concentrated around the former town centers. The size disparity of potential levels ≤ 3 among different streets correlates broadly with the existing developed land size within those streets. The distribution map of various land-use renovations in Shenzhen is shown in Figures 3–6.

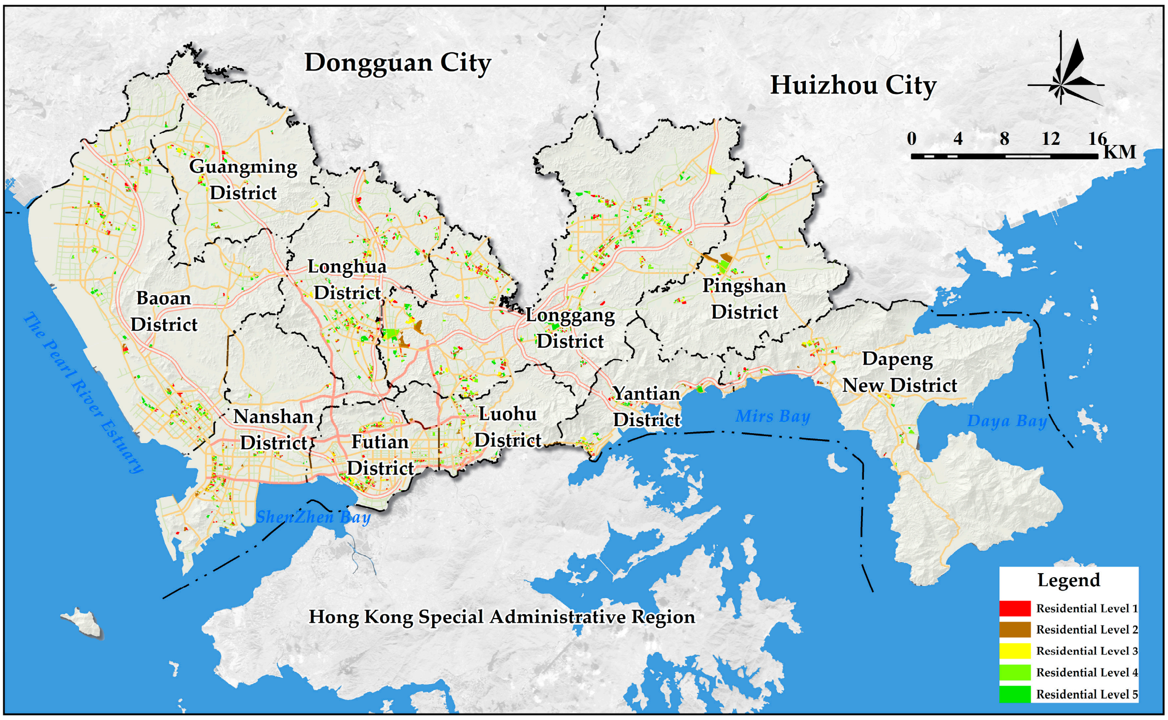

Figure 3. Distribution of Residential Land Renovation Units.

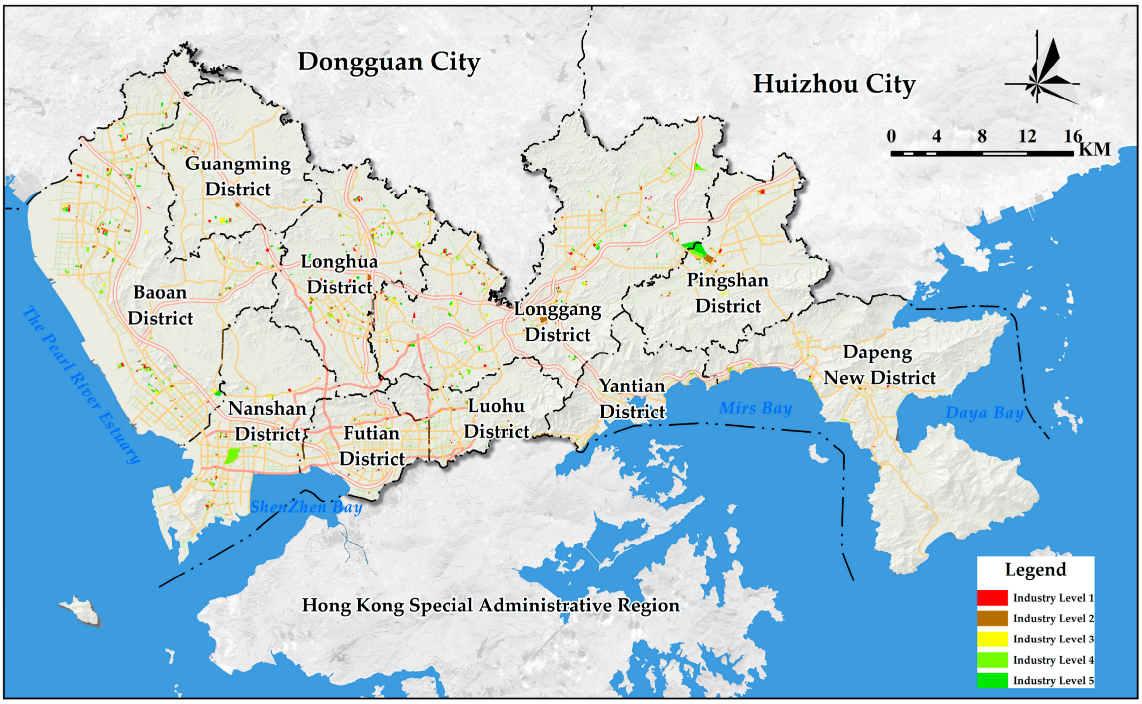

Figure 4. Distribution of Industrial Land Transformation Units.

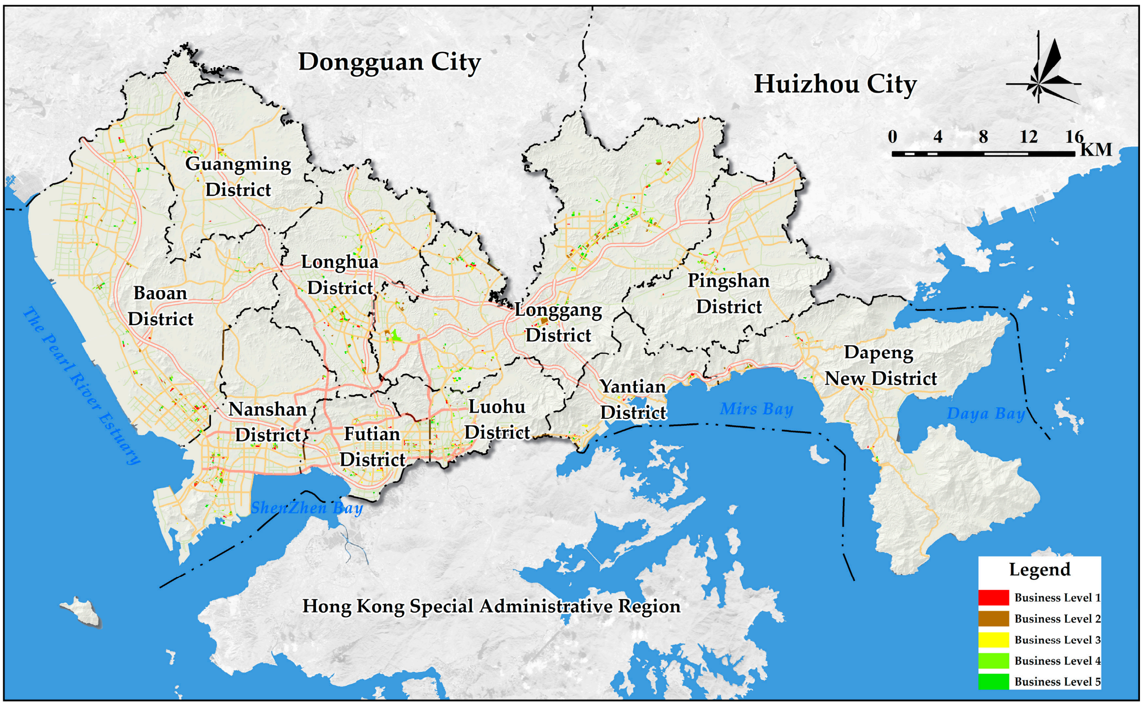

Figure 5. Distribution of Commercial Land Renovation Units.

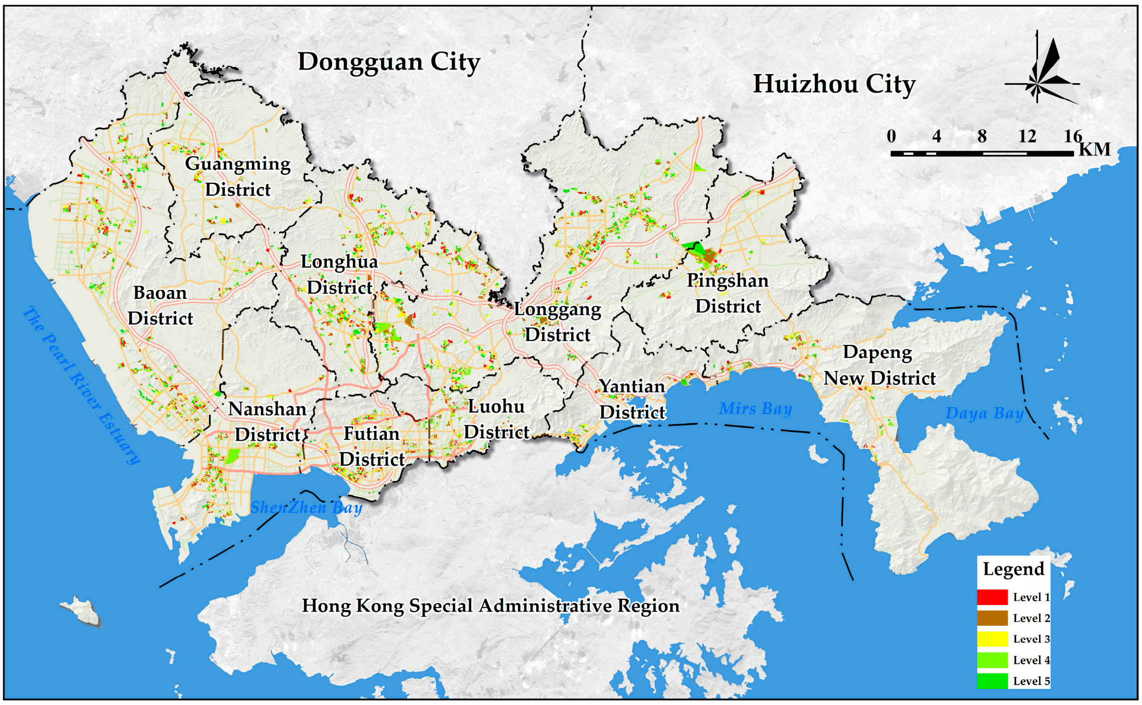

Figure 6. Distribution of Urban Renewal and Reconstruction Units in Shenzhen.

5.3. Verification of Potential Evaluation Results

The timeframe for the potential evaluation data in this study was focused on the year 2020. The evaluation results were validated by comparing them with the urban renewal plans established by the Shenzhen Planning and Land Resources Commission from the first quarter of 2010 to the fourth quarter of 2020 (data obtained from the publicly released urban renewal plans). Evaluation units with a potential grade of ≤III were selected from the above evaluation results as the units that should be prioritized in the government's urban renewal decision making and planning processes. A total of 982 planned pre-renewal units were extracted from the Shenzhen urban renewal plans established from the first quarter of 2010 to the fourth quarter of 2020. As of the fourth quarter of 2020, plans for 515 planned units were publicly displayed and approved through public voting. By matching the unit names of the planned renewal units with the land ownership location data, we found that 417 units had a potential grade of ≤III. Therefore, the accuracy of the evaluation results reached 81%. Overall, the urban renewal potential evaluation method proposed in this study could provide a valuable reference for the government in formulating urban renewal planning decisions.

6. Conclusions and Discussion

6.1. Conclusions

Under the guidance of relevant policies such as stock planning, integrated urban planning, and comprehensive urban planning reform, the development of urban space is gradually transitioning from "incremental expansion" to "stock optimization". Urban renewal and transformation have become the primary means of development and construction for first and second-tier cities, serving as a pathway to shift from the inefficient model of outward expansion to the exploration of internal potential and the enhancement of land use efficiency. Various land parcels are being subjected to urban renewal and transformation, each with distinct yet fundamentally similar driving mechanisms. This study focuses on the driving factors of urban renewal and transformation, primarily stemming from the perspective of enhancing urban functionality. Using Shenzhen as a case study, a comprehensive multi-factor evaluation method was employed to calculate the urban renewal potential in the city. The results were then subjected to validation and analysis. The main conclusions drawn from this study are as follows:

(1) The comprehensive analysis of the urban renewal potential across various land types and districts in Shenzhen has revealed crucial insights. The city's transformation potential has been categorized into distinct levels, ranging from Level I (highest potential) to Level V (lowest potential). Notably, this evaluation methodology has guided the identification of priority areas for urban renewal decision-making, with a focus on units exhibiting the top three potential levels. These findings underscore the robustness of the assessment in guiding urban renewal strategies.

(2) The study's rigor was validated through an evaluation of urban renewal potential over the decade spanning from 2010 to 2020, with a validation accuracy rate of 81%. This model and methodology offers a tangible framework for evaluating and enhancing urban renewal and transformation strategies.

(3) The influence of diverse factors on the urban renewal potential has been thoroughly investigated. Building development intensity, land distribution concentration, transportation accessibility, and the presence of regional public facilities have emerged as pivotal drivers. To foster urban renewal, it is imperative to intensify building development, bolster industrial synergy, upgrade transportation networks, and channel investments into regional public amenities. These actions are pivotal for the successful transformation of aging villages, industrial zones, and urban districts, resulting in a more vibrant and sustainable urban landscape.

(4) Objective assessment methods, as proposed in this research, play a pivotal role in selecting key transformation areas and allocating resources effectively. Furthermore, the meticulous evaluation of urban renewal potential across different districts highlights the unique attributes and challenges associated with each region. For instance, Bao'an District's industrial focus and manufacturing prowess make it an ideal candidate for targeted industrial land renewal. Futian District's central location and high population density make it apt for commercial land transformation, particularly in rejuvenating commercial hubs like Huaqiangbei. Guangming District's emphasis on industrial transformation aligns with its geographic distribution and the imperative to upgrade aging industrial infrastructure. Moreover, Yantian District's coastal charm

and residential potential underscore its prospects for comprehensive residential land renewal. Pingshan District, characterized by traditional manufacturing industries, can capitalize on its industrial clusters for effective transformation. Luohu District, being centrally located and heavily commercialized, is presented with opportunities to revamp its commercial and residential segments. Meanwhile, Nanshan District, a high-tech industrial hub, can utilize its technology-oriented prowess for industrial transformation. Longgang District, as a key player in Shenzhen's urban renewal efforts, is actively seeking to harness its ecological and cultural potential for comprehensive transformation. Dapeng New District, with its national-level ecological protection status, can harmonize development with ecological preservation for a sustainable future. Additionally, Longhua District, a growing economic zone, is poised to enhance its urban landscape through a balanced approach to residential and industrial land renewal.

In conclusion, this study bridges the gap between urban renewal potential assessment and strategic urban development. By assimilating the insights gleaned from evaluating potential and aligning them with Shenzhen's transformation goals, the city can usher in an era of holistic urban renewal, fostering sustainable growth, improved quality of life, and enhanced urban functionality for its residents.

6.2. Discussion

Contemporary urban renewal research predominantly leans towards qualitative analyses, with quantitative evaluation systems for assessing renewal and transformation potential often neglected. In this research, we ventured beyond conventional boundaries, focusing on land parcels aligned with urban renewal plans and constructing distinct indicator frameworks for residential, industrial, and commercial transformations. We meticulously studied the neighboring activity areas influenced by each renewal unit.

Many prior studies rely on conventional data sources such as remote sensing surveys, statistical records, and land surveys. These sources, however, often lag behind real-time data and lack the agility required for dynamic urban planning and renewal projects. This limitation, especially concerning the public's evolving needs, necessitates a paradigm shift. Incorporating open big data emerges as a promising avenue to fulfill these demands. Leveraging a quantitative approach, we devised an evaluation indicator system and integrated open big data to compute metrics like population density, land distribution concentration, and regional facilities. This adaptation bridges the gap between urban renewal and the evolving needs of the populace, resulting in a more nuanced appraisal of renewal and transformation potential. The scientific foundation of this indicator system underpins an objective assessment of project feasibility.

While commonalities may exist among influencing factors for renewal and transformation potential in various regions, evaluation indicators are subject to dynamic shifts due to evolving temporal and socio-economic contexts. Furthermore, technological advancements yield a wealth of data that necessitates constant refinement of evaluation indicators. This study, confined to quantitative data, regrettably overlooked public participation willingness and satisfaction. Future investigations could enhance the indicator system, refine evaluation methodologies and models, and thereby render evaluation outcomes more robust, scientifically grounded, and reasonable.

Author Contributions: Conceptualization, Y.L. (Yuefeng Lu); Data curation, K.Y., Y.S., Y.L. (Yanru Liu) and J.L.; Methodology, Y.L. (Yuefeng Lu) and K.Y.; Project administration, Y.L. (Yuefeng Lu), X.L. and H.R.; Supervision, Y.L. (Yuefeng Lu), X.L. and H.R.; Writing—original draft, K.Y., F.G. and S.S.; Writing—review and editing, Y.L. (Yuefeng Lu), X.L., F.G. and S.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Geological Survey Project of China Geological Survey (No. DD20220956); the Major Project of High Resolution Earth Observation System of China (No. GFZX0404130304); the Open Fund of Hunan Provincial Key Laboratory of Geo-Information Engineering in Surveying, Mapping and Remote Sensing, Hunan University of Science and Technology (No. E22201); a grant from State Key Laboratory of Resources and Environmental Information System; and the Innovation Capability Improvement Project of Scientific and Technological Small and Medium-sized Enterprises in Shandong Province of China (No. 2021TSGC1056).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Restrictions apply to the availability of these data. Data were obtained from a third party and are available from the authors with the permission of the third party. For the third parties, see acknowledgments.

Acknowledgments: The authors thank the providers of the data used in this article, including the Geospatial Data Cloud (http://www.gscloud.cn/, accessed on 13 March 2023); Gaode Map POI Data was derived from Map JS API Gaode Open platform (https://lbs.amap.com/api, accessed on 23 March 2023); Population density were obtained from Unicom mobile signaling platform (http://daas.smartsteps.com/#/, accessed on 5 April 2023); Supply of urban renewal sites in Shenzhen City, Land use status data in Shenzhen, Shenzhen road network data, Base land price data, Administrative divisions of Shenzhen, Land title confirmation data from Planning and Natural Resources Bureau of Shenzhen in China.

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

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