A Review of GIS- and Multi-Source-Data-Based Methods for Identifying Urban Renewal Potential

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Abstract: Against the background of the global shift of urbanization from incremental expansion to stock-based optimization, urban renewal is becoming an important lever for restructuring urban space and improving living quality, and the orderly implementation of renewal hinges on accurately identifying parcels with renewal potential. The introduction of Geographic Information Systems (GIS) has moved parcel potential evaluation from qualitative description to quantitative analysis. Taking methods for identifying urban renewal potential as the research object, this paper reviews research progress along three technical routes-rigid constraints, spatial quality, and multi-source data fusion-and compares their applicability and shortcomings. The review shows that existing research has completed the transition from single-dimension rigid-constraint screening to multi-dimensional integrated comprehensive evaluation, while bottlenecks remain in data fusion standards, dynamic simulation capability, and quantification of social dimensions. Accordingly, this paper prospects future directions such as intelligent decision-making, standardized frameworks, and human-oriented approaches, aiming to provide a theoretical reference for scientific decision-making in the renewal of densely built old urban areas.

Keywords: Urban Renewal; GIS; Spatial Overlay Analysis; Multi-Source Data; Potential Identification

1. Introduction

As global urbanization enters the stock era, urban development has shifted as a whole from incremental expansion to stock optimization[1], and urban renewal has accordingly become an important lever for improving spatial structure, upgrading environmental quality, and passing on historical context. Yet earlier renewal planning relied heavily on subjective experience and lacked scientific tools for evaluating parcel potential, so the allocation of renewal resources was insufficiently balanced and renewal efficiency was hard to improve.

The application of Geographic Information Systems (GIS) technology has created the technical conditions for urban planning to move from "qualitative description" to "quantitative analysis": through the integration of multi-source heterogeneous data, GIS can quantitatively measure the development potential of parcels and provide support for government decision-making. This paper accordingly reviews research progress on GIS applications in urban-renewal potential evaluation at home and abroad, dissects the strengths and weaknesses of existing evaluation frameworks, and provides a theoretical reference for the sustainable renewal of high-density cities.

In terms of literature sources, this paper used keywords such as "old-city renewal", "urban renewal", "GIS", "spatial overlay analysis", and "potential evaluation" to conduct a thematic search in the China National Knowledge Infrastructure (CNKI), supplemented by backward citation tracking from core literature; the search period extends to 2026. After two rounds of screening-initial screening by title and abstract, and re-screening by full text-literature weakly related to the theme of parcel potential identification was excluded, and 11 Chinese and English papers highly relevant to the research theme were finally retained for analysis.

The structure of the paper is arranged as follows: Chapter 2 reviews existing research along the three types of identification methods; Chapter 3 compares and dissects the methods and discusses their application value; Chapter 4 points out existing shortcomings and prospects development trends; Chapter 5 summarizes the research conclusions.

2. Literature Review

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2.1 Identification Methods Based on Rigid Constraints

Early research focused on land "availability". Xu et al. designed a "four-step clearing method" that uses overlay of rigid data such as restricted/prohibited construction zones and land-use procedures to identify available but unused land, and ultimately identified 98 potential parcels in the Shenzhen North Station area[2]. This type of method is clear in logic and easy to operate, and can complete a baseline inventory of renewal potential in a relatively short time, but its evaluation dimensions are relatively single, essentially depicting only the available-for-use state of land, with insufficient consideration of spatial quality and social vitality. Overall, the rigid-constraint approach established the basic paradigm of potential identification from the perspective of land-supply management: its core contribution lies in relying on authoritative planning data to complete a baseline inventory of renewal potential quickly and economically; its limitation is that it can only answer "whether renewal is possible" and cannot address the quality and effects of renewal, which leaves room for the evolution of subsequent methods.

2.2 Identification Methods Based on Spatial Quality

To make up for the shortcomings of rigid methods, some researchers turned their attention to spatial quality. Taking the historic urban area of Hohhot as a case, Hu Yike et al. introduced a subjective-objective dual-dimension measurement method, proposed the concept of "optimal spatial granularity" (350–400 m), and formed the technical chain of "measurement-granularity judgment-zone delineation"[3]. Tang Jingxian, Long Ying, et al. completed the measurement and change evaluation of street spatial quality using large-scale multi-temporal street-view images, laying a data foundation for fine-grained identification of spatial quality[4]. This type of method fuses multi-source data such as street-view images and points of interest (POIs), and can characterize the ring-layered distribution of spatial quality more precisely, but it also imposes higher requirements on data collection and processing capability. Wang Chengfang et al. further combined space syntax with GIS technology, built GIS databases at the three levels of buildings, streets and alleys, and parcels, and conducted a multi-factor overlay evaluation of building conservation value, providing quantitative support for conservation-oriented renewal planning of historic districts[5]. Looking at the internal relations among the above studies, Hu Yike et al. answered "at what scale to measure", Tang Jingxian et al. answered "with what data to measure", and Wang Chengfang et al. answered "how to model and evaluate"; the three form a complementary chain of "scale-data-method" within the same technical pathway rather than replacing one another. Overall, spatial-quality methods shift potential identification from land-supply management to human-scale spatial experience; their core contribution is making the identification of renewal potential finer and closer to people's actual perceptions, while their common limitations are the relatively high threshold of data acquisition and processing and the still unclear pathway for translating evaluation results into implementation strategies.

2.3 Identification Methods Based on Multi-Source Data Fusion

In recent years, multi-source data fusion has gradually become a research hotspot in this field. Long Ying et al. introduced spatial big data to support urban-renewal decision-making, attempting to break through the limits of single indicators[4]; Li Deren et al. continuously advanced the theory and methods of spatial data mining, laying a technical foundation for the in-depth application of GIS in urban planning[6]; foreign scholar Batty et al. integrated space syntax with GIS methods to parse the evolutionary characteristics of urban spatial structure[7]. At the empirical level of potential evaluation, Wang Jingli et al. took the land parcel as the basic evaluation unit, built a multi-factor indicator system with open internet data, determined weights by combining the Analytic Hierarchy Process with the mean-variance method, and measured Shenzhen's renewal-reconstruction potential with the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method, with evaluation results showing high consistency with the actual situation[8]; Xiao Tong et al. further incorporated multi-source big data such as mobile-phone signaling and social media, built a 14-factor evaluation system around the five dimensions of cultural revival, quality improvement, industrial revitalization,

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slow-traffic optimization, and service enhancement, and graded the renewal potential of Guangzhou's stock space[9]. Meanwhile, some scholars attempted to build comprehensive analytical frameworks integrating multiple dimensions such as space, function, and society: Fan Lai et al. applied multi-scale geographically weighted regression to reveal the influence mechanism and spatial differentiation characteristics of block vitality, providing a quantitative paradigm for comprehensive evaluation[10]. Overall, multi-source data fusion methods push potential identification from single-factor overlay toward systematic evaluation of "space-function-society"; their core contributions lie in the refinement of potential grading and the verifiability of results, while their common limitations are reliance on static cross-sectional data, strong dependence on expert experience in weight determination, and remaining deficiencies in dynamic adaptability and handling of spatial heterogeneity.

3. Critical Appraisal of Methods

3.1 The Evolutionary Logic of the Three Method Categories

The three types of methods do not constitute mutually substitutive competitive relations; rather, they appear as an evolutionary sequence unfolding sequentially in time and deepening progressively in problem awareness. Judging from the publication dates of representative literature, rigid-constraint methods appeared earliest (Xu et al., 2014), with their focus on "how much land is still available in the old city"-in the early stage of stock transition, data conditions were limited, and overlay analysis based on authoritative planning data was arguably the most feasible technical route. The exploration of spatial-quality methods did not start late (Wang Chengfang et al. had completed the integration of space syntax and GIS by 2012), but their large-scale development benefited from the maturation of new perception-type data sources such as street-view imagery and POIs after 2016 (Tang Jingxian et al., 2016; Hu Yike et al., 2022), and the research focus accordingly shifted to "whether renewal is done well". Multi-source data fusion methods gradually became mainstream only after 2019 (Wang Jingli et al., 2019; Xiao Tong et al., 2026). Three forces drive the continuous upgrading of methods: the first is the substantial improvement in data availability-the large-scale emergence of open internet data, mobile-phone signaling, and social-media data has created the data conditions for multi-dimensional evaluation; the second is the continuous progress of analytical techniques-GIS, space syntax, and machine learning have kept enriching the methodological toolkit for evaluation; the third is changing policy demands-policy orientations such as "strictly controlling large-scale demolition and construction" and scientific decision-making in urban renewal require potential identification to balance efficiency and equity. It can thus be seen that the essence of method evolution is the superposed effect of the triple forces of data, technology, and policy, which pushes the object of identification from "land" toward "space" and further toward "people". The specific differences among the three types of methods are shown in Table 1.

Table 1. Comparison of Three Types of Methods for Identifying Urban Renewal Potential in Old Urban Areas

Method type	Representative literature	Main data sources	Analysis unit	Core method	Advantages	Limitations
Rigid-constraint type	Xu et al. [2]	Rigid data such as restricted/prohibited construction zones and land-use permits	Parcel	Spatial overlay ("four-step clearing method")	Clear logic and convenient operation; suitable for baseline inventory of renewal potential	Evaluates only the "availability" dimension, with insufficient consideration of spatial quality and social vitality
Spatial-quality type	Hu et al. [3]; Wang et al. [5]	Street-view images, POIs, street and alley networks	Block (350–400 m)	Subjective-objective dual-dimension measurement; space syntax integrated with GIS overlay	Finely characterizes the ring-layered distribution of quality, supporting conservation-oriented renewal planning	Relatively high cost of data collection and processing; difficult translation into implementation strategies
Multi-source data fusion type	Wang et al. [8]; Xiao et al. [9]	Mobile-phone signaling, social media, open internet data	Land parcel	Combined weighting and comprehensive evaluation such as TOPSIS	Relatively fine-grained potential classification; results can be cross-validated	Based on static cross-sectional data; weight determination relies on expert experience

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3.2 Application Scenarios and Value Responses

At the level of policy implementation, GIS technology can provide effective support for the policy requirement of "strictly controlling large-scale demolition and construction": overlay analysis of historical-conservation data and development intensity can help scientifically delineate renewal boundaries and prevent extensive development. At the level of social equity, overlay analysis of public-service and population data helps identify weak parcels with inadequate supporting facilities and insufficient vitality, promoting the equitable allocation of renewal resources; in addition, visualization tools for potential-parcel grading can enhance decision-making transparency and help mitigate social conflicts during the renewal process.

4. Existing Problems and Future Trends

4.1 Existing Shortcomings

First, data fusion remains immature. Fusion standards for multi-source data have not yet been unified, and the phenomenon of "data silos" among departments persists, constraining the stability and comparability of evaluation results. Second, dynamism is insufficient. Most existing research stays at the level of static cross-sectional analysis, lacking dynamic simulation of the urban evolution process, and can hardly support the arrangement of renewal sequences and tracking evaluation of implementation effects. Third, quantification of social dimensions is difficult. Although research generally emphasizes the value orientation of social equity, how to convert social factors such as "gentrification" and "community identity" into computable indicators remains an unresolved challenge.

4.2 Future Trends

First, intelligent decision-making. With the help of machine learning and artificial intelligence technologies, dynamic weighting models are built to push the evaluation paradigm from "static assessment" toward "dynamic simulation". For example, Bai Ting et al. combined deep learning with remote-sensing imagery and realized intelligent identification of "retain–modify–demolish" units in urban renewal, providing a preliminary paradigm for the automated delineation of renewal units[11]. Second, standardized frameworks. Evaluation standards are promoted into industry norms, forming replicable and generalizable open-source toolkits that lower the application threshold of relevant technologies. Third, human orientation. The research focus shifts from "parcel value" to "human needs", deepening research on safeguarding the spatial rights and interests of disadvantaged groups so that the identification of renewal potential truly serves inclusive urban renewal.

5. Conclusions

Based on a systematic literature review, this paper distills three core judgments. First, the evolution of the three types of methods reflects a cognitive-upgrading process in urban-renewal decision-making: rigid constraints answer "whether it can be built", spatial quality answers "whether it is built well", and multi-source fusion answers "which areas have higher renewal potential and how multiple dimensions jointly influence prioritization", with the cognitive focus shifting gradually from land supply to spatial quality and further to comprehensive social effects. Second, the main thread of method evolution is that the object of evaluation keeps moving closer to human needs; data and technology constitute the underlying support for this shift, while policy demands prescribe its direction. Third, existing methods have on the whole not yet stepped beyond the framework of static cross-sections; quantification of social dimensions is currently the most prominent weak link, and the inertia of efficiency-oriented evaluation remains stronger than fairness-oriented institutional design. The above judgments bring two implications for research and practice: first, future potential identification should balance efficiency and equity, incorporate social dimensions into routine evaluation frameworks, and push potential identification from a technical tool toward normalized decision support; second, efforts should be accelerated to unify data standards and develop dynamic simulation methods, so that renewal decisions become trackable and evaluable and truly serve inclusive, sustainable urban renewal.

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