Lecture Notes in Education, Arts, Management and Social Science,
2026, Volume 4, Issue 7
https://bbwpublisher.com/journal/LNE
Online ISSN: 2705-053X
Print ISSN: 3083-1091

Exploration of Landscape Renovation Strategies for Old Residential Areas under AI-Driven Influence

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Abstract: Against the backdrop of urban transformation focusing on stock renewal and quality improvement, old residential communities across China are plagued by aging landscape facilities, monotonous spatial functions, and poor environmental adaptability. Conventional landscape renovation methods, which rely heavily on manual design and empirical judgment, usually suffer from low construction efficiency, serious design homogenization, and insufficient consideration of residents' actual living demands. With the rapid development and widespread application of artificial intelligence technology, innovative solutions have emerged to support refined, intelligent, and human-centered landscape upgrading of aging residential neighborhoods. Taking the landscape renewal of old residential areas as the core research theme, this study systematically sorts out the prevailing problems existing in current community landscape renovation practices. By integrating the technical strengths of artificial intelligence in multi-source data acquisition, intelligent quantitative analysis, scenario simulation, and dynamic operation management, this research proposes targeted renovation strategies from the perspectives of demand matching, spatial optimization, ecological improvement, and characteristic landscape shaping. The research findings aim to resolve the inherent drawbacks of traditional renovation modes, create high-quality and livable community landscape spaces that adapt to residents' daily needs and urban development trends, and provide feasible theoretical references and practical guidance for the stock renewal of urban old residential communities.

Keywords: Artificial intelligence; Old residential areas; Landscape renovation; Urban renewal; Spatial optimization

Online publication: July 26, 2026

1. Introduction

As China's urban construction shifts from extensive incremental expansion to intensive stock optimization and quality upgrading, the renewal and renovation of old residential areas have become a key component of refined urban governance. As an essential public spatial carrier of residential environments, community landscape directly determines residents' living experience and the overall livability of urban neighborhoods.

Most old residential communities were constructed decades ago with outdated landscape planning concepts, resulting in common environmental defects including disordered greening layout, insufficient leisure and activity facilities, single landscape functions, and weak ecological regulation capacity. Traditional landscape renovation practices are highly dependent on designers' personal experience and lack quantitative data support, which easily leads to inconsistent design schemes and resident demands, unreasonable space resource allocation, and difficult subsequent maintenance work. In contrast, artificial intelligence technology, characterized by powerful data processing capabilities, accurate scenario simulation, and dynamic intelligent supervision, can effectively make up for the deficiencies of conventional manual renovation modes and facilitate high-quality transformation of old community landscapes.

2. Current status and core deficiencies of landscape renovation in old residential areas

2.1. Homogenized landscape planning and lack of regional cultural characteristics

At present, most landscape renovation projects for old residential communities adopt unified standardized design templates, resulting in highly similar spatial styles and a lack of customized design that fits local cultural backgrounds and residents' living habits [1]. Most renovation practices merely focus on updating hardware facilities and simply copy popular landscape styles. In the renovation process, native vegetation and traditional landscape elements carrying community memory are often randomly removed, leading to the rupture of local cultural context. Limited by insufficient pre-design field research and over-reliance on designers' subjective experience, the unique regional cultural features of communities fail to be fully explored and inherited. The renovated landscape spaces generally have low spatial recognition and lack distinctive community styles. Such homogenized renovation not only fails to meet residents' personalized demands for high-quality living environments, but also causes unnecessary waste of construction funds and spatial resources, weakening the cultural and spiritual value of community landscape spaces.

2.2. Unreasonable functional layout and insufficient spatial adaptability

Restricted by the economic and technical conditions of early urban construction, the landscape spatial framework of old residential areas has inherent functional defects, which can hardly satisfy the diversified and personalized usage needs of modern residents. Most community green spaces only retain basic greening functions, while public activity spaces suitable for elderly rest, parent-child interaction, and neighborhood communication are seriously insufficient. The fuzzy division of spatial boundaries leads to serious overlap of greening areas, pedestrian passages, and activity zones, resulting in crossed pedestrian routes and unreasonable shading problems. In view of the aging population and large proportion of children in old communities, existing landscape facilities lack targeted accessibility design and safety protection measures. Traditional manual planning methods cannot quantitatively analyze the behavioral characteristics and functional demands of different age groups, resulting in low utilization efficiency of renovated landscape spaces and obvious disconnection between spatial functions and actual residential scenarios.

2.3. Fragile ecological landscape system and low environmental benefits

Long-term lack of systematic scientific management has caused the fragmentation of ecological landscape structures in old residential areas, with weak microclimate regulation capacity and overall low environmental

quality. The community greening structure is relatively simple, dominated by single-tree and shrub collocation without reasonable arbor-shrub-grass layered planting, resulting in poor ecological stability and frequent vegetation growth problems such as wilting and unbalanced growth. The excessive proportion of hard pavement further reduces ecological space, lacking ecological facilities for rainwater collection, dust purification, and noise reduction. Consequently, community problems including seasonal waterlogging, local heat island effect, and poor air circulation remain prominent. Traditional renovation usually prioritizes visual landscape effect while ignoring the original ecological foundation of the site. The blind introduction of exotic vegetation with poor local adaptability leads to low long-term survival rates. In addition, conventional regular manual maintenance cannot respond in a timely manner to vegetation diseases, insect pests, and soil moisture changes, making it difficult to maintain the sustainable ecological benefits of community landscapes.

2.4. Backward operation and maintenance mechanism restricting long-term renovation effect

Most old community renovation projects focus excessively on construction and ignore post-operation management, forming an extensive maintenance mode that seriously restricts the sustainable effectiveness of renovation achievements. Old residential areas feature open spatial structures, and landscape facilities and vegetation are vulnerable to natural aging and human damage. Relying solely on regular manual inspections leads to delayed discovery of potential safety hazards and environmental problems, so facility damage and vegetation degradation cannot be handled in a timely manner. The existing maintenance system lacks hierarchical management standards, and the resource allocation for vegetation conservation and facility inspection is arbitrary, easily causing either maintenance omission or resource waste. Since traditional management methods cannot continuously collect dynamic data such as space usage frequency, facility loss rate, and vegetation growth status, maintenance decisions lack quantitative and scientific support. With the passage of time, community landscape quality gradually declines, and the initial renovation investment fails to form long-term environmental benefits.

3. Core advantages and application value of AI-driven landscape renovation

3.1. Multi-dimensional data collection supports accurate demand analysis

Equipped with big data statistics and intelligent analysis functions, artificial intelligence effectively breaks through the subjectivity and one-sidedness of traditional manual investigation, realizing comprehensive and accurate identification of community renovation demands. Through AI image recognition, real-time sensor monitoring, and public opinion mining technology, researchers can obtain full-scale data covering community greening distribution, facility status, spatial layout, and environmental indicators. Meanwhile, residents' behavioral preferences, activity rules, and functional demands can be quantitatively summarized through intelligent data screening and statistical analysis. AI algorithms can integrate multi-dimensional information to accurately identify landscape shortcomings and distinguish urgent renovation contents from optimized upgrading items. Compared with traditional manual surveys limited by small sample size and subjective judgment, AI data analysis covers the whole community space and all resident groups, effectively avoiding design deviation caused by empirical thinking. It enables landscape schemes to fully fit community actual conditions and resident livelihood needs, fundamentally solving the problems of design homogenization and poor spatial adaptability [2].

3.2. Intelligent scenario simulation optimizes spatial planning schemes

AI visual simulation and algorithm deduction technology realize pre-evaluation and optimal adjustment of landscape planning schemes, greatly improving the scientificity and rationality of renovation design [3]. Traditional landscape design mainly relies on static drawings to display design effects, which cannot accurately predict dynamic changes of light, ventilation, pedestrian flow, and ecological environment after renovation, often resulting in poor practical adaptability of completed projects. AI technology can construct high-precision three-dimensional real-scene models of residential communities, import different design schemes, and simulate multi-dimensional effects including vegetation growth trends, pedestrian aggregation distribution, light and shadow changes, rainwater runoff, and noise reduction effects. Designers can adjust landscape layout, vegetation collocation, facility placement, and spatial scale in real time according to simulation data, so as to optimize functional zoning and landscape proportion. Moreover, AI can comprehensively consider site spatial constraints, budget limits, and ecological conditions to screen the optimal renovation scheme, effectively avoiding space waste, landscape conflict, and functional failure, and improving the overall implementation quality of landscape planning.

3.3. Ecological intelligent analysis improves landscape sustainability

AI ecological monitoring and analysis technology provides scientific support for constructing stable and long-term community ecological landscape systems and makes up for the ecological defects of traditional renovation modes. Based on community soil quality, illumination duration, hydrological conditions, and local climate data, AI algorithms can intelligently screen vegetation varieties with strong adaptability, high survival rate, and excellent ecological benefits, and build multi-level arbor-shrub-grass composite greening structures to enhance the stability of community plant communities. At the same time, AI can simulate site hydrological circulation, heat distribution, and dust diffusion rules, guide the design of permeable pavement, rain gardens, and ecological green belts, and effectively improve community microclimate, rainwater storage capacity, and noise reduction effect. In addition, AI can predict vegetation disease incidence and growth cycle based on historical ecological data, providing accurate guidance for refined ecological maintenance and realizing the benign and sustainable development of community landscape ecosystems.

3.4. Dynamic intelligent supervision perfects full-cycle operation and maintenance system

AI intelligent monitoring and automatic control technology completely subverts the traditional extensive manual maintenance mode and builds a full-life-cycle intelligent management system for community landscapes. Combined with visual recognition, Internet of Things sensors, and intelligent terminal equipment, the system can achieve 24-hour uninterrupted dynamic monitoring of landscape facilities, vegetation growth, and environmental order. It can automatically identify facility damage, vegetation withering, garbage accumulation, and irregular occupation behaviors, and realize real-time early warning and precise positioning of problems, greatly improving maintenance efficiency. Based on long-term accumulated operation data, the AI system can summarize facility loss rules, vegetation growth laws, and space usage characteristics, formulate differentiated refined maintenance plans, and realize precise allocation of maintenance resources. Through intelligent data ledgers to record the whole maintenance process, the standardized and dynamic management of landscape operation is realized, which effectively solves the problems of lagging response and low efficiency in traditional maintenance and ensures the long-term stability of landscape renovation effects.

4. Practical strategies of AI-driven landscape renovation for old residential areas

4.1. AI demand modeling to build personalized and characteristic landscape systems

Based on big data modeling technology, this study explores community characteristics and resident demands in depth to eliminate design homogenization and build culturally distinctive landscape spaces. Firstly, AI text mining and image analysis are adopted to sort out the regional context, architectural style, and historical features of the community, extract localized landscape elements and cultural symbols, and provide design materials for characteristic landscape creation. Secondly, through intelligent analysis of questionnaire data and resident behavior trajectory monitoring, the landscape demand differences among age groups are quantitatively evaluated, and the proportion of elderly-friendly, child-friendly, leisure, and ecological landscapes is reasonably allocated. On the basis of multi-dimensional data, a targeted community demand model is constructed to replace unified and rigid design templates. Local cultural elements are integrated into landscape sketches, greening layout, and lighting design. Meanwhile, AI comparative analysis of similar renovation cases helps avoid homogeneous design pitfalls, optimize characteristic landscape layout according to community spatial defects, and realize the organic integration of landscape aesthetics, cultural inheritance, and community individuality [4].

4.2. AI spatial deduction to optimize landscape functional zoning layout

By virtue of AI 3D modeling and spatial simulation technology, the functional layout of community landscapes is scientifically optimized to improve space utilization efficiency and practical adaptability. Aiming at the problems of tense space, mixed functions, and disordered pedestrian flow in old communities, AI real-scene modeling restores the overall spatial structure of the community and realizes accurate division of passage space, green space, activity area, and rest space to avoid spatial cross-interference. Through pedestrian flow simulation algorithms, residents' daily travel tracks and activity aggregation areas are analyzed to identify idle blank spaces and inefficient crowded areas. On this basis, functional sections such as fitness activity areas, children's playgrounds, neighborhood communication spaces, and quiet rest areas are reasonably planned. Combined with barrier-free spatial simulation, the layout of elderly- and child-friendly facilities is optimized, and walkway width, facility height, and vegetation spacing are adjusted to ensure the safety and comfort of special groups. According to the data deduction results, the scale of each functional space is accurately matched to fully activate fragmented space resources and realize precise docking between landscape functions and residents' living needs.

4.3. AI ecological empowerment to construct circular ecological landscape systems

Taking AI ecological intelligent analysis as the core technical support, a compound ecological landscape system adapting to local environmental conditions is constructed to enhance community ecological benefits and sustainable development capacity. Firstly, AI environmental monitoring equipment collects real-time ecological data such as soil, illumination, hydrology, and temperature. Combined with local vegetation growth characteristics, intelligent collocation of evergreen, deciduous, and flowering plants is carried out to build multi-level and highly stable green plant communities, improving vegetation survival rate and landscape hierarchical aesthetics. Secondly, AI hydrological simulation technology optimizes low-impact development designs including rain gardens, ecological ditches, and permeable pavement, accurately calculates rainwater collection and runoff regulation parameters, and effectively solves community waterlogging, hard surface overheating and poor water circulation problems. In addition, the AI intelligent

pest identification system monitors vegetation growth status in real time, early warns of disease and insect pest risks, and formulates targeted maintenance schemes. Through dynamic regulation of ecological data, the community landscape realizes self-regulation and a virtuous ecological cycle, continuously optimizing the micro living environment while maintaining good landscape ornamental value [5].

4.4. AI intelligent maintenance to establish full-cycle long-term management mechanism

Constructing an AI intelligent landscape maintenance platform to realize full-cycle intelligent management of landscape renovation, operation, and maintenance, so as to guarantee the long-term effectiveness of renovation achievements. Integrating visual monitoring, IoT sensing, and big data analysis technologies, the platform realizes integrated supervision of landscape facilities, vegetation growth, environmental hygiene, and spatial order. The system can automatically identify various environmental problems, issue maintenance instructions in real time, and shorten problem processing cycles. By accumulating long-term operation data, the platform analyzes landscape aging rules and resident usage characteristics, dynamically optimizes maintenance schemes, and realizes refined differentiated management. Meanwhile, relying on resident feedback intelligent analysis modules, the system summarizes public evaluation of landscape space in real time, dynamically adjusts landscape layout and maintenance priorities, and forms a closed-loop optimization mechanism of "renovation–operation–feedback–upgrade." This mechanism continuously improves community landscape quality and spatial livability, providing a reliable long-term guarantee for the sustainable development of old community landscape renewal.

5. Conclusion

Landscape renovation of old residential areas is an important starting point for urban refined governance and livelihood improvement. Traditional renovation modes dominated by empirical design, homogeneous construction, and heavy construction but light management have severely restricted the upgrading of the community living environment. With the unique advantages of data quantification, intelligent simulation, and precise management, AI technology effectively solves various bottleneck problems in traditional landscape renovation and realizes accurate demand matching, scientific spatial planning, sustainable ecological development, and closed-loop maintenance management. This paper systematically discusses the application value and practical strategies of AI empowering old community landscape renovation, providing effective theoretical and practical references for intelligent and refined renewal of urban stock communities. In future research and practice, it is necessary to further deepen the integrated application of artificial intelligence and landscape design, and promote the transformation of old residential area landscape renovation towards humanization, high efficiency, ecologicalization, and long-term sustainability.

Disclosure statement

The author declares no conflict of interest.

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