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Discussion on Traditional Residence Remodeling and Renewal Design Pointing to Green Building System--Take Wanggezhuang Traditional Residence as an Example

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Abstract: Since China advocated the conservation of historical and cultural heritage and rural rejuvenation strategy, finding a balance between "protection" and "adaptive use" of traditional villages has become a core challenge for their sustainable development. In November 2023, the Department of Culture and Tourism of Shandong Province announced the list of cultural-ecological demonstration villages and towns in the province, in which Wanggezhuang Street stood out and was awarded the title of cultural-ecological town, becoming a unique representative of Qingdao. This study aims to realize the "harmonious coexistence of multiple interests" by comprehensively examining the current situation of the village through a combination of on-site research, literature analysis, in-depth interviews, and other research methods, supplemented by questionnaires and other means to build a multi-dimensional evaluation system to assess user satisfaction, and then systematically summarize the problems and their root causes of conservation and development. It aims to provide targeted optimization suggestions for village planning, promote the deep integration of traditional village protection and development, achieve a win-win situation for all parties, and contribute to the in-depth implementation of the strategy of rural revitalization.

Keywords: Wangjiazhuang; Traditional houses; Win-win situation; Rural revitalization

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1. Introduction

Driven by the goal of "Carbon Peak and Carbon Neutral", China is accelerating the green transformation of urban and rural construction, and the "14th Five-Year Plan" for cultural development emphasizes "strengthening the protection and inheritance of history and culture, and promoting traditional villages." The "14th Five-Year Plan" for cultural development underscores the importance of preserving and passing down historical and cultural heritage. It calls for enhanced protection and sustainable use of traditional villages, ethnic minority settlements, and towns and villages with historical and cultural significance. Traditional residential buildings are recognized

not only as vessels of cultural heritage but also as ecological units. Accordingly, the renovation and upgrading of these structures have evolved from merely improving spatial functionality to a more holistic approach, one that integrates cultural preservation, energy efficiency, and environmental sustainability. How to protect the traditional architectural style, and the continuation of regional cultural genes under the premise of green technology empowered to achieve functional iteration has become an important issue in the field of urban and rural construction.

2. Wanggezhuang Fengshan West community building status quo

Fengshan West Community is located in Wangjiazhuang, Laoshan District. The community houses have different forms, such as single-family houses, three-sided enclosures, villas, etc. Most of the houses were built around thirty years ago and are generally of average quality and appearance. A smaller portion has been renovated or newly constructed in recent years, featuring better construction quality. Among these, the houses used as bed and breakfasts also stand out for their more appealing architectural style. There are also a small number of old houses with gray bricks and tiles built a long time ago, some with damaged walls, some with collapsed roofs, small in size and poor in quality, but the overall preservation of these houses is good and they can be preserved or remodeled for the spirit of the village. Each house looks like an independent work of art when viewed on its own, but it is extremely incongruous when put into the same picture.

Their facades have different shapes, some pursuing modern simplicity, with smooth and cold lines, while others retain their ancient flavor, with carved beams and paintings that show the traces of age. However, the differences in materials exacerbate this sense of incongruity. Some of the walls are made of smooth tiles, reflecting blinding light; some are rough adobe walls, revealing originality and simplicity; and some are mottled wooden structures, with traces of erosion visible. They present different textures and colors under the sun, making the whole village look like an unfinished collage, lacking the harmony and unity it deserves.

This kind of disorderly splicing makes people feel a bit messy, and it is difficult to capture the unique flavor and characteristics of the village, which is also the fundamental problem that exists in most of the traditional houses in China. Therefore, for such a village, how to retain its distinctive advantages while realizing the harmony and unity of the overall appearance will be a topic worthy of deep thought and discussion [1].

3. The meaning of the green building system and Wangjiazhuang traditional residential remodeling methods

A green building system is a comprehensive construction model that takes the concept of sustainable development as the core, and realizes the efficient use of resources, minimization of environmental loads, and health and comfort of human beings in the whole life cycle of a building (design, construction, operation, and dismantling) through the systematic integration of ecological, technological, economic, and socio-cultural elements [2].

Traditional Chinese houses contain regional cultural genes and ecological wisdom, but their spatial functions, material properties, and energy utilization patterns are difficult to adapt to the needs of modern life [3]. As a typical area where mountain and sea cultures meet, Wanggezhuang Street in Laoshan District, Qingdao City, has provided an innovative sample for the construction of sustainable human settlements in the context of rural revitalization by adopting the “green building system” as the guide for the renovation of traditional residential buildings, and through the regeneration of functions, upgrading of technology and continuation of culture.

The traditional houses in Wanggezhuang are built along the mountains and the sea, with stone and wooden structures, reflecting the simple ecological concept of local materials and natural ventilation. With "safety as the foundation, culture as the soul, and ecology as the vein", Wangjiazhuang Fengshan West Community has realized the transformation from a dilapidated residential area to a model of green human settlements through the combination of technological empowerment and traditional wisdom, providing a replicable practical path for the renewal of similar mountain settlements. The following are the methods of remodeling and upgrading Wanggezhuang's buildings:

(1) Structural safety and ecological restoration at the same time

Located in a mountainous area, the traditional buildings of Fengshan West community are mainly stone and wooden structures, and the transformation needs to prioritize solving the problems of collapsing walls and unstable foundations caused by age and disrepair. According to the professional requirements, the stone walls, beams columns, and other load-bearing components use carbon fiber reinforcement, steel cladding, and other modern technologies to enhance seismic performance, while retaining the original stone texture, to avoid the destruction of the landscape, for the collapse of the stone walls and other hidden dangers, the use of "villagers repair + community support" mode, restoration of the embedded ecological berming technology, and replanting of native vegetation (such as tea seedlings) to stabilize the soil, and the ecological restoration. The restoration is embedded with ecological slope protection technology and replanting of native vegetation (such as tea seedlings) to stabilize the soil, forming a cycle of "restoration-protection-regeneration".

(2) Functional optimization and spatial activation

To meet the demands of rural tourism, renovations should strike a balance between residential functionality and cultural tourism services. Unused residential houses can be transformed into distinctive bed and breakfasts, preserving the traditional courtyard layout while incorporating shared amenities such as tea rooms and intangible cultural heritage workshops, for example, a Laoshan noodle-making experience area. These upgrades should enhance both cultural display and interactive experiences. At the same time, aging plumbing and electrical systems in the old houses should be modernized, modular sewage treatment technology should be introduced to enable resource recycling, and lighting and drainage systems should be optimized to improve overall living comfort [4]. Optimize lighting and drainage facilities to enhance living comfort.

(3) Integration of local materials and green technologies

Using local stone, bamboo wood, and other renewable resources, artistic reuse of demolished old bricks, tiles, and wooden components (e.g., cultural wall masonry, landscape vignettes), combining the climate characteristics of the mountains and the sea, adopting passive design (e.g., naturally ventilated patios, solar photovoltaic tiles) to reduce energy consumption, and simultaneously introducing an intelligent monitoring system to optimize energy management.

(4) Cultural heritage and industrial development

Cultural protection zones should be clearly delineated, with efforts focused on the repair and preservation of historically valuable old mansions, ancient trees, and traditional handicraft workshops. It is essential to prevent the excessive commercialization that could compromise their original character [5]. Intangible cultural heritage elements, such as Mantis Fist and tea culture, can be artistically reproduced through wall paintings and carvings to reinforce regional identity. Additionally, drawing on the "court-community

mediation" model, a collaborative platform should be established involving residents, government, and designers. This platform would help ensure that the renovation process respects the interests of all stakeholders and minimizes potential conflicts. Relying on mountain and sea resources, the project has created a composite eco-tourism node, utilizing the experience of transforming deserted beaches to develop tent camps, eco-trails, and supporting rainwater recycling systems. At the same time, it has combined tea gardens, fruit orchards, and bed and breakfasts, and has designed a picking experience line to form a closed-loop of "lodging-production-consumption" and promote economic development. At the same time, combining tea plantations and orchards with lodging and designing picking experience lines, forming a "lodging-production-consumption" closed loop and promoting sustainable economic development.

4. The green building system of the traditional residential transformation and its renewal design strategy

(1) Material green transformation

On the application of locally sourced and renewable materials, mountainous areas can directly mine local stone for wall masonry and floor paving, which not only reduces transportation costs, but also highlights the regional characteristics [6]. In areas with abundant forest resources, local wood is selected to make beams and columns, door and window frames, while bamboo weaving finishes and straw fiber boards are introduced for indoor wall decorations, and formaldehyde-containing materials such as plywood are used less frequently. On the recycling of old materials, after cleaning and repairing the dismantled green bricks, the staggered collage can be used to create a characteristic cultural wall. The old timber will be sanded and polished for the production of furniture or porch shelves. When new energy-saving materials are replaced, in the cold northern regions, 50 mm-thick rock wool boards can be added to the outside of the original walls, and moisture-proof treatment can be done [7]. In the hot and humid regions of the south, vacuum insulation boards are laid on the roof, which can effectively block the solar radiation heat from being transmitted into the room and significantly reduce the frequency of air conditioning use.

(2) Energy system optimization

In terms of solar energy utilization, in residential houses with suitable roof slopes and no shade, monocrystalline silicon solar photovoltaic panels are installed, combined with energy storage devices to store excess electricity for nighttime use; at the same time, split solar water heaters are set up, with the collector panels mounted on the roof and the tanks placed indoors, to ensure a stable supply of hot water [8]. In the design of natural ventilation and lighting, the location and size of doors and windows are adjusted through computer simulation analysis to form a passage through the hall; tiger windows are set on the sloping roof to enhance the ventilation effect and introduce natural light. For areas with cold winters and hot summers, if the geological conditions allow, a ground-source heat pump system is installed, with underground buried pipes in a U-shaped arrangement, absorbing or releasing underground heat through the circulating medium to realize energy-efficient heating and cooling.

(3) Renewal of space function

When optimizing the functional zoning, the hall of traditional houses can be used as the center of family activities, with private spaces such as bedrooms and kitchens set up around it. The attic or mezzanine

floor can be used to create a storage area or a leisure study. In the accessibility and aging-adapted renovation, anti-slip ramps are paved at entrances and exits, with slopes of no more than 1: 12 and double handrails installed [9]. Indoor doorways are widened to 900mm to facilitate the passage of wheelchairs and toilets are equipped with toilets, handrails, and emergency call devices. In terms of flexible and variable space design, folding partitions are used to divide the living room and dining room area, which can be completely opened when needed to form open space. Multifunctional sofa beds, liftable dining tables, and other furniture are used to meet the needs of different scenarios of use, and various types of living spaces are divided in detail to fully utilize the limited space to the fullest extent.

(4) Water environment sustainable design

Water environment sustainable design can effectively enhance the utilization rate of water resources, by setting up an underground rainwater collection pool in the corner of the courtyard and installing filters and precipitation devices in the pool, after preliminary purification of the collected rainwater, it can be used for watering courtyard plants through the automatic irrigation system. It can also be set up in the landscape plunge pool to realize the landscape use of rainwater. In terms of sewage purification and reuse, the small sewage treatment device can adopt the biofilm method process, and the treated water is stored in a special tank and used for toilet flushing through an independent piping system [10]. The application of water-saving appliances, the installation of sensor-type faucets, and two-stage flushing toilets, compared with traditional appliances, can save more than 30% of water.

(5) Ecological environment creation

Choosing native tree species for courtyard greening, such as planting *Acacia* and elm trees in the North, camphor trees and banyan trees in the South, and matching flowers such as moonflower and daylily to form a rich plant community. At the same time, setting up rain gardens and utilizing plants and soil to purify rainwater. Vertical greening can be done by planting climbing plants such as creepers and ivy on the exterior walls of the buildings or installing modular green walls. Balconies are arranged with hanging flower pots and planted with herbaceous plants such as mint and *Perilla*, which have both ornamental and practical values. In the ecological landscape design, a small artificial wetland system is introduced, and aquatic plants such as reeds and irises are planted to purify the water while creating a natural and wild landscape atmosphere.

5. Conclusion

Facing the new context of the “dual-carbon” goal and urban-rural integrated development, the transformation of traditional residential buildings needs to further strengthen interdisciplinary collaboration and deepen innovation in material recycling technology, renewable energy application, and community governance model. It is expected that this study can provide a reference for the protection and renewal of more historical and cultural villages, promote the traditional houses from “static protection” to “dynamic regeneration”, and help realize the dual goals of habitat improvement and low-carbon transformation while guarding the cultural roots.

Disclosure statement

The author declares no conflict of interest.

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