Research on the Rural Housing Design to Explore the Rural Labors

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Abstract. The rural housing industrialization in China relies on long-term accumulation and is a process of gradual integration with the handicraft Industry. However, the eager to develop deglamorized housing products is hard to adapt to the building capacity of villagers and not favourable for the sustainability of the rural construction industry. Clearly, housing design should not only satisfy the physical functions of housing, but also provide convenient, comfortable and pleasant hardware conditions for the interaction between housing products and rural labors, alleviating the living and consumption burden of villagers and improving the residential satisfaction of villagers. Based on the housing industrialization demands under the strategy of rural revitalization, our work studied the principle of applying rural labor force into housing design and the design requirements for housing products by stressing the importance of technology-labor integration. And then together with the design practice of building components, facilities and ornaments, we probed into the methods of rural housing design. It will be theoretically and practically meaningful for rural housing modernization.

1. Introduction

So far, the developed countries have basically succeeded in the manufacture mode modernization of rural housings depending on the complete housing industrial chain, excellent materials, economic foundation and high quality of rural labor force. For instance, rural areas in Japan have generally manufactured houses online in factories and then transported the houses into in-site fast installation. However, there are no conditions like that to realise fully industrialized architecture in rural China[1,2], due to the relative shortage of architecture resources and the weak economic ability. The large-sized machine for transport and construction, village housing products based on professional and technical personnel and management personnel are often limited to build by the inability or financial shortage of villagers, which restrict the scaled development of rural housing industry.

In view of the dominant position of villagers in current rural housing construction in China, more humanized design needs to make the rural labor resources usable for housing products. In our work, the generation mechanism of rural housing products was studied from the perspective of polyatomic crossover, the principles and methods of housing product design with easy construction and maintenance, learnable and usable to rural labors were explored to offering an innovative path for rural housing industry.

2. Action mechanism of rural labors on housing products

In the majority of rural areas in China, the principal force of residential construction is still villagers, who are following an interdependent and interactional cooperative relationship to the housing
products[3]. The traditional rural housing design usually, through the manual or semi-manual characteristic of housing products, makes the housing products cooperate with the villagers in all procedures of building, using and maintenance. Then, the rural labour power capitals will convert into a part of values and income of residential construction.

2.1. Coupling efficiency of rural labors
The coordination between rural labors and housing products is essentially a matching and interactive process between technology and human resources, and in the housing technique system, they two possess the characteristic and efficacy of system coupling[4]. Thus, the concept of coupling was used to illustrate the action mechanism of rural labor force in housing products. "Coupling" originated from ancient Greece and means consonance and coordination. System coupling is defined as the tight cooperation and mutual influence between two or more elements, and transmits energy through interaction from one end to the other end, leading to a cooperative, compatible and coexisting process and finally reaching the 1+1>2 effect[5][6]. Clearly, the rural labor factors considered in housing design can not only reduces the cost expenditure and material depletion by the houses, but also stimulates the principal values and spirits of villagers and enhances their satisfaction with the houses, thereby making the relationship between the villagers and housing products more harmonious and stable.

2.2. Coupling relation between housing products and rural labors
To illustrate the coupling relationship between housing products (e.g. components, facilities, ornaments) and rural labors, the mutual coordinated connotation between that was expressed as follows referencing for the ecological coupling theoretical model[7].

- RHCS ⊆ { S1,S2, Rel, Rst, O, T, L }, Si ⊆ {Ei, Ci, Fi}

Where RHCS is Rural Housing Coupling System coupled from two types of architecture resources, including housing products (S1) and villager labors (S2);

- Si is the i-th architecture system;
- Ei, Ci and Fi are the element, composition and function of Si, respectively;
- Rel is the coupling set of architecture systems and a coupling relationship set in RHCS, which contains not only the coupling relationship between two types of architecture resources, but also the coupling relationships among resource elements;
- Rel is a coupling relationship set of RHCS, and contains not only the coupling set between Ei, Ci, Fi of S1 and Ei, Ci, Fi of S2, but also the coupling set between the architecture function units of S1 and S2;
- Rst is the limiting or restraining factor set of house architecture resources (e.g. economic elements, institutional elements, cultural elements in the environment of the housing, and are the parallel elements that constitute the orderly development of this coupling system);
- O is the objective set of the architecture system;
- T, L are the variables of time and space, respectively.

Rural housing products result from the mutual matching among the elements, structures and functions of building materials, technology and rural labors under given space-time and systematic environment. Regardless how new and old technology or materials, the material resources are integrated or replaced by rural labors, this mode will match with the objective as long as a balance within the given coupling relationship for rural housing system can be achieved[8].
3. To exploit the rural labors on housing products
As relatively low economic capability, low civilized quality and low technical skills for this population, the high-technology housing products obviously do not meet their requirement for villagers’ participation, and the traditional housing products with overload labors are not satisfied with their requirements for the efficiency and quality of rural housing.

3.1. Core issue of rural housing design
Although the living environment can be improved within short time though the modern urban housing design, but the comfort of houses is usually achieved at the sacrifice of environment and economic devotion and highly dependent on the external input, and the original diversity and flexibility of living states will be easily lost[9,10]. Moreover, to achieve the recycle and reuse of living materials as much as possible in the traditional rural housing system, the villagers have to cost abundant labors for housing products’ running, but housing design are not good at creating more comfortable and efficient hardware environment because that housing products are developed under an instinctive reaction of villager when they handle uncertainty factors in the nature[11]. The degree of using rural labor factors by housing products in the housing system reflects the coupling level between the two, as it largely affects the human-house harmonious relationship and the sustainability of houses. It is unfavourable for the cooperation between housing products and villagers because that an insufficient or overly coupling result in the isolation of technology and labor will be lacking of material exchange, substitution or compensation. So clearly, the rural housing design is at the transition phase to the integration between modern technology and traditional architecture achievements, and thus the core issue of rural housing design is to reasonably utilize rural labors.

3.2. Major tasks of rural housing design
For a certain architecture system, the coupling-based housing design is essentially a process of exchanging, replacing, compensating material and energy between housing products and rural labors, it is aimed to promote the virtuous circle among human and house with materials, energy and information, etc. The final target is to reduce material consumption and economic investment during the construction of rural housing and to achieve incomes at low consumption, low economic costs and high emotional returns[12]. Thereby, the main tasks of housing design are to balance the low and high techniques in a planned way by integrating the traditional and modern architecture achievements to sustainably exchange materials and energy between housing products and labours. The physiological/psychological adaption and experiences of villagers should be paid more attention during rural housing products design, so as to villagers can transit from the passive adaptation to the active conformity on high/new techniques.

3.3. Designing characteristics of rural housing products
The Designing characteristics of rural housing products to be suitable for rural labors are shown as follow:
   1) Convenience for manufacture. The building parts/products should be manufactured in a small-batch and quantitative way, which will relieve the labor burden of villagers.
   2) Convenience for construction and maintenance. The technical threshold and operational difficulty should be reduced to meet the psychological, physiological and educational levels of villagers. Ergonomics and perceptual technology can be use to make housing products convenient, comfortable and safe to improve the coupling efficiency.
   3) Controllability of devoted labor quantity. That is mean more chances for villagers to initiatively control the housing products. For instance, the housing products can be switched among full-auto/mechanized, semi-auto/mechanized or full manual according to their real living demands and economical abilities, so that the building and living materials can be more reasonably controlled by villagers according to their immediate demands.
4) Increment of belongingness. The "experience" housing products design will bring villagers more spiritual happiness during their operating processes and creation activities.

3.4. The guiding idea of rural housing design

The guiding idea in practices of rural housing design is to reasonably utilize rural labors through the housing design, and the effects are reflected in the more-humanistic hardware conditions offered by the housing products for farmer participation, which raises the adaptability of low-level rural labours resources (labor force, life concepts and skills). The rural design should allow villagers to enjoy the modernized material achievements while retaining the traditional rural residence state of low economic costs and low material depletion, moreover, works for enhancing the civilization level of villages are emphasized in our design practices.

4. Design practices for making the most of rural labors on housing products

The comprehensive benefit of interaction between human and environment is emphasized in our design practices, the constraint conditions and available resources of rural housing construction should be considered to making the most of rural labors, so related architectural elements especially housing products must be re-designed and manufactured.

4.1. The design case of building components

The methods of rural housing products design were studied from the perspective of architecture components considered the rural labors, such as the development of small-sized assembled plate wall structures(figure 1). This work ensures the wall thermal performance and the lower house construction costs, and significantly improves the cost performance ratio of rural housing construction and maintenance. Moreover, the new type of building blocks and auxiliary components with simple structures and manufacturing process are suitable for industrialized mass-production and for the manual operation by villagers. This system featured by fast construction speed and low construction difficulty well solve the problems of low labor force level, insufficient building resources and low economic levels in most rural areas of China. Moreover, this system can efficiently save building land.

4.2. The design case of building facilities

Our design allows villagers to actively or subconsciously energy-saving behaviors to cooperate with living facilities during daily life, so that they can conveniently and targeted modulate the housing products. For instance, the traditional ground well-cellars (only for food storage) can be changed into cabinet embedded well-cellars, and a liftable storage box was used instead of the refrigerator, so that villagers can take foods conveniently and hygienistically (figure 2). Moreover, the well-cellar liftable facilities were divided into two types of electric (figure 3) and manual (figure 4).
Figure 2. The section of built-in Cabinet

Figure 3. Electric lifting mechanism

Figure 4. Manual lifting mechanism

4.3. The design case of building facilities

The newspapers are usually pasted on the walls in the traditional rural housing of North China, which is cheap but non-aesthetic. Modern finished wallpapers are aesthetic, but rely on professional construction staff and assisting materials (e.g. special wall protection glues), which is high labor costs and material purchase costs for villagers, especially those living in distant rural.

The new type of wallpaper integrates the advantages of traditional and modern wallpapers (figure 5). In brief, the traditional newspaper pasting and framing skills are used to locally modify the sizes and paper materials of modern finished wallpapers. For instance, A2 krafts can be used instead of finished wallpaper rolls, reducing the difficulty of sticking, so that the labor costs of professional staff can be saved by utilizing the simple works of villagers. Moreover, to allow farmers to lay and stick wallpapers in an aesthetic and skill-less way, the wallpapers can be designed as non-buttin patterns, so that farmers can repair at any time, which saves the costs of large-area wallpaper replacement. In this way, the sticking difficulty is reduced by using small patterns and non-continuous design.

Computer-aided design and small-batch fast printing ensure the wallpaper quality, and an experiential consumption way is created by using customized patterns, which increase the sense of achievement of villagers.

Figure 5. The new type of wallpaper
5. Conclusions
In this study, the housing design theories and methods targeted at the insufficient labor force resources in rural China were explored. The works of rural housing designers should more frequently investigate the concrete building conditions of rural families, so as to customize housing products suitable for villagers. For such tasks, designers should test the characters of villagers during construction and consider the related factors at early stages in rural housing design, such as the quantity, working time and working skills of available labor resources. Then the architectural elements and interactive mode of housing products are selected and adjusted, so as to adapt to the participation willingness of villagers.

Above all, it is the requirement and trend of reducing construction consumption and financial investment under the economical and resource background in the rural transition stage, and is the new challenge and responsibility of builders. We hope the complementary advantages between modern techniques and rural labor resources can be utilized to efficiently assimilate the bonus of modern urban development.

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