

The Evolution of Dwellings Spatial Pattern and its Influence Factors in Guanzhong Region

Wei Na^{1,*}, Wei Jia² and Xu Juan³

¹*Xi'an University of Architecture and Technology, P.O. Box 93, Yanta Road-13 Xi'an, China;* ²*Shaanxi Aerospace Education Industry Group co., LTD, Hangtian Road 59 Xi'an, China;* ³*Changan University, Changan Road-161 Xi'an, China*

Abstract: Traditional dwelling in Guanzhong region is one specific kind of architecture whose spatial pattern is character of distinctive local features. With the development of society, the spatial pattern of dwellings in the Guanzhong region changed. This paper taking the dwellings of Zhiyang village that lies in the city of Hancheng in the Guanzhong region of Shaanxi Province for example, the evolution and development of spatial pattern of dwellings under the influence of natural environment, culture, economy, production and life way is studied with the methods that involves the architecture and environmentology based on the field measurement and interview, which can provides some reference for architects to understand and design such houses when involved in.

Keywords: Dwellings, evolution, guanzhong region, spatial pattern.

1. INTRODUCTION

Rural dwellings are the oldest and the most basic building in human history. They are the basis and source of architecture. As the specimen to record the human way of life, the Chinese traditional dwellings are always taken as the research object in the field of architecture. With the development of rural economy and the change of the mode of rural residents' production and life, the spatial pattern of rural dwellings changes constantly. It is on the surface that the evolution of spatial pattern of rural dwellings reflects the villagers' demand on the living space and production space in different eras. It is at profound level that it also reflects the feature of times, the regional characteristics and the economic conditions of the villages. Therefore, the study on the rural dwellings has important significance for local human geography [1].

There are some articles that studied on the dwellings [2-8]. The heat and moisture environment for rural dwellings in Zhejiang province was studied the reference 2. The construction experience and the shortcoming of rural dwellings were analyzed and the design method of ecological dwelling was put forward in Qinba Mountain Regions in the reference 3. The courtyard arrangement and the rural dwellings form of Hui autonomous in Qinghai was researched the reference 4. The thermal comfort of rural dwellings in the vicinity of Mexico City was studied the reference 5. The "Square Yard" mold based on 160m² country curtilage restriction in the central Shaanxi plain was proposed in the reference 6, which is a new dwelling type design for updating Guanzhong new rural

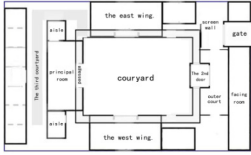
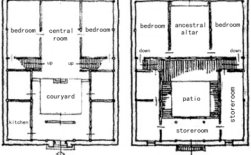
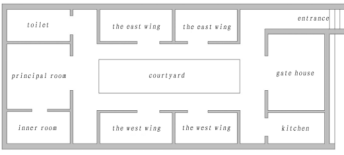
dwelling model development. The Guanzhong dwelling was taken as the research object and the combination of modern and traditional elements in contemporary architectural design was explored in the reference 7. The Dangjia Village is the most representative village of dwelling in Guanzhong region, its layout, plane from, classification and art decoration were analyzed and summarized in the reference 8. Obviously, these articles focus on the study on the structure, form, spatial pattern and thermal comfort of dwellings in specific areas. So far, there are hardly articles on the evolution and the development of the dwellings spatial pattern. Therefore, based on the field survey and interview, this paper takes the rural dwellings in Zhiyang village, Hancheng city, Guanzhong region of Shaanxi province for example and uses the multi-disciplinary approach that involves in architecture and culturology *etc.* to analyze the evolution process and the characteristics of dwellings spatial pattern that are affected by natural environment, culture, economy and the mode of villagers' production and life.

2. THE INFLUENCE FACTORS OF DWELLINGS SPATIAL PATTERN IN GUANZHONG REGION

According to the geographical features, Shaanxi Province is divided into three areas that are the Northern Shaanxi, GuanZhong region and Southern Shaanxi from north to south [9].

The GuanZhong region belongs to the semi-humid and semi-arid monsoon climate region in temperate zone. It is the transition area from the arid climate in Northern Shaanxi to moist climate in Southern Shaanxi. In the GuanZhong region, the annual average temperature is between 6-13°C. The summer and winter are long. The rainstorm is frequent in summer but the precipitation less rainfall in winter.

Table 1. The relationship between courtyard form and climate in different area.

Area	Quadrangle Dwellings of Beijing	Quadrangle Dwellings of Shanxi Province	Quadrangle Dwellings in Guanzhong Region of Shaanxi Province
Plane layout			
Storey of the principal room	One storey	Most of the buildings are two-storey	One storey
Shape of the inner court	Similar to square	Square or rectangle	narrow-long shape
Area of the courtyard	Small	Small	Small
The relationship between courtyard form and climate	Summer and winter are windy season in Beijing, winter prevailing wind direction is northwest, the fence of courtyard can block the cold wind in winter and the sand-storm in spring, the thick walls can keep rooms warm in winter and isolation the heat in summer.	Shanxi quadrangle is popular in Jinzhong region, the urban and rural areas near the Taiyuan. Because of the day lighting of north room is good, therefore, during the process of house building, the north space and ground has been fully utilized, therefore, the shape of courtyard is irregular.	The Guanzhong region is hot in summer and cold in winter, therefore, the Guanzhong quadrangle is narrow and long in the south-north direction, in order to place the courtyard space in shadow zone that formed by the buildings on either side and make the courtyard be cool in summer. In addition, the thick and high walls can keep warm in winter and isolation the heat in summer].

The GuanZhong dwellings had experienced a long developmental process, which is influenced by various factors. The form of dwellings was more and more diversified and the internal space division evolved gradually in this process. From the view of development process, the major factors, such as the natural environment, culture, economic and technology, influence the internal space of dwellings and their influence degrees are different in different periods [10].

2.1. Natural and Geographical Environment

The relationship between natural environment and buildings is mutual, which means that the buildings depend and remould the environment, meanwhile, the environment impacts and restricts the buildings [11]. The influence of natural environment for buildings is profound. “Throughout the human history and the buildings in history, the climate is the only constant factor except the basic geological structure of the landscape” Yang Jingwen said [12]. Therefore, the traditional dwelling spatial pattern should be being affected greatly by natural environment and geographical characteristics, and the influence is continuous and stable. It shows the diversity due to the different climate, even if the building form is homologous. For example, the courtyard buildings in Beijing, Shanxi and Guanzhong region are different (Table 1).

2.2. Social Culture

Social culture is also one important factor that affects the architectural forms and characteristics. It is not the simple master-slave relation that the relation between social culture and natural environment factor from the viewpoint of influencing the architectural form and spatial pattern. Peng Yi-

gang said, “If the degree of development of the human civilization is higher, the influence of natural factor would become less obvious and the influence of social factor would become more obvious. Conversely, if the degree of development of the human civilization is lower, the influence of natural factor would become more obvious and the influence of social factor would become less obvious” [13]. Therefore, the form and pattern of traditional dwellings is affected by social culture such as cultural, religion, custom, etc. For example, the sitting room is an important and relatively independent space in traditional dwellings, which is affected by traditional culture and etiquette. With the change of the social culture and people’s living idea, a new pattern appears. In this new pattern, the sitting room and bedroom be set together in one room. For another example, some notions with obvious cultural symbol, such as the principal room and wing room, have been gradually disappeared with the evolution and development of dwellings spatial pattern in Guanzhong.

2.3. Economy and Technology

Good economic gain and the technology are the precondition and the assurance of dwelling construction, respectively. Since the reform and opening in China, the village economic conditions was gradually improved. Specially, under the influence of the western development and new rural construction of China, the village has experienced several dwelling construction booms. Nowadays, the dwellings not only satisfy the peoples’ requirements for life, but also become a mirror to reflect the people’s living standard [14].

For past decades, under the impetus of the economy and technology, the spatial pattern of dwellings becomes bigger

and bigger. For example, the porch in traditional dwellings was the passage for residents, livestock and rack truck in the past, but the subsequent porch of dwellings became larger and larger for the motor vehicle, because each family purchases the motor vehicle with the development of economy in village. However, the porch, as the function of gateway, has been not changed. At present, there is a kind of new pattern in rural dwellings. In his new pattern, the porch is replaced by the hall that it is set at the middle of the dwelling. It not only can be used as a passageway, but also as the place for production and living. Meanwhile, because of the development of construction technology and construction materials, the multistory dwellings have been appeared in villages.

2.4. Production and Life Style

The development of rural economy and the change of rural residents' lifestyle caused that the structure and spatial pattern of rural dwellings has changed. For example, the form of sloping roof, as one of eight kinds of strange customs in Guanzhong region has gradually disappeared. This is because of the developed times and building material. The primary building materials consist of soil and wood and each family has the specific place for drying crops in the agrarian age, but the primary building materials consist of concrete and brick, crops decrease and cash crops increase in cash crop age, which led to the emergence of flat roof that is suitable for drying crops and cash crops [15]. Meanwhile, most villagers don't produce grain by themselves, but buy grain, which means that the grain storage of dwellings can be ceased to exist for most villagers. For another example, the stable in traditional dwellings has been already disappeared with the mechanization of agricultural production.

3. THE EVOLUTION AND DEVELOPMENT OF DWELLINGS SPATIAL PATTERN IN GUANZHONG REGION—TAKING ZHIYANG VILLAGE IN HANCHENG CITY FOR EXAMPLE

3.1. The Introduction on the Research Base

Zhiyang Township is located in the southwest of Han Cheng city, Shaanxi province, it is 14 km away from downtown its area is 59 km² and its elevation is 526m. There are 24 village committees and 22,000 people in Zhiyang Township. The Zhiyang village in Zhiyang Township is regard as the research base, where the local products are apple and Chinese prickly ash. In this region, the production method and life style belongs to the agriculture society until the 1990 s, in the late 1990s, this region transformed gradually to the economic society. The industrial crop is popular and the crop is complementary.

Because of the influence of the natural environment and geographical factors, most of the earlier dwellings were civil structure, and its doors faced north or south. With the transformation of people's living concept, the improvement of the economic conditions and the construction technology, since the 1990 s, the brick structure become the mainstream in dwellings. In this structure, the clay brick is the main kind of materials for wall and the cement plaster or white ceramic tile is use to treat the wall surfaces, at the same time, the interior space pattern of building has also changed dramatically.

3.2. The Evolution and Development of Dwellings Spatial Pattern in Guanzhong Region

3.2.1. The "Bay"— The Basis of Spatial Pattern Formation of Dwellings

The "bay" is the basic unit in the traditional dwellings in China, it is also a most basic unit of timberwork in ancient China and its characteristic is that the space is surrounded by four wood pillars [16]. Because of the influence of strict hierarchy, the traditional dwellings followed the rule of bilateral symmetry. Therefore, the inner spatial pattern of the traditional dwellings consists of 3 bays or 5 bays that center the hall, as shown in Fig. (1), which is the prototype of the inner spatial pattern of the dwellings in Guanzhong region.

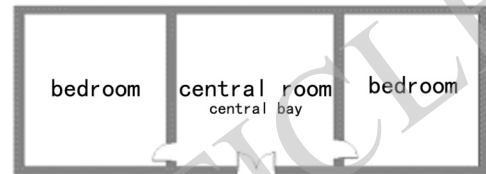


Fig. (1). Three bay pattern of dwelling.

3.2.2. The Extension of Dwelling is Based on Bay

1) Horizontal extension (1960s--The early 21st century)

With the growth of the family population, the area per capita in the original interior space gets more and more small, this makes people feel uncomfortable and inconvenient. Therefore, since the 1960 s, in order to provide housing for increased population and improve the living conditions, local villages are initiative to build house. Because of the absence of construction example that can serve as the reference for local villages, the villagers in Zhiyang village only improves the spatial pattern of original building. The improvement includes mainly the size enlargement of specific space and the expansion of depth in building plane, which is only the continuation of the traditional building (Fig. 2).

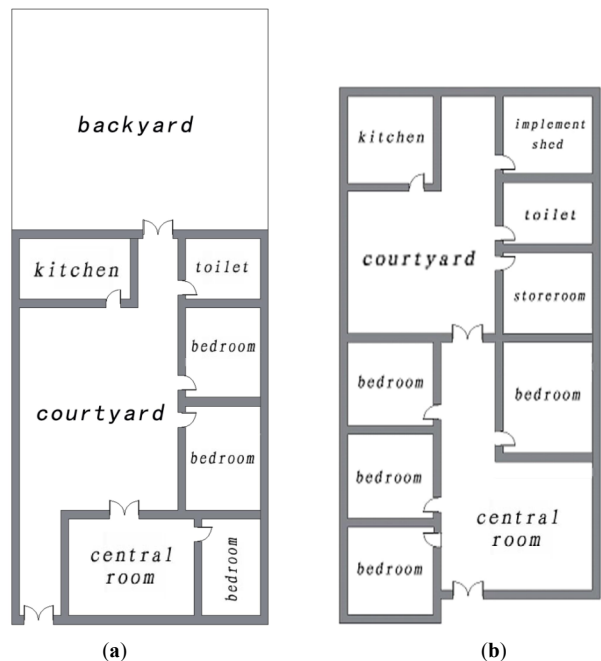


Fig. (2). The lateral extension of dwelling based on the traditional form.

Since the late 1980 s, the agricultural production transformed from crops to cash crops in this region, the people’s production and lifestyle was changed gradually and the roof style of the dwellings transformed from slope to flat. With the improvement of economic, most of the villagers have purchased the motor vehicles, so the porch of the dwellings became bigger and bigger, and the traditional grain storage also disappeared in village.

At the early 21st century , with the change of the social culture and the people’s living concept, a new pattern appeared gradually. In the new pattern, the living room and bedroom become one room. Meanwhile, the concept of the principal room and wing-room has been gradually faded. Nowadays, in Zhiyang village, the living room and bedroom of dwellings become one and the area of the bay becomes bigger and bigger (Fig. 3).

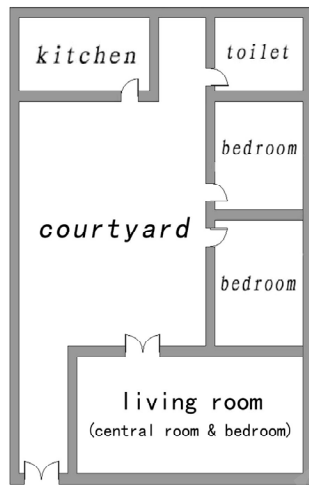
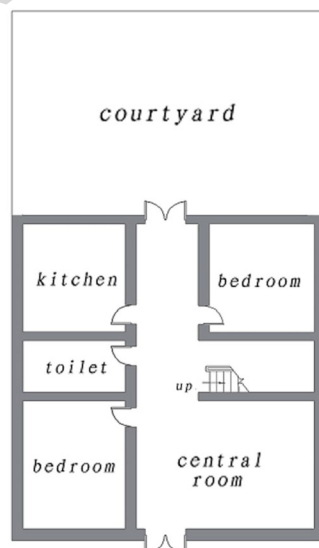


Fig. (3). Spatial pattern of the sitting room and bedroom combined into one.

2) Vertical extension (2005-2010)

In Guanzhong region, most of the traditional dwellings are one layer. Since the beginning of this century, with the



transformation of people’s living concepts, the development of the rural construction technology and the improvement of construction materials in village, more and more two storied dwellings are built. From the perspective of the plane layout, the plane layout of the 1st and the 2nd floor is basically identical. Although the area is widened, the layout of the dwellings is still on the basis of the traditional bay (Fig. 4).

Due to the vertical extension of the dwellings, the stairs become an indispensable component. Therefore, the setting up of the stairs is one of the main problems in dwellings design. In Zhiyang village, according to the dwellings pattern and whether the courtyard is covered by the roof , the stairs are divided into indoor stairs and outdoor stairs. In the early days, the stairs of the dwellings are installed in the outdoor. In order to improve the sanitary condition of courtyard later, the courtyard is covered by the roof. Therefore, the indoor stairs appeared in dwellings, even there is a special room for setting the stairs.

3) New space form (2011 – today)

In the late 1990 s, the most important Chinese prickly ash distribution center is set in Zhiyang village from August to October each year. The traditional dwellings space can not meet the requirements of Chinese prickly ash trading platform. In order to improve the market conditions of the Chinese prickly ash trade, the new space, such as the manufacturing area and transaction area, appeared gradually in new dwellings since the beginning of this century. The new space can satisfy the people’s need such as processing, dispose and classifying Chinese prickly ash etc., and the area also is one common in other time.

Meanwhile, the porch is gradually replaced by the hall. The hall is set in the middle of the dwellings. It is not only the entrances, but also the place for people’s production (Fig. 5). During this stage, in order to improve the sanitation of dwelling, the local villages use the glass and algam capping the courtyard. Therefore, the triangle glass roof and arch algam roof appeared over the courtyard.

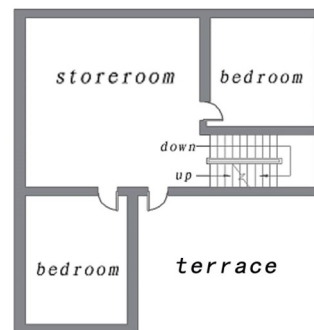


Fig. (4). The vertical extension of dwelling based on the traditional form.

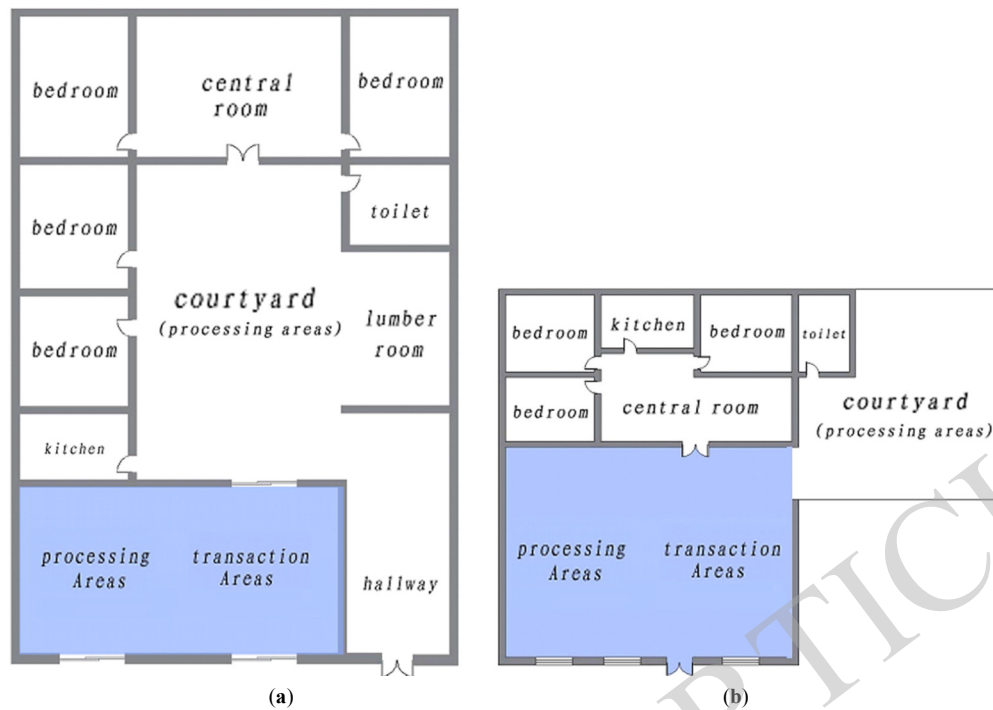


Fig. (5). The multifunctional space of new dwelling.

Table 2. The character of spatial pattern of dwellings in Guanzhong region.

Period	Spatial Features	Compound Form	Structure	Materials	Life-Style
1960-1990	courtyard (narrow and elongated)	front and back yard, the inner court in the middle of the dwelling (surrounded by the buildings or building and fence)	civil or brick-timber	soil, wood, brick, stone, tile	traditional farming life
1990-2005	courtyard (narrow and elongated)	the inner court in the middle of the dwelling (surrounded by the buildings or building and fence)	brick-timber or brick-concrete	brick, wood, concrete, tile	modern life
2005-2010	courtyard (flexible)	inner court (surrounded by the buildings or building and fence)	brick-concrete	brick, concrete	modern life
2010-now	courtyard (flexible)	inner court (surrounded by the buildings or building and fence or building and fence and courtyard roof)	brick-concrete	brick, concrete	modern life

3.3. The Evolution Characteristic of Dwellings Spatial Pattern in GuanZhong Region

Under the influence of the factors such as the natural and social environment, the production and life style of people, economy and technology, the dwellings spatial pattern have changed drastically in GuanZhong region, the process and characteristic of dwellings evolution are listed as follows [17] (Table 2).

3.4. The Problems Arising from the Spatial Pattern Evolution of Dwellings

While the dwellings spatial pattern changed in Guanzhong region, the material and structure of dwellings has also changed greatly. For example, the early structure of dwellings was civil structure, it was brick timber structure in

the 1970 s, and it has been brick concrete structure since the late 1980 s. The roof changed from slope into flat and the area and height of the room significantly increased in the late 1980 s, for example, the width of the small traditional dwellings is 9-10m in most cases, the size of each room is 3m×3m, 4m×3m and the height of the room is about 3m, but the rooms of new dwellings are more spacious, most of the room size is 4m×5m, 5m×5m, 6m×5m, and the height of the room is about 4-5m. However, the changes of dwellings had a great impact on the indoor thermal comfort, the main reason is the lack of environmental protection material use and ecological technology.

In the early days, the most of the wall materials of the dwellings with civil structures are soil, but in recent years, the most of the wall materials of the new dwellings are brick and concrete. In contrast, the heat preservation performance

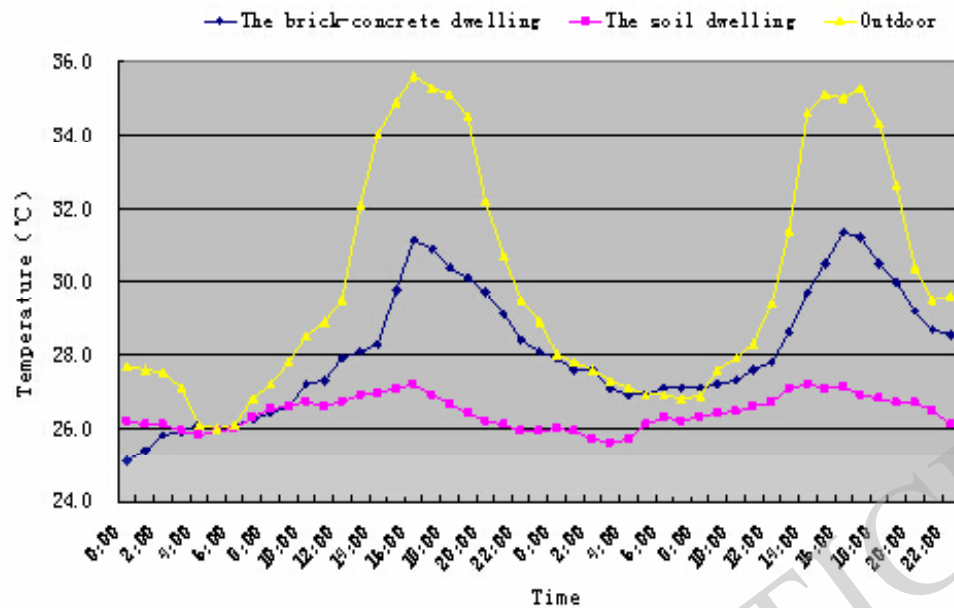


Fig. (6). The air temperature profile of brick-concrete dwelling, soil dwelling and outdoor in summer.

of brick concrete is less than soil. In addition, the flat roof, large window and larger room space caused the less temperature difference between indoor and outdoor, which also make the indoor thermal comfort become worse, especially in the winter and summer. In 2014.8.8-8.9, we did a testing on one old dwelling with civil structure and one new dwelling with brick concrete structure in Zhiyang village. The test data showed that the indoor temperature of the dwelling with civil structure is far lower than that of the dwelling with the brick concrete structure in summer (Fig. 6).

CONCLUSION

Under the influence of many factors such as natural environment, economy, culture and the way of production and life, the spatial pattern of dwelling in Guanzhong region changed gradually from satisfying initially the etiquette requirement to meeting the demand of life and production. Firstly, the social factor such as population growth directly cause the number of residential interior room increase. Secondly, the improvement in economic conditions puts something such as enlarging room space of dwelling into reality and the improvement in building materials and technology supports the change in structure. At the same time, the change of way of production and life improves further the development of spatial pattern of dwelling. The change model of spatial pattern of dwelling in Guanzhong region accords with the evolution logic of "pattern & adjustment" of vernacular architecture that is concluded by Amos Rapport, and the spatial pattern changes based on the prototype where three bays center on hall, it adjusts constantly according to people's actual demand and residential conception and the new spatial pattern finally forms.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

This research is supported by the Shaanxi Province Natural science foundation research fund (No. 2014JQ2-3016), the Shaanxi Province Department of Education Specialty Research project (No. 2013JK0962), and Xi'an University of Architecture and Technology Youth Fund project (Grant No. QN1446).

REFERENCES

- [1] G. Wu, X. Chen and X. Liu, "Protection and sustainable development of traditional folk dwellings in new rural construction", *Journal of Huaihua University*, vol. 28, pp. 26-28, 2009.
- [2] J. Li, "Investigation and survey on the thermal and humidity environment for the rural residents in Zhejiang", *Zhejiang Construction*, vol. 32, pp. 42-46, 2015.
- [3] J. Xu and X. Huo, "Study of ecological design on rural building in Qinba Mountain Regions", *Journal of Architecture and Civil Engineering*, vol. 31, pp. 132-136, 2014.
- [4] D. Zuo, "The analysis of the ecological design on traditional residence of Hui autonomous in Qinghai", *Sichuan Building Science*, vol. 41, pp. 241-244, 2015.
- [5] E. García-Lopez and C. Heard, "A study of the social acceptability of a proposal to improve the thermal comfort of a traditional dwelling", *Applied Thermal Engineering*, vol. 75, pp. 1287-1295, 2015.
- [6] J. Chen, Y. Yu and J. Liu, "the construction experiment of "square courtyard" folk house based on 160m2 country curtilage in the central Shaanxi plain DaShi Tou Villag", *Architecture & Culture*, vol. 7, pp. 46-50, 2014.
- [7] Y. Qin and Y. You, "The Analysis of the Inheritance and Evolution of Traditional Dwellings Element in Guanzhong", China, The Chinese Folk House, 2014, vol. 4, p. 134.
- [8] F. Yang, "From Dangjia-cun Village study on Residence of Guanzhong", *Fujian Architecture & Construction*, vol. 174, pp. 19-22, 2014.
- [9] X.-H. Zhang, "Analysis of form reasons of Shaanxi cultural divisions", *Human Geography*, vol. 3, pp. 17-21, 2000.
- [10] J. Xu, "Research of regional architecture's creation mode based on the characteristics of traditional residential architecture in Guanzhong District", *Xi'an: Xi'an University of Architecture and Technology*, 2013.
- [11] N. Wei, "Optimization study of external environment design in the mountainous village in China's West regions", *Xi'an: Xi'an Uni-*

- versity of Architecture & Technology(Natural Science Edition), 2011, vol. 43, pp. 432-437.
- [12] T.-F. Tang , "Natural geographical environment factors and building design", *Construction & Design for Project* , vol. 2, pp. 47-49, 2011.
- [13] Y. Peng, *Traditional Rural Settlement Landscape Analysis*, China, Beijing, Building Industry Press, 1994.
- [14] X. Wang, "The initial research of "self-help construction under overall control mode in rural-urban fringe zone", *Architecture & Culture*, vol. 1, pp. 68-70, 2011.
- [15] P. Wang, "Study on the Pattern and appropriate ecological strategies for the traditional dwelling", *Xi'an: Xi'an University of Architecture and Technology*, 2010.
- [16] G. Pan, *A History of Chinese Architecture*, China, Beijing, Building Industry Press, 2009.
- [17] Z. Yu, Research on pattern of new vernacular dwellings in Guanzhong rural region of Shaanxi province", *Xi'an: Xi'an University of Architecture and Technology*, 2009.

Received: June 10, 2015

Revised: July 29, 2015

Accepted: August 15, 2015

© Na et al.; Licensee Bentham Open.

This is an open access article licensed under the terms of the (<https://creativecommons.org/licenses/by/4.0/legalcode>), which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.

RETRACTED ARTICLE