

Typological Analysis of Vernacular Farmhouses in Zhagana: A Case Study of Dorje's House

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Abstract: This study is based on fieldwork investigation of the mountainous countryside of Zhagana, Tewo county, Gannan Tibetan autonomous region, where the number of traditional local houses is decreasing rapidly with rural development in recent years. The purpose of this paper is to define and identify the characteristics of traditional dwellings within the local vernacular context, to probe the design principle of “reproductions” from house to house. The research object is an extant traditional Tibetan farmhouse named Dorje's house, which is still in use and has not been renovated or damaged so far. By the meticulous architectural survey and typological analysis, the features of vernacular farmhouse in form, structure & space, the design approaches and tectonic wisdom pervaded in this region are interpreted. Furthermore, the relationship between this sample and its variations is deeply clarified. This case study sought to provide an architectural base map as historical reference for the cultural preservation and development.

Keywords: Zhagana, Fieldwork, Vernacular farmhouse, Typological analysis

1. Introduction

From the perspective of human geography, complexity and ambiguity of “cultural boundary” are frequently investigated through fieldwork on vernacular dwellings, dead or alive. Analogous to the archipelago, Tibetan traditional settlements with a wide range of variations are scattered in the Tibetan plateau, which include parts of Gannan, Sichuan and Qinghai in China. Significantly, the region between Tibetan Plateau and Loess Plateau is manifested as ethnic mixtures, also called “Han-Tibetan corridor”, which differentiates from the outback of Tibet[1]. Apart from both the component of identity and culture, and the geographic condition in nature, form of habitation is not static and impacted by other factors, particularly the influence of modernization. But at least, the houses which inlaid the cultural boundary of “pre-modern society” would make it feasible to probe into such a question of how the transition of cultural patterns occurs. There is no doubt that the subject could not be fully addressed only with one brief paper, however, this paper presents some details about the basic approach supported by architectural research, which is a fundamental and significant step for relevant research, as is shown in Figure 1.



Figure 1: Region of Han-Tibetan corridor

Surveying, sampling and verifying are the fundamental scientific methods of studying architecture. In the above central regions of Han-Tibetan corridor, the traditional settlements inhabited by an ethnic group (the bo) of Tibetan have triggered lots of researchers to explore during the last decade. Zhagana is one typical example, which consists of four settlement clusters, including Dongwa, Yeri, Daiba and Dari (Figure. 2). It is not because of the American botanist and explorer Joseph Rock (1884-1962) who had lived there for nearly three years, but the most widespread authentic cultural asset of a specific culture represented by architecture. Much more pictorial, “no soil inside and no wood outside” is the general feature embodied in each of the self-sufficient and idyllic two-story Tibetan vernacular farmhouses, which composed the village mutually[2] (Figure. 3). Unfortunately, they are also a rapidly vanishing species and on the verge of extinction (Figure. 4). According to the current research of Zhagana, the background of cultural continuity and integrality is shared in common, and more or less interpreted by the folk tectonic wisdom of a certain type. Wu-Cheng Du[3] focuses on the decoration application by studying Locke’s house. Wen-Ting Jia[4], Yi Liu[5] and Lan-Ruo Zhao[6] analyze the characteristic of local houses and settlement based on architectural survey and mapping. Yi-Tong Zhao[7] and Li-Sha Shi[8] concern on the spatial pattern of village. In addition, there are also some researches from the perspective of rural tourism and conservation, studied by Ya-Jie Li[9] and Yangzong Zhaxi[10], etc. But on architecture, the formal analysis of a specific sample and the internal generative mechanism in its variations are still insufficient and even blank. Thus, the characteristics and the reproducing process of vernacular farmhouses in Zhagana are two main problems demanding for solutions.



Figure 2: Distribution of the four villages in Zhagana



Figure 3: Aerial view of Dongwa village (Photographed in 2021)

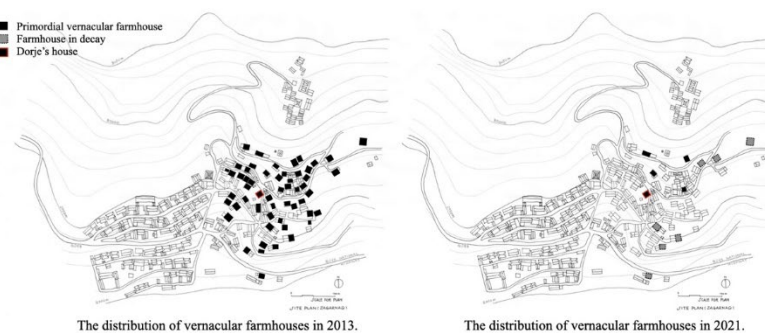


Figure 4: The changes in number of vernacular farmhouses in Dongwa village, Zhagana

Amos Rapoport (1929-) has already defined the realistic significance of vernacular dwellings in his book *House form and culture*, “these houses, being the direct expression of changing values, images, perceptions, and ways of life, as well as of certain constancies”[11]. Unlike monumental architecture, it is not easy to discover a well-preserved and authentic farmhouse as a research object in Zhagana. The realistic circumstance is that the aggravation of tourism development and the implementation of rural poverty alleviation have played a tremendous negative impact on the residents inevitably, such as lifestyles, social industry structures, environments and resources[12]. The rapid influx of commercial investment accelerates the recession of racial identity[13]. Furthermore, the massive extension and renovation of original farmhouses are guiding the appearance of village into a decorative unity on color, which totally overlooks the architectural language (Figure. 5). As the saying of “the authority of tradition cannot be guaranteed in a rapidly changing society.” by Xiao-Tong Fei (1910-2005) [14], culture is vulnerable. Fortunately, due to the fieldwork in Zhagana, the presence of Dorje’s house in Dongwa village provided a rare and precious opportunity to carry out this research. Firstly, as one of the few extant farmhouses (Figure. 6), it is still in use and has not been renovated or damaged so far. Secondly, Dorje’s house is a detached volume (Figure. 7), a self-contained complete unit leaned on the terraced hillside, which shares a typical instance representing the type of vernacular farmhouse in this region.



Figure 5: Street view of Dongwa village (Photographed in 2021)



Figure 6: Location of Dorje’s house in Dongwa village, Zhagana



Figure 7: Site plan of Dorje’s house

2. Three features of Dorje's house

Aldo Rossi (1931-1997) gave a definition about type: "I would define the concept of type as something that is permanent and complex, a logical principle that is prior to form and that constitutes it[15]." Meanwhile, the vernacular farmhouse architecture as part of Tibetan cultural identity is a distinct and extremely rich architectural tradition that shows a surprising diversity and flexible adaptation to local climatic conditions, economic necessities, the availability of building materials and the influence of local ethnic groups[16]. Besides earth-timber and stone-timber structures, Tibetan vernacular farmhouse also apply hybrid structure as their main structure[17]. Beyond the physical factors, there is always a cultural condition which should be considered as well. In this chapter, the distinctive features of Dorje's house would be interpreted by three subjects, the form, structure and space.

2.1 Possible basis of form

According to the research on vernacular architecture, Stanford Anderson (1934-2016) had defined two types of memory system, the social and the disciplinary. A distinction was drawn between the "societal memory carried in architecture" and the "operation of memory within the discipline of architecture itself"[18]. Firstly, Dorje's house has inherited the most widespread formal characteristics in Tibetan cultural region (Figure. 8), which are presented by walls with timber structures and arga earth technics. It is the definite evidence that building technology has passed from generation to generation in memory of Tibetans (Figure. 9, Figure. 10). Secondly, Dorje's house makes use of wood both in building constructions and interior decorations. Unless the vast areas of Tibetan plateau, the surrounding mountains in Zhagana rise steeply from the bottom of the valley and are covered with vegetation, such as conifers. This provides sufficient wooden material (Figure. 11). Meanwhile, mostly due to the high precipitation, each of farmhouses interspersed with cultivated fields has developed a sloped timber roof with independent structure. It is feasible to recognize that both cultural and adaptable factors in built structures influence the form, although every farmhouse is different.



Figure 8: View of Dorje's house from the north (Photographed in 2021)

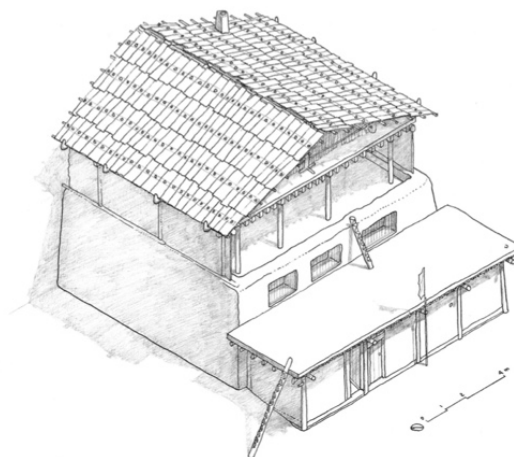


Figure 9: Isometric view from west

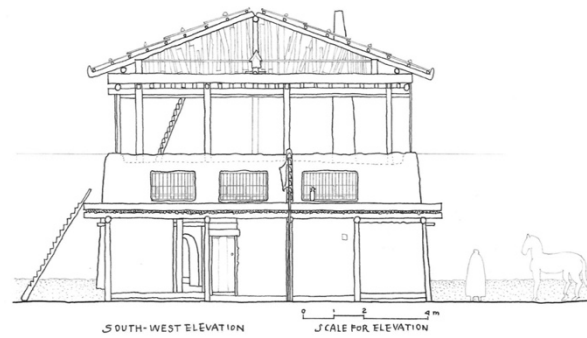


Figure 10: Front view of Dorje's house



Figure 11: Interior of main room in Dorje's house (Photographed in 2021)

2.2 Flexibility of structure

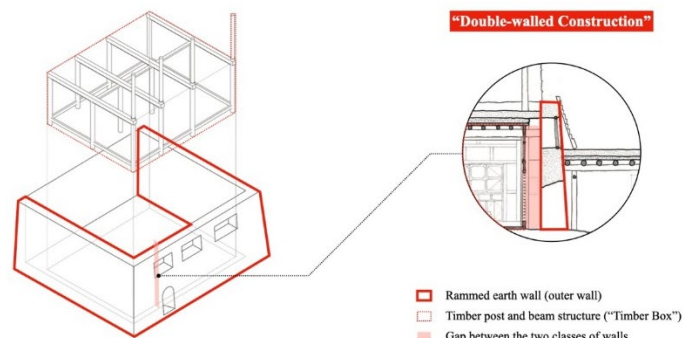


Figure 12: Diagram of double-walled construction.

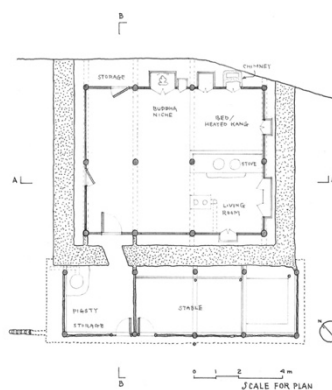


Figure 13: First floor plan of Dorje's house

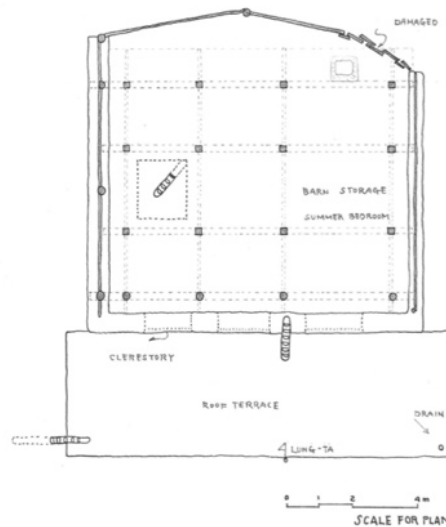


Figure 14: Second floor plan of Dorje's house

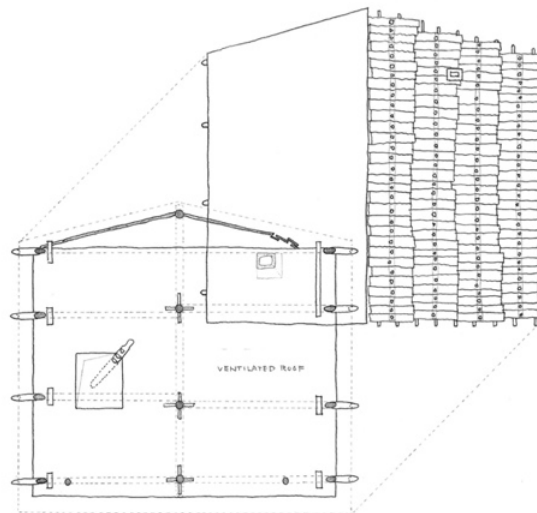


Figure 15: Roof plan of Dorje's house

Gottfried Semper (1803-1879) classified the building crafts into two fundamental procedures: the tectonics of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the stereotomics of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements. The tectonic/stereotomic distinction was reinforced in German by that language's differentiation between two classes of wall, between die Wand, indicating a screen like partition, and die Mauer, signifying massive fortification[19]. Based on the terraced flat ground and the equal altitude difference of hillside, the main body of Dorje's house leans on the mountain and is enveloped by double-walled construction (Figure. 12), which can be drawn from the two classes of walls mentioned by Gottfried Semper[20]. The exterior is built by the 4.5m high rammed earth wall with a thickness of nearly 90cm at the bottom, 50cm on the top. The interior is a timber box built up by post and beam structure. The main structures of the timber box are not attached but adjacent to the rammed earth wall with a certain distance, while only the ends of beams insert partly into the outer walls. As a residential boundary, the main body has been defined by an approximate 10.9m wide and 9.4m depth square. From the ground to the top of roof, it is almost 9.4m high with three-stage division, which are the living space (first level) (Figure. 13), open space for farm work (second level) (Figure. 14) and attic (top level) (Figure. 15). In front of the entrance, there is an additional shed for livestock, built by detached timber structure and mud walls with timber bones (also called "wattle and daub" as architectural terms). Mostly, the stable for pigs and horses can expand for requirements from multiple functions. In general, the composition of Dorje's house could be divided into two parts, the main body for human living with definite form and an annex for livestock with alterable layout.

As seen by the elaborate and rational plans of each level, there are two factors that play decisive roles in design, one is material condition, e.g., the limited length of log, while the other one is the specific function filled in the main room which integrates different aspects of daily life orderly, e.g., sleeping, dining, resting and praying. The religious beliefs of local residents must be considered in the decoration of interior, particularly, the location of Buddha established the central axis of Dorje's house, which is in the middle bay (with span of 2.55m). It is converted into a sacred "place", a niche inlaying on the plank wall, where the statues of Buddha live. Meanwhile, the entrance door is arranged diagonally to the stove-heated bed platform on both sides. Due to the three bays reduced in width successively, the sequence of timber posts has amplified the visual perception and enhanced the perspective of interior scene.

According to the two levels of Dorje's house, what can be captured obviously is the flexible system of post and beam structure. First and foremost, as far as the main body is concerned, four timber columns in the first row are the principal components of vertical structure. They are made of conifers approximately 6.5m high, and define the reference point of column-grid construction. Secondly, there is a structural transformation between the two levels that the six-square grid of the ground floor is shifted to the nine-square grid of the upper floor. In terms of ground floor, the spans of three bays between four principal columns are gradually 2.25m, 2.55m and 3.25m in turn, the spans in depth are 3.2m and 3.35m successively. Meanwhile, in terms of upper floor without fixed function, the nine-square grid is much more homogeneous. Followed the bays of ground floor, the spans of upper floor in depth is 1.95m, 2.55m and 1.95m, respectively (Figure. 16).

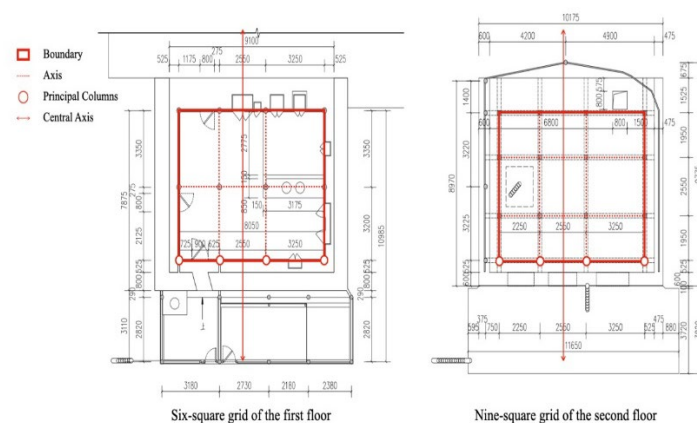


Figure 16: Transformation from six-square grid to nine-square grid

By comparison of the two levels, there is a latent regulation in the construction of Dorje's house. The linkage mechanism of Dorje's house consists of two aspects. One includes the bilateral symmetry in horizontal and vertical dimensions as privilege compositional preferences, and the other are practical intervention factors included specific functions and requirements, even the limited conditions of material. The more the intervention impacts, the further it deviates from prior ideal of symmetry. Although symmetry is the primordial manifestation of symbolic art, and the first embodiment of the human spirit in sensuous form. With its symmetry, "architecture prepared the way for the inadequate actuality of God"[21]. In the whole building process of vernacular dwellings, there is a tacit agreement that the objective factors have been considered positively through the adjustment of original ideal in order to adequate the built environment. The ambiguous regulation is not only a method to materialize the ideology of tectonic culture about symmetry, but also a manifestation of the flexibility instinct in architectural system.

2.3 Integrated space

According to the layout of functions and the quality of spatial decorations, there are three basic hierarches in Dorje's house, which are timber interior room for human living, stable enclosed mud wall for livestock, and open space for farm affairs. As Table 1 showed, the most crucial part is the space of first floor, and highlights how it generates from the interaction between form, structure and function. In a sense, cultural rationality is engaging to maintain the integrality and purpose for purification of the matrix volume in architecture. Meanwhile, it is also making a total design synthesized the hidden space and functional configuration. Mythical space, pragmatic space and abstract space as mentioned by Yi-Fu Tuan[22] have been overlapped into one space in Dorje's house.

Table 1: Description of different functions on each level

	Plan	Description
First floor	<p>FIRST FLOOR PLAN</p>	<p>1.1. Hallway provides access to the main room. Former pig stable with stove now used as storage for farm tools, or kitchen sometimes.</p> <p>1.2. Horse stable.</p> <p>1.3. Living area. There is a wash basin beside the wall.</p> <p>1.4. Open kitchen with two types of stove. One connected to the bed is used for cooking and heating, another is a metal stove with metal pipe piercing the clerestory and discharging the smoke. The area is also for dinning, kitchen devices such as pots, cups and plates are held here in the inbuilt timber cabinet.</p> <p>1.5. Food storage.</p> <p>1.6. Open storage. A large water barrel stands here, and many sundries are piled up.</p> <p>1.7. Sacred cabinet for Buddha. It is not always located in the center bay, but aligned with the axis of stove-heated bed platform.</p> <p>1.8. Heated bed with stove for sleeping.</p> <p>1.9. Storage room</p>
Second floor	<p>SECOND FLOOR PLAN</p>	<p>2.1. Roof terrace with prayer flags (Lung-ta).</p> <p>2.2. Notched log ladder to the roof.</p> <p>2.3. Multi-function space. Now it is food and grass storage, and enveloped by mud wall with wooden bones temporarily. It would be used for living and sleeping rooms after decorating by timber plank walls in the future.</p>
Roof	<p>VENTILATED ROOF</p>	<p>3.1. Notched log ladder to the second floor.</p> <p>3.2. Roof. The roof is well ventilated and was used to store food for animals, such as dried grass. It is covered by the timber shingles on the top, which are fixed only by round field stones. The timber is left untreated, every three years, the shingles are all turned. This process also serves to check every shingle, rotting or weak shingles are eliminated and replaced.</p>

As Figure. 17 shown, single room with multi-function containing sleeping, cooking, dinning, living and sacred praying; Gap space encompassed the main room is similar to a hollow structure form, an

effective utilization for serving, which has been already refined into an exquisite craft by carpenters in Zhagana. There are many inbuilt timber cabinets extruded from the back side of the timber plank wall to serve the main room. Plain batten doors, sacred niches for Buddhist statues, sideboard cabinet, wine cabinet, wardrobe and lockers, are all regulated in the dividing frame strip of every bay of wainscoting. Moreover, it is greatly convenient in daily life. Obviously, all the approaches about furniture design are aiming to release the main room, and to maximize the integrity. Besides that, no decoration such as painting or wood carving has not been applied in the entire farmhouse, except the adornments like textile chorten. The elegant simplicity seems to be a tangible ambience crystallized in Dorje's house.

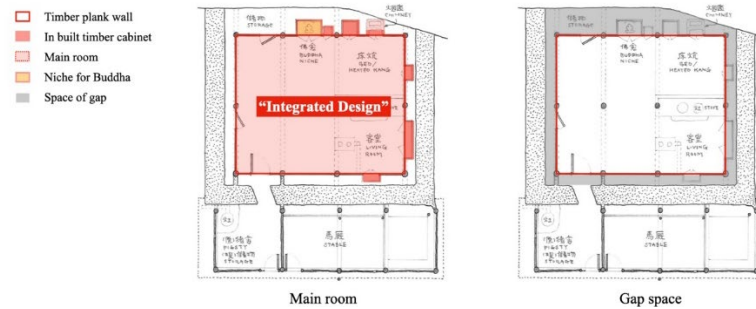


Figure 17: Diagram of main room and gap space

Gap space is not conceived only by an interior design, but the product of utilizing the nature of different materials to resist the rainy climate. In particular, the separation of rammed earth wall and timber post-and-plank wall is rooted in the consideration of firmness and durability. Firstly, the massive rammed earth wall provides a support to prevent from the impact of earthquake as much as possible, no more than the locals said, “wall falls, but no collapse of house”, to be the result[23]. Secondly, by the well-ventilated space in-between the walls, the material could be kept dry for the most part. Thirdly, the double-walled construction has possessed a better thermal insulation property and offers the maximum comfort of human habitation. Followed the routine from the exterior to the main room, the gap space cannot be observed easily. In regard to the circulation, before entering the room, the hallway used to be a pig stable reveals a premodern tradition: cohabitation with animals. In according to the convention in living, vernacular farmhouses have always been surrounded or gathered by stables, which is another kind of functional space.

In addition, there is a question how to let the natural light flood into the interior? It revealed an unexpected design for windows. By taking advantage of the height difference between the interior ceiling and the flat roof of shed, three indoor clerestories are the only daylighting of living room (Figure. 18). As the counterpart, there are three cavernous rectangular holes on the frontal part of the rammed earth wall above the shed, meanwhile, an indicator of home signal like beacon illuminates the night. In the front view, it is not quite symmetrical that the three holes with clerestories are a bit deviated from central axis, but the reason hidden in the internal structure has been mentioned above.



Figure 18: Longitudinal section of Dorje's house

3. The sample and its variations

3.1 Tectonic system and architectural components

Table 2: Classification of the tectonic system

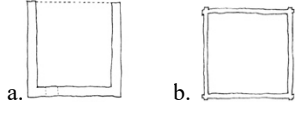
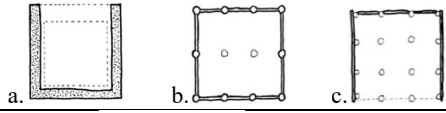
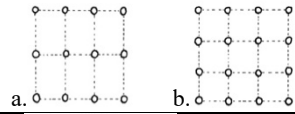
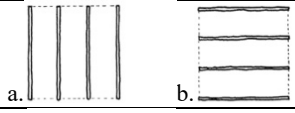
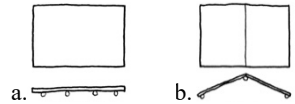
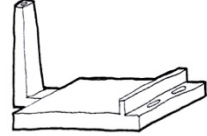
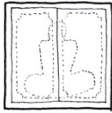
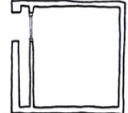
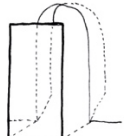


System	Diagram	Description
Groundsill		a. Rammed earth wall with stone masonry base. b. Log ring ground beam as the base of timber post and plank wall.
Wall		a. Rammed earth wall. b. Timber post and plank wall. c. Mud wall with wooden bones.
Post		a. Six-square grid. b. Nine-square grid
Beam		a. Principal beam on first floor. b. Principal beam on second floor.
Roof		a. Timber shingle sloped roof. b. Arga earth flat roof.

Table 3: Classification of the architectural component

Component	Diagram	Description
Stove-heated bed platform with chimney		System of kitchen and living integrated, stems from utilizing the fire.
Inbuilt timber cabinet		Divided into two styles, showcase with glass and concealed niche.
Clerestory		Way of daylighting on the ground floor.
Door with cave		There is an arched cave in rammed earth wall, lower than the entrance door which aligned to the cave with log ring ground beam as threshold.
Ladder		Carved by a entire log to provide access to the roof.
Stable		The addition unit with individual load-bearing structure is built by post and beam structure, mud wall with wooden bones enveloped and arga earth flat roof.

Through the interpretation and analysis mentioned above, the characteristics of Dorje's house can be further refined and summarized. Aiming at delineating the ubiquitous paradigm of vernacular dwellings in Zhagana, two categories are classified as follows, tectonic system and functional components. In Table 2, the tectonic system is disassembled into five primary structural elements, which are groundsill, wall, post, beam and roof. Simultaneously, in terms of spatial organization and vertical structure system, there are three transformations from bottom to top. The first is the wall

transformed from the double-walled construction to the single layer made of mud with wooden bones. The second is post-and-beam structure transformed from six-square grid regulation to nine-square grid order. The third is the roof form transformed from the traditional Tibetan flat roof called "arga earth roof" to the timber shingle sloped roof. Functional components (Table 3) comprise six elements, which are stove-heated bed platform with chimney, inbuilt timber cabinet, clerestory, door, ladder and stable. Due to the integration of different sections of the spatial interface, the relative stability and certain changeability of their locations are compatible.

Therefore, it can be seen that the interconnection and combination of these basic features construct the flesh-body of vernacular farmhouse, and give rise to a result of integrated design which merged architecture, interior and furniture vividly. Obviously, it implies the convention of protogenetic construction approaches created by the collective collaboration of users, craftsmen and workers. The built environment is regulated by factors such as folk beliefs, micro climate, specific geography, site of house, material conditions, even requirements of users. The composition of farmhouse has the capacity to accomplish the on-site adjustment with the diverse constraints. Furthermore, it gives rise to the flow of form, and it is also the underlying factor of diversity embodied by vernacular dwellings of the same type.

3.2 Design principle manifested in three cases

Based on the characteristic analysis of Dorje's house, there is a possible extended study on the correlation of vernacular. Locke's house in Dari village and the old house in Daiba village are two additional samples. The similarity embodied in these three houses is highlighted briefly by unfolding the plans (Figure. 19). However, it is crucial to discuss the difference, repetition and the sensitivity to the intrinsic mechanism of the variations.

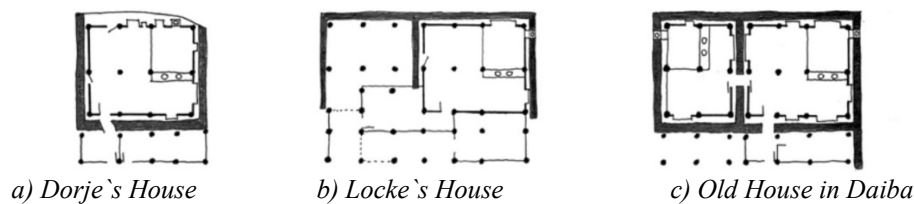


Figure 19: Plans of three houses

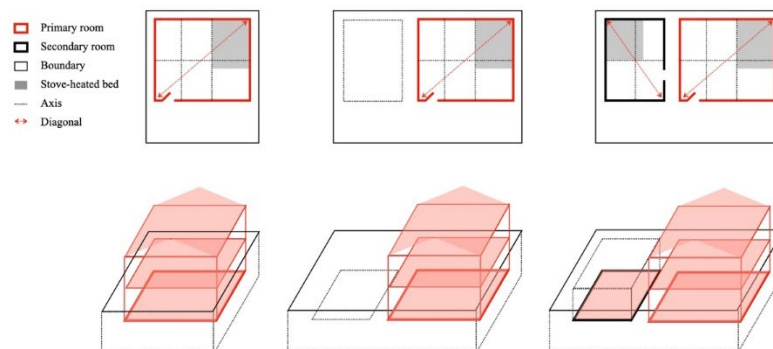


Figure 20: Diagram of spatial organization analysis

In general, the design principle is manifested through characteristic identification. Three vernacular farmhouses have the same tectonic system and architectural components as mentioned above, particularly the form of the main room. Double-walled construction, six-square grid and stove-heated bed are apparently shown the coherence, but they are not uniform. Firstly, different from the other two, there are two rooms in the old house of Daiba. On the first floor, the four-square grid attached to a six-square grid is a secondary room with one-story. In Dorje's house, it has been interpreted that the stove-heated bed platform with chimney in side bay is arranged diagonally to the entrance door. Following the specific principle of layout, the secondary room with sliding door and skylight also presents the characteristics of the primary room (Figure. 20). Secondly, comparing Locke's house with the old house in Daiba, what can be sure is that the two houses share similar plans and sizes. Although the part of the rammed earth wall has been damaged in Locke's house, the post and beam structure still imply the initial mode of "unequal double room". Thirdly, the stable is always erected in front of the main body. It is not only a requisite functional area to undertake the agrarian production, but also a cushion

space between exterior and interior. Finally, the arga earth flat roof as terrace is a public place to communicate and do farm work. The ladder carved by an entire solid log provides access to the roof, and an offering stove located on the terrace, the small chorten, is adorned with juniper twigs for praying every morning. Especially on sunny days, the terrace is fully stacked with grains harvested to dry.

4. Conclusion

General speaking, the characteristics of vernacular farmhouse in same type have overlapped with each other as a tacit relationship to reject simple replication. But through the case study of Dorje's house, this paper has analyzed, identified and summarized the specific manifestation from the view of architectural composition. Moreover, the design principle of vernacular farmhouse has been traced and speculated by comparing different cases. Based on the process of surveying, sampling and verifying in order, we can understand its generative mechanism on architecture more readily, even the formation of intrinsic motivation on settlement. The main conclusions are as follows:

(1) The uniqueness of vernacular farmhouse in Zhagana is a result impacted by double factors, including the purification of Tibetan tectonic culture and the adaptation of locality. The protogenetic farmhouses in small arcadian villages are not diverse but simple two-story detached houses surrounded terrace fields. There is no other alternative prototype such as courtyard house or twin house in its origin construction system.

(2) There are two basic versions of the farmhouses in Zhagana. The one with single main room is represented by Dorje's house, while the other one is the main room with a secondary room, as the old house in Daiba. The flexible design in tectonic system and architectural components has shown the exquisite conception and craft, and especially it provides a high quality and livable environment as a result.

(3) "Integrated design" combined architecture, interior and furniture has been applied sufficiently in the vernacular farmhouse, which is seriously overlooked by researchers. It is surprised that the great notion is a technique of modern preference. From the view of designers, the case study does not only aim to depict a typical farmhouse or define a criterion of vernacular heritage, but also to acquire the revelation about how to design in the context.

Although this paper has some limitations on how to preserve and utilize the vernacular farmhouses, even how to confront the reality of rapid development in Zhagana. But at least, the research provides a base map as reference. It could be confirmed that such an underlying convention has ever had the general potency and materialized into a mutual motif in the changing architectural morphology as well.

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