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Indigenous Modernization in New Design and Architectural Renovation of Rural Housing in The Red River Delta (North of Vietnam)

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ABSTRACT

In the minds of the Vietnamese people, the house has always been regarded more than just shelter that keeps them from the heat and rain. It also represents the beauty of the family, traditional culture, and the nurturing of the Vietnamese people's souls. Vietnam's rural house design is shaped and evolved in tandem with the country's natural conditions, including its geographic location and climate, as well as social aspects, including daily life, labor, movement, belief and culture. The architectural style of a rural house is now recognized as both tangible and intangible cultural heritage. Nonetheless, the rural architecture in region has been negatively affected by the uncontrollable development. The integration movement is reshaping rural housing architecture, with major influences from the current urbanization and industrialization. Under the so-called rapid urbanization, the construction of rural houses in Vietnam faces numerous challenges, such as changing production methods, habits and lifestyles, design, economic and technical factors. Traditional architecture is gradually being replaced by high-rise reinforced concrete houses and apartment buildings. The qualities of this countryside housing architecture that were formerly thought to be historic have been endangered. By investigating a number of case studies ranging from theoretical housing designs that have been recognized as world heritage sites to the actual modern rural housing projects that have recently been constructed, the authors can validate research hypotheses, viewpoints, and put forward principles for new rural architecture, which will enhance living quality in Vietnam's rural areas while still preserving the distinctive features in those traditional villages. It will also be necessary to assess the present rural architecture and offer guidance on modernizing it so that planners and experts are able to make appropriate policies and suggestions, as well as to propose principles for rural architecture in the future, thereby supporting the integration process of rural innovation.

1. Introduction

1.1 Traditional rural housing (RURAL HOUSING) architecture in the Red River Delta

1.1.1 Initial formation process

The Red River Delta, located in the Northeast region of Vietnam, was formed by alluvial deposits from the system of two large rivers, the Red River and the Thai Binh River. It is a fertile flat land area, where Vietnamese people live, build villages and develop communes. Historical traces dating back to the first to the tenth centuries in the Red River Delta (Nishimura, 2005).

During the years of settling down in the large plains, the Vietnamese created unique rural settlement models, including a harmonious integration between architecture and landscape. Based on the images as found on the surface of bronze drums of Dong Son culture, it is posible to see that there are two types of housing architecture in the region: stilt houses with boat-shaped curved roofs and stilt houses with circular roofs. For a long time, Vietnamese folk houses have been mainly stilt houses constructed on columns, as a type of house suitable for the natural environment of the delta.

Based on the records in the book "Vietnamese Ancient Architecture" by Vu Tam Lang published in 1991, starting from the Northern colonial period, the architecture of RURAL HOUSING in the Red River Delta had completely transformed from stilt houses to land houses. The reason for such a transformation was given by the fact that the old housing structure and form were no longer suitable when the Vietnamese people tended to move from the semi-mountainous areas to the vast plains. Since then, spatial organization has also considerably changed to adapt to new and environment-friendly production methods.

Vietnamese RURAL HOUSING architecture had a fairly stable structure and form, which did not change so much until 1945. Research outcomes on the origin and development process of Vietnamese folk housing architecture gained from the survey of 1,700 ancient houses in the Northern Delta conducted by Tran Thi Que Ha highlight the following features of the basic structure in RURAL HOUSING architecture in the Red River Delta before 1945:

- RURAL HOUSING architecture had a tropical and open-air style
- Houses were often built facing south, which would be suitable for tropical climate conditions, make use of cool air in summer and avoid cold wind in winter.
- The house usually occupied a relatively small part of the land plot, most of it was used as a garden to grow vegetables, flowers and fruit trees, and often with a fence.
- In the house, there was usually a main house and 1-2 sub-house(s) built in a perpendicular direction to the main house, forming a worker-shaped or U-shaped layout, overlooking a large and open courtyard. There was a garden and sometimes with fish ponds in front of the yard.
- Rural houses in the Red River Delta during this period, no matter the family was rich or not, were mainly one storey in height with a rectangular floor plan and divided into several spans/compartments (always in odd number), such as five compartments or three compartments and two wings. The structure was mainly made of wood or bamboo and the roof is tiled or covered with plant leaves (straw, thatch, mulch, palm leaves, etc.).
- The roof of the house was designed with a steep slope to enable rainwater drainage and minimize leaks, hereby taking advantage of the space beneath the roof to store rice, corn, sweet potatoes, etc. The roof was often extended, providing shade and preventing the rain from splashing on the wooden column and wall, then the porch could be created.
- The yard was also an indispensable component of the RURAL HOUSING complex in the Red River Delta. The yard could be used as a space for production (drying rice, sowing seeds), and as a playground for children as well as an open space to welcome guests.

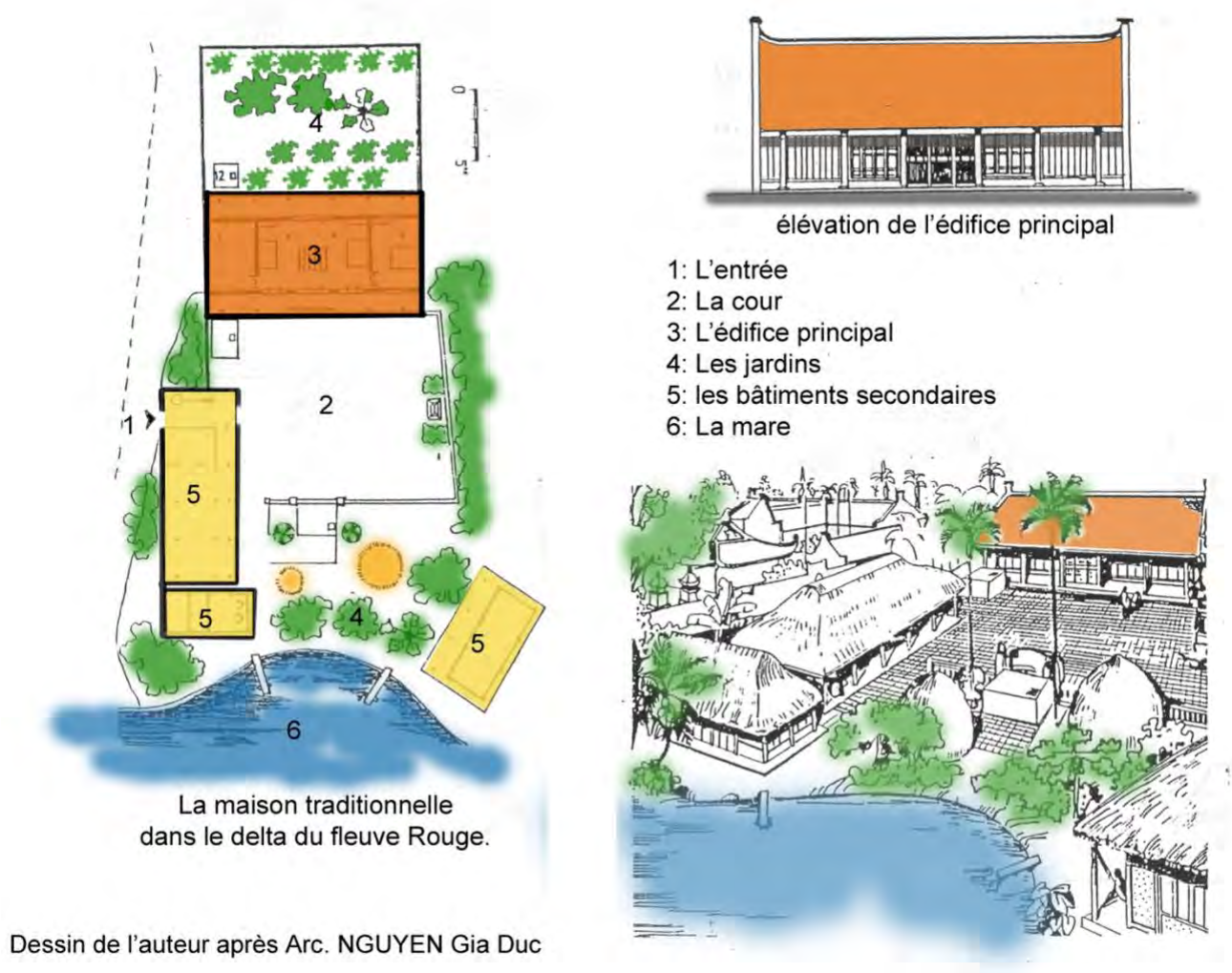


Fig. 1. The traditional house in the village of Quan Nhân (Hanoi) (Author)

1.1.2 Theories in traditional architecture and characteristics of traditional Vietnamese architecture

Traditional architecture is a type of architecture that reflects the culture, history and traditions of a country, a region or a specific community. Characteristics of traditional architecture often include the use of styles, techniques and building popular materials in that region from ancient to modern periods. Traditional architecture often represents stability, cultural diversity and the continuation of historical features. Classical Greek and Roman architecture, medieval European architecture, and the traditional architecture of ethnicity and communities around the world can be considered traditional architecture. (Joachim Langhein, 2005).

According to the research in the book "Vietnamese Traditional Folk Architecture" by Chu Quang Tru published in 2022, the characteristics of Vietnamese traditional architecture are reflected in the following basic elements:

- Modest and simple: Traditional Vietnamese folk architecture is mostly quite simple, modest, not extravagant or elaborate. This contributes to showcasing a strong national character, symbolizing the beauty of the soul, as well as the simplicity in the personal character of Vietnamese people;
- Harmony with nature: Most buildings, especially rural houses, promote harmony with and close connection to nature as a typical characteristic of residents based on the wet rice civilization;

- Beautiful colors and rich in folk characters: Vietnamese architecture, from small details to large-scale structures, are characterized with bold national identity, such as brown, brick red, etc., expressing solemnity and realisticity but still looking really nice in use;
- Mainly using local materials: Traditional Vietnamese buildings often gave priority to the use of local materials to emphasize the tradition;
- Structural features and architectural details: Roof system (sloped roof, straight roof slope), proportion (the roof usually accounts for two thirds of the height of the whole structure), column system (main columns, secondary columns, porch columns), beam system (primary beams, peripheral beams), lines (main lines, edge lines).

From the above-mentioned characteristics of traditional Vietnamese architecture, combined with the descriptions of RURAL HOUSING architecture in the Red River Delta as analyzed, it is concluded that the RURAL HOUSING concept before 1945 could be regarded as the traditional RURAL HOUSING concept of the Red River Delta.

This RURAL HOUSING concept was considered traditional housing architecture because of its existence and adaptation to the local people, climate and indigenous culture, and was associated with the characteristics of the production method of agricultural lifestyle as well as handicraft-based residential areas (Nguyen Dinh Thi, 2021).

Understanding the concept and fully identifying the traditional RURAL HOUSING architecture of the Red River Delta will be the basis for accurately evaluating the transformation process of RURAL HOUSING architecture from tradition to modernity in the current development.

1.2 The transformation process of RURAL HOUSING architecture in the Red River Delta in the development today

In the so-called modern era, climate change, urbanization and population aging are important issues that have an enormous and direct impact on architectural design. Architecture aims at environment-friendly and sustainable solutions, and a way of thinking that may not stay away from the mainstream – that is to say building and learning from principles based on the experiences of indigenous people. (Frey Pierre, 2010).

But strangely, the transformation of RURAL HOUSING architecture is shifting from indigenous elements to new trends of urbanization.

Indeed, the current rural house in the Red River Delta is very different from the original housing concept. Nowadays, there are often new types of houses designed and built to meet the requirements of modernization and urbanization. This difference can be explained for climatic and economic reasons and especially major changes in people's lifestyle. In fact, the number of typically traditional architecture of houses in villages in the Red River Delta continues to decrease. Today, farmers in the areas when building their houses are hugely influenced by house types in neighboring urban areas or mixed styles (half-rural and half-urban) (Nguyen Viet Huy, 2021).

It can be seen that from 1945 onwards, the form of betting in RURAL HOUSING in the Red River Delta changed many times, but there was always inheritance and promotion from the previous fundamentals. After 1945, traditional house trusses in the region did not change much or changed very little. Indeed, this is explained by the fact that farmers either use existing models to build houses in the traditional way or build concrete houses in the style of city houses. (Tran Que Ha, 2008).

From the original period until before 1986, the change only took place in terms of materials, but the form of RURAL HOUSING remained the same with typical elements such as the front porch and sloping roof system. Since 1986 (the renovation period), RURAL HOUSING architecture has changed in both form and construction materials. More box-shaped tube houses with flat roofs have appeared. (Nguyen Viet Huy, 2023)

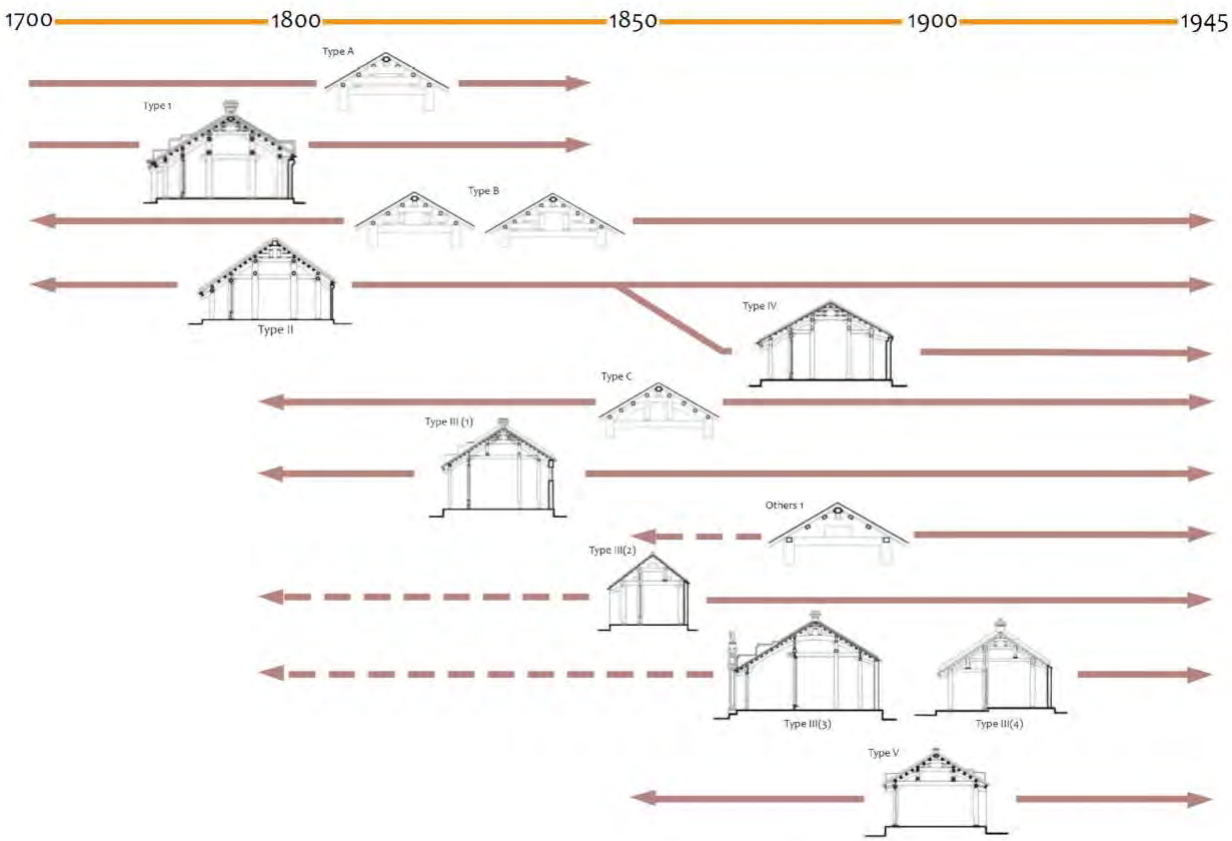


Fig. 2. The process of developing traditional house frame model trusses in the Red River Delta. (Tran Que Ha, 2008)

This change in RURAL HOUSING architecture in the Red River Delta can be explained for the following reasons:

- Transformation from regulations and management policies;
- The waves of migrants from rural to urban areas as a consequence of urbanization and modernization;
- Transformation in lifestyles and production methods;
- Transformation in technology, construction materials and changes in design concepts

(Vu Ngoc Dung, 2021)

Fig. 3. Overview of the transformation process of RURAL HOUSING architecture from the primitive period until now (Nguyen Viet Huy, 2023)

The transformation proves to be inevitable. However, the approach to RURAL HOUSING architecture in the Red River Delta in recent years has turned out to be obviously changing. Instead of starting from indigenous elements, such as traditional houses, it is today going ahead from new elements imported from modernization and globalization.

From the perspective of these two arguments, it is apparent that the development of RURAL HOUSING architecture in the Red River Delta in the course of modern architecture is encountering numerous conflicts. The RURAL HOUSING architecture does not meet the challenges of the new era.

1.3 The consequences of developing RURAL HOUSING architecture as an outsider of the development trends in the new era

Among the factors changing the panorama of rural architecture, the type of urban tube houses tends to have developed more and more rapidly in recent years. It should be clearly understood that urban tube houses in rural areas are spontaneous. It is acknowledged that the morphology of rural housing in the form of tube houses stems from the needs and trends of life and are not really unreasonable. (Ngo Doan Duc, 2012).

The development of urban tube house styles of RURAL HOUSING architecture has at first satisfied the urgent need for accommodation for the rural population as equipped with more modern facilities, hereby better meeting the demand of the inhabitants. However, developing rural housing subject to the trend of urban tube housing architecture has also caused certain problems to the landscape and environment in rural areas.

Loss of values considered to be the identity of rural architecture in the Red River Delta

Building houses in the style of urban tube houses is architecturally not suitable for the village context and has somehow spoilt the landscape architecture. RURAL HOUSING architecture in the Red River Delta is actually a simple copy of urban housing styles without any studies to go along well enough with local elements.

To verify such statements, the research team conducted a survey with 100 ancient houses in Cu Da Ancient Village selected as a quite typical example. The ancient village with authentic Vietnamese houses finely mixed with French-style villas built hundreds of years ago has become a major construction site in a so-called chaotic situation. Many ancient houses have been destroyed, and modern high-rise buildings have been constructed on a large scale in such a high density that they look just like main streets in the city.

Negative impacts on the environment

The design and construction of new rural housing without comprehensive research on local culture, society and environment have not only changed the rural landscape but may also have left direct impacts on the environment and even resulted in climate change.

Indeed, urban tube houses have damaged the structure of traditional villages and completely deteriorated them. Furthermore, due to the increase in built blocks, especially those exposed directly to sunlight these houses have absorbed much more heat and then they discharge heat into the ambience, making the village atmosphere become increasingly uncomfortable. At the same time, the demand for electricity to cool keeps on increasing (Khuat Tan Hung, 2021).

Lack of attractiveness in the eyes of young people

RURAL HOUSING architecture is largely influenced by urban architecture, reducing its appeal to a group of young people who live in big cities.

According to data in the study on "Immigration and factors that affect rural housing architecture"(Nguyen Dinh Thi, 2012) showed that only 20% of people interviewed would like to return to the countryside that have been immensely affected by urbanization, such as An Khanh village

(An Khanh urban area today) in Hoai Duc district (Hanoi). In case of Nom village (Dai Dong commune, Hung Yen province), this group accounts for 60%.

These so-called appeal factors will significantly affect the immigration and development orientation for the city in the future.

From the above analysis, it is imperative to note that the spontaneous development of RURAL HOUSING architecture in the Red River Delta has gone beyond the development trend of the present day, and caused huge problems in terms of economic, social and environmental development of the region. Therefore, the goal of the article is to find out an appropriate development orientation for RURAL HOUSING architecture in the Red River Delta so that it should meet the needs of the new era.

1.4 Is indigenous modernization a suitable development scenario for RURAL HOUSING architecture in the Red River Delta in the new era?

The architectural value of RURAL HOUSING in the Red River Delta is significantly demonstrated in its indigenous elements. In order to be in accordance with the development of the new era, when returning to indigenous elements has become a tendency as aforementioned, RURAL HOUSING architecture needs to be developed on the basis of learning more from tradition and promoting its values in the modern context.

Along with localization as a trend, modernization is also inevitable of the development process (Volker H.Schmidt, 2012). Therefore, it is necessary for RURAL HOUSING architecture to combine the application of advanced techniques and technologies, while taking into account the socio-cultural factors and typical natural features of the region.

In this regard, the hypothesis to pose here is: Is modernizing indigenous architecture a proper development orientation for RURAL HOUSING architecture in the Red River Delta in the new era?

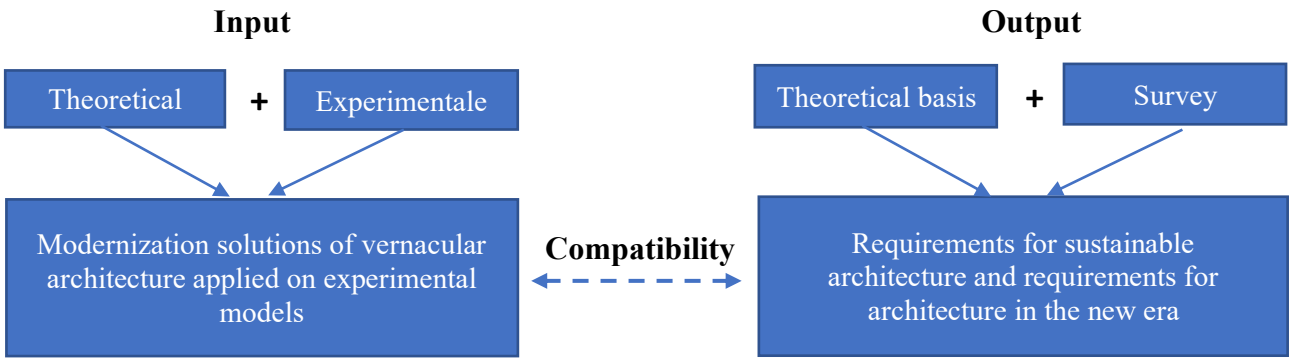
To prove this hypothesis, the authors need to answer the following questions: What is indigenous modernization? Which indigenous elements should be modernized in the architectural design of RURAL HOUSING in the Red River Delta? How does indigenous modernization correspond with the demands of the new era?

2. Methods and materials

To prove the research hypothesis, the research team started with gathering relevant documents to summarize solutions for modernizing indigenous elements in architecture.

Indigenous modernization solutions were implemented directly by the research team on two real-life projects selected as experimental samples. Methods of analysis, data synthesis and on-site survey supported with quantitative research are applied to demonstrate the suitability of solutions to modernize indigenous architecture on two experimental samples with the requirements of the new era.

The suitability is quantified by quantitative analysis and evaluated through a one-to-five Likert Scale employed in assessing the levels of how well the solutions to modernizing indigenous architecture in the Red River Delta meet the requirements of the new era.



2.1. Theories of indigenous architecture

Indigenous architecture is a concept that has been in use for a long time and an important proof of design that properly considers environmental conditions and the context of the location.

In history, it is possible to note that some features of this issue came out very early, which developed throughout the modern era of architecture and have become a mainstream today. Architect Bernard Rudofsky (1964) provided evidence of the diversity and abundance of local architecture built by people in his exhibition entitled "Architecture without architects"; Architect Frey Pierre (2010) emphasized the value of indigenous elements in architecture, or architect Rubenilson Brazão Teixeira (2017) pointed out two main attributes related to indigenous architecture: tradition and cultural context. He claimed that indigenous architecture is traditional and originates from specific ethnic groups and it is the result of a long process over time, always based on the continuation of the past experiences. In addition, indigenous architecture also respects local conditions, harmonizing with the geographical context of the surrounding environment, including climate, vegetation and topography. Therefore, it can be understood that indigenous architecture is built by people, subject to the local environment in a specific context. The design of indigenous architecture depends on various factors, such as availability of resources, cultural elements, construction techniques and the living environment of a specific area at a particular time. Indigenous architecture is a kind of “testament” to human ingenuity in building their homes by means of different methods and techniques to adapt to the environment as best as possible.

Architecture regarded as indigenous adaptation needs to take into account three factors: (Vu Thi Huong Lan, 2024)

- Adaptation to natural conditions (Environment): including weather, climate, topography, geology, ecosystem and environment;
- Adaptation to socio-cultural conditions: including cultural factors, points of view, needs, religions, beliefs, ethnic groups and social institutions.
- Adaptation to local economics and techniques: including construction materials and construction technology.

2.2. Theory of modern architecture and the modernity of architecture

In the history of architecture, according to Michel Ragon's argument, the modern era of architecture began with metal constructions, typically the "Crystal Palace" which was built on the occasion of the first international exhibition held in the UK in 1980.

This building could be considered a landmark for a new period of architecture with new construction materials of iron, steel and glass, and a new construction method of large-scale mechanical erection. This project allowed the creation of a large space (covering an area of 7.5 hectares) with daylight, proving to be suitable for exhibition. At the same time, it ensured a record construction speed in view of industrial production.

Thus, the modern period of architecture is the result of a new stage of development in science and technology, especially in the production of new construction materials (iron and steel, concrete, glass, plastic, etc.) in line with new industrialized construction methods, offering buildings with completely different functions and aesthetics from previous buildings with conventional construction materials, such as bricks, stone, wood, and so on. Therefore, the modernity of architecture is reflected first and foremost in the technical characteristics of the building and also in its functionality which should fulfill the requirements of modern lifestyle.

2.3. Theory of housing

Lewis Henny Morgan was the founder of housing studies and theories, followed by Amos Rapoport (1969), Architecture: Housing architecture is divided into three main categories, namely type, form and technique.

Table 1.
Elements of residential architecture

Type	**Elements**
Type	Function
Form	Scale
	Architectural form
	Architectural details
	Organization of space
Technique	Structure
	Building materials
	Construction methods

2.4. Theory of sustainable development

Sustainable urbanism includes elements of sustainable development that enable cities to maintain their long-term development, meeting current needs without jeopardizing future needs. Sustainable cities must also be energy-efficient and economical. In fact, the following three factors - economy, society and environment (biotic and abiotic) - need to be used flexibly and harmoniouly to determine sustainable development. Depending on each historical period and geographical context, the level of use of these three elements may vary.

Sustainable architecture is the optimal level of the sustainable design philosophy, as demonstrated throughout the design methodology, design solutions and decisions to be made in the construction, operation and use, as well as the reuse when the building has reached its full life cycle. In order to ensure sustainability, architecture has to fulfill the criteria of location, use of energy resources, quality of the built environment, identity in architecture and social sustainability. These factors can be intepreted as indigenous adaptation and indigenous adaptive architecture should be sustainable architecture. From this perspective, it apparent that sustainable development is a must for development in the new era.

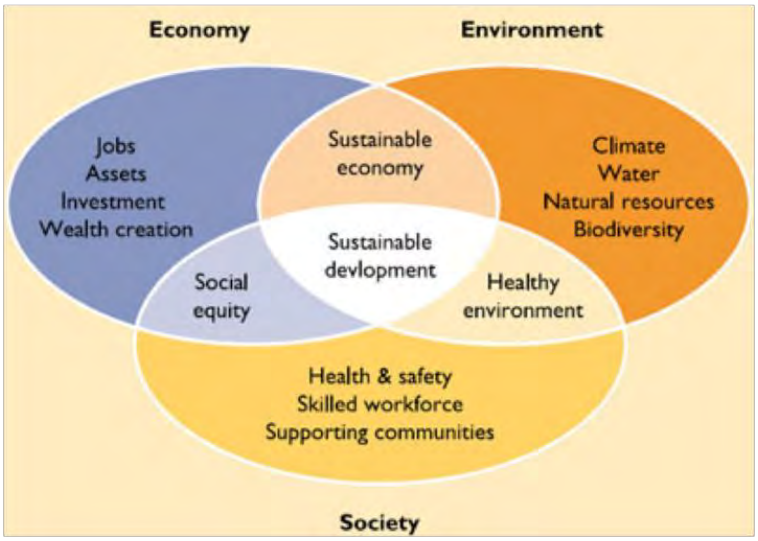


Figure 4. Elements of sustainable development in the 21st century include three main elements: Economy, Society and Environment. (Campeol, Carollo, Masotto, 2017)

2.5. Theory of adaptive architecture in the new era

An architectural solution considered to be suitable (or compatible) with modern architecture in terms of application today must meet the following requirements and characteristics (Hunjak & Strahonja, 2014):

(1). Can shape local identity values when applied;
(2). Using materials as a solution can be made possible to current conditions, especially the availability of local materials and handmade materials;
(3). Construction is a convenient solution that does not require too much manual labor;
(4). The compatibility of the solution with the cultural, social and environmental conditions of the construction site;
(5). Flexibility in customizing the solution to different contexts and projects (but the key solution can be kept);
(6). Fulfillment of manual technology;
(7). Fulfillment of modern technology;
(8). The solution improves indoor environment and living quality, including micro-climate and quality of living and working;
(9). The solution ensures uniqueness, efficiency and positive aesthetic effects in contemporary architecture, both spatially and visually considered.

From there, it can be seen that all the criteria mentioned by Hujak and Strahonja must meet the three elements proposed by the theory of sustainable development: Economy, Society and Environment. The requirements for sustainable development are affirmed as a trend and an inevitable requirement in the new era.

2.6. Research samples

Starting with the studies and theories of modernizing indigenous architecture, the research team propose a number of perspectives and principles as well as key solutions for modernizing indigenous RURAL HOUSING architecture in Red River Delta. To strengthen the proof for the research hypothesis, these solutions have been recently applied to two projects, designed and built by the research team.

These two projects are considered two typical experiments because they represent two main categories in architecture and construction: new construction and renovation.

New construction: The so-called large-roof house is a typical project for indigenous modernization philosophy in RURAL HOUSING architecture in the Red River Delta. The project is located in a rural area with a low population density and slow urbanization rate, which is an opportunity for the authors to put architectural design philosophy into practice with this large roof project.

With analyses in every detail of the land plot and understanding well the local culture and characteristics as well as discussing the demands with clients, the design team has strived to develop a design concept with creative solutions, combining modernity and tradition, and highlighting Vietnamese identity in a contemporary context.

1. main gate	4. gardens	7. **Large roof house (new construction)**
2. front yard	5. livestock area	8. side gate
3. current house	6. pond	9. agriculture

Figure 5. The large roof house project (Atelier dubosc et Associes, 2022)

Renovation: Completely different from the context of building the large-roof houses, the reunion house project is located in a rural village, not so far from the center of Hanoi, where the urbanization has been going on quickly.

The architecture and landscape, as well as the lifestyle and rituals of the people throughout the town have been changed so much due to the urbanization. High construction density means that there is not much space left for green areas, which is a real challenge for the design team. The second problem to deal with is how to connect the new building with the existing houses that has been in use for almost 100 years without a big gap in terms of age.

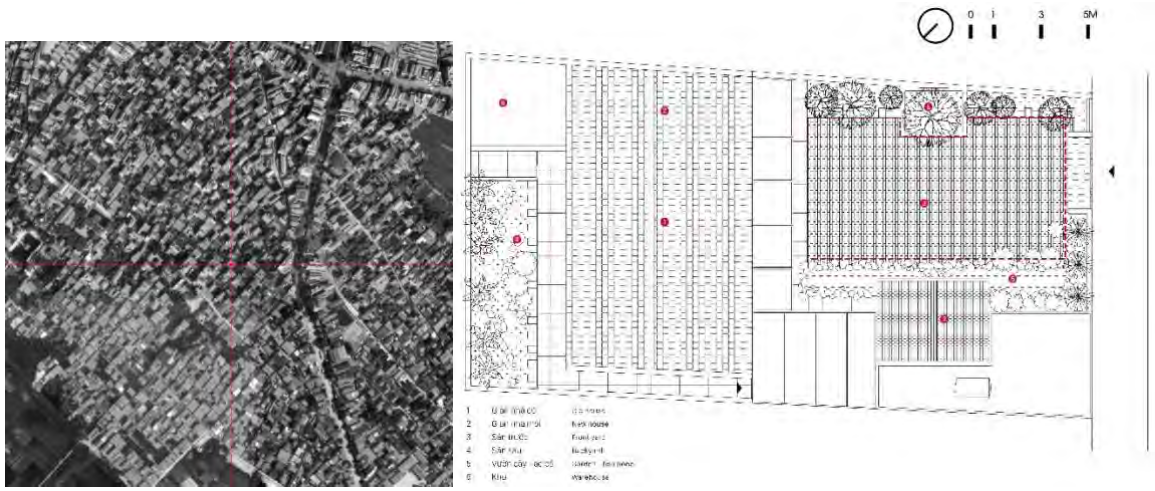


Figure 6. Doan Vien House is a project combining new construction and renovation, in areas with high construction density (Atelier dubosc et Associes, 2022)

The architectural elements to be evaluated on the two experimental samples are determined based on the theory of residential architecture including 3 main elements. Theories of indigenous architecture and modernization in architecture are used to define and specifically interpret each solution.

- Type: Including purpose of use. The type of building needs to be appropriate to contribute to the so-called "unique spirit" of the location.
- Form: Including all elements of an architectural form, architectural details, floor plans and master plan, and colors, which together create a typically indigenous architecture.
- Technique: Including structural elements, construction materials and construction methods. These are the factors that help revitalize indigenous techniques.

Table 2.
Architectural solutions in view of modernization theory and indigenous architecture theory applied to two experimental samples

CATEGORY	ELEMENTS	ARCHITECTURAL SOLUTIONS
TYPE	Function	The architecture is diverse and flexible in use
FORM	Scale	The scale of the project is consistent with the surrounding context
		In renovation, it is necessary to keep the old architecture intact and avoid a big difference in building volume
	Architectural form	The large roof system casts shadow and microclimate for the building
		The two-layer roof system provides voids for ventilation and heat release
	Color	Simple colors, using light tones to minimize solar radiation absorption
	Floor plans and master plan	Design of semi-open spaces (eaves, yard)
		Design of a mix of public and private spaces. Priority is given to common spaces for extended families, in the center of the house
		Determine the importance of courtyard spaces and skylights
		Master plan is designed with priority given to greenery, water surface and yard in front of the building

TECHNIQUE	Structure	Simple structure, applying modern construction techniques to ensure the sustainability of the building
	Building materials	Flexible in using materials
		Applying new materials with proof of sustainability
	Architectural details	Minimize excessive decorative details.

Respondents

To evaluate the level of response of solutions to modernizing indigenous architecture in the design of rural housing in the Red River Delta with the requirements of the new era, a survey was targeted at 100 respondents consisting of architects, project managers, building occupants and local people about the level of response.

Survey results of 100 respondants are summerized as follows:

- architects (40%);
- project managers (30%);
- building occupants (20%);
- local people (10%).

Before analyzing the research survey results, the questionnaire using Cronbach's alpha reliability coefficient should be evaluated. The questionnaire shows reliability if the Cronbach's alpha reliability coefficient is equal to or greater than 0.6. Analytical results of evaluating the reliability coefficient for the group of questions on assessing the level of response of modernizing indigenous architectural solutions in the design of RURAL HOUSING in the Red River Delta to sustainable development requirements in the new era amounted to 0.81. The result proves that the questionnaire is reliable.

3. Result

3.1. The rating system of the level of response in design solutions to modernizing indigenous architecture in the new era

An architectural solution considered suitable (compatible) with modern architectural applications today must meet the requirements and show characteristics that are compatible with sustainable development factors aforementioned.

The characteristics of an architectural solution can be relatively quantified by means of the following variables:

(CT1). Ability to shape local identity
(CT2). Availability of materials
(CT3). Complexity of the solution
(CT4). Cultural and social compatibility
(CT5). Level of customization (but the characters remain unchanged)
(CT6). Response of local technology
(CT7). Efficiency of the solution in improving microclimate and the quality of life
(CT8). Aesthetic effect of architectural form, the built environment and uniqueness.

The criteria (CT1 - CT8) will be scored on a scale from 0-100, divided into 5 grades of the Likert Scale to evaluate the level of response.

Table 3.
Scoring scale to evaluate the level of response of solutions to modernize indigenous architecture of RURAL HOUSING in the Red River Delta to the criteria of sustainable development in the new era.

Score	Evaluate
0-20	No response
20-40	Low response
40-60	Average response
60-80	Good response
80-100	Fully response

Formula

CT_{1-8} = D.KTS x 0,4 + D.QL x 0.3 + D.SD x 0.2 + D.ND x 0.1

In which:

- D.KTS: Average score given by the architect
- D.QL: Average score given by the project manager
- D.SD: Average score given by the building occupants
- D.ND: Average score given by local people

To help designers make accurate and well-founded choices, this study proposes a measurement called "Appropriateness" of a modernized indigenous architectural design solution and based on the criteria of sustainable development theory. Therefore, this study employs a set of compatibility index (Compatibility evaluation - compatibility index) including three crucial indicators as follows:

Indicators	Economic compatibility index: **CSKT**	Social compatibility index: **CSXH**	Environmental architecture compatibility index: **CSMT**
Criteria	(CT2). Availability of materials (CT3). Complexity of the solution (CT6). Response of local technology (CT7). Efficiency of the solution in improving microclimate and the quality of life (CT8). Aesthetic effect of architectural form, the built environment and uniqueness.	(CT1). Ability to shape local identity (CT4). Cultural and social compatibility (CT6). Response of local technology (CT8). Aesthetic effect of architectural form, the built environment and uniqueness.	(CT1). Ability to shape local identity (CT2). Availability of materials (CT3). Complexity of the solution (CT4). Cultural and social compatibility (CT5). Level of customization (but the characters remain unchanged) (CT6). Response of local technology (CT7). Efficiency of the solution in improving microclimate and the quality of life (CT8). Aesthetic effect of architectural form, the built environment and uniqueness.

1. Economic compatibility index: CSKT

CSKT = a*CT2 + b*CT3 + c*CT6 + d*CT7 + e*CT8

2. Social compatibility index: CSXH

CSXH=f*CT1 + g*CT4 + h*CT6 + i*CT8

3. Environmental architecture compatibility index: CSMT

CSMT=j*CT1 + k*CT2 + l*CT3 + m*CT4 + n*CT5 + p*CT6 + q*CT7 + r*CT8

In which, (CT1), (CT2), ..., (CT8) are variables as mentioned above. The parameters a, b, c, ..., p, q, r for variables are positive real numbers. The above parameters comply with the rules:

$$\begin{pmatrix} a+b+c+d+e=1 \\ f+g+h+i=1 \\ j+k+l+m+n+p+q+r=1 \end{pmatrix}$$

In each set of parameters, the value of each parameter is determined as presented, in addition to knowledge gained from experience and properties of the variables associated with that parameter. Therefore, after reviewing and considering the research results of Niemi et al. (2008), the authors propose the following set of parameters to be used in this study. The set of reference numbers is calculated according to the importance rating ratio according to a survey of 50 architects and architectural managers.

1. Economic compatibility index: CSKT

CSKT = 0.3*CT2 + 0.2*CT3 + 0.3*CT6 + 0.1*CT7 + 0.1*CT8

2. Social compatibility index: CSXH

CSXH=0.2*CT1 + 0.45*CT4 + 0.1*CT6 + 0.25*CT8

3. Environmental compatibility index: CSMT

CSMT=0.15*CT1+0.1*CT2+0.05*CT3+0.1*CT4+0.05*CT5+0.05*CT6+0.2*CT7+0.3*CT8

Illustrative example of measurement method

Elements	Solution	illustration	Parameter value according to survey							
Shape	Large roof system casts shadows and microclimates for the building		CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8
			70	60	50	70	60	70	80	70

Thus, the solution of the large roof system with shadows and microclimate for the project has obtained certain points that demonstrate the response to each criterion of sustainable development in the new era as follows:

- Economic: CSKT

CSKT= 0.3*60 + 0.2*50 + 0.3*70 + 0.1*80 + 0.1*80 = 64.0

- Society: CSXH

CSXH = 0.2*70 + 0.45*70 + 0.1*70 + 0.25*70 = 65.5

- Environment: CSMT

CSMT=0.15*70 + 0.1*60 + 0.05*50 + 0.1*70 + 0.05*60 + 0.05*70 + 0.2*80 + 0.3*70 = 69.5

Table 4.
Statistical table of the ability to meet the solutions to modernize indigenous architecture implemented in two projects with the criteria of sustainable development in the new era

Elements	Architectural solutions	CSKT	CSXH	CSMT
Function	The architecture is diverse and flexible in use	58.0	70.5	62.5
Scale	The scale of the project is consistent with the surrounding context	63.0	69.0	64.0
	In renovation, it is necessary to keep the old architecture intact and avoid a big difference in building volume	63.0	72.5	65.0
Architectural form	The large roof system casts shadow and microclimate for the building	64.0	65.5	69,5
	The two-layer roof system provides voids for ventilation and heat release	52.0	67.0	70.5
Color	Simple colors, using light tones to minimize solar radiation absorption	71.0	63.0	66.0
Floor plans and master plan	Design of semi-open spaces (eaves, yard)	70.0	74.5	77.5
	Design of a mix of public and private spaces. Priority is given to common spaces for extended families, in the center of the house	61.0	72.0	68.0
	Determine the importance of courtyard spaces and skylights	69.0	65.5	72.5
	Master plan is designed with priority given to greenery, water surface and yard in front of the building	63.0	74.5	73.5
Structure	Simple structure, applying modern construction techniques to ensure the sustainability of the building	81.0	69.5	64.5
Building materials	Flexible in using materials	80.0	78.0	70.5
	Applying new materials with proof of sustainability	56.0	70.5	62.5
Architectural details	Minimize excessive decorative details.	65.0	58.5	54.0

All solutions applied help both projects achieve a score of 50 points or above, denoting that the solution to modernizing indigenous architecture meets the requirements of sustainable development in the new era, either to a certain extent or at a high level.

3.2. Solutions to modernizing indigenous architecture in terms of architectural form fully meet environmental factors for the sustainable development requirements of the new era

From the scorecard, it is apparent that such solutions as designing a large roof system, building a double roof system or designing semi-open spaces meet quite well the requirements of environmental factors for sustainable development in the new era.

This can also be explained with the elements of architectural form as well as spatial design concepts that have been investigated and summarized throughout the entire history of the Vietnamese people to adapt themselves to the local environment and climate.

These conclusions are clearly demonstrated in practice using large-roof buildings designed and built by the research team. Large-roof systems, verandas and the so-called “half-indoor-half-outdoor” spaces have been optimally applied in the large-roof housing project. On-site surveys show that the large-roof system considerably reduces the effects of solar radiation on the building's facade system. In winter, the large-roof system prevents the cold wind from directly blowing through the openings on the façades, for instance windows and doors.

Actual surveys show that the large roof system clearly reduces the effects of solar radiation on the building's facade system. Through measurements, the temperature at the wall surface under the roof layer is always 2-3 degrees Celsius lower than the uncovered walls on summer days. At the same time, many concrete roof degrees and room temperatures are also 2-3 degrees Celsius lower than spaces that are only covered by a layer of concrete roof even though a layer of insulation is equipped. In winter, the large roof system limits the cold wind from directly affecting open surfaces on the facade such as windows and doors.

Modern technology elements such as solar power systems and water recycling systems have also been applied by the research team when designing and constructing the project to bring sustainability to the project in the long term future. A survey of homeowners' energy needs shows that with modern technology applied, project operating costs are reduced by 30% compared to normal.

Figure 7. Large roof system creates shadow and buffer space (Atelier dubosc et Associes, 2022)

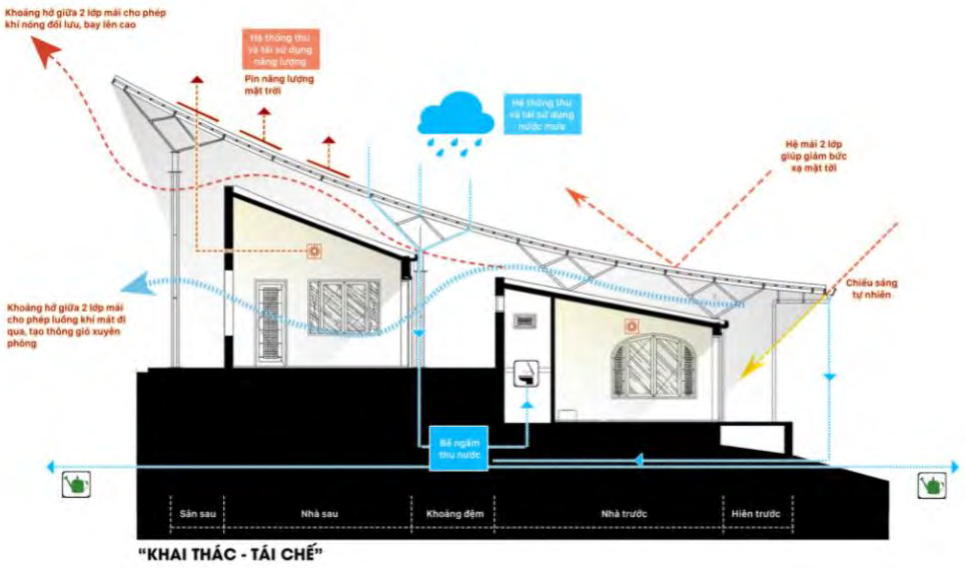


Figure 8. The cross section shows the ventilation effect of the two-layer roof system in the building. (Atelier dubosc et Associes, 2022)

Based on data from a survey of 20 building occupants, we gave results on the level of convenience used in the building with three basic elements: hearing, visual, and tactile convenience.

Table 5.
Assessment of comfort level among 20 building occupants

Evaluation factors	**Assessment scale** (0-20: No comfort 20-40: Poor comfort 40-60: Average comfort 60-80: Good comfort 80-100: Very high comfort)
Tactile comfort (comfort in terms of temperature, natural humidity and natural ventilation in the rooms)	78.0
Hearing comfort (comfort in terms of soundinsulation and noise protection)	75.0
Visual comfort (Ability to connect with surrounding yard in terms of landscape,)	81.0

3.3. Solutions to modernizing indigenous architecture in terms of architectural design mostly respond to social factors for sustainable development requirements in the new era

From the results shown in the scorecard, it is essential to find out the following facts: the scale of the project needs to respect the landscape in general, in terms of spatial planning and design, semi-open spaces should meet most of the social needs in sustainable development. This can also be explained on the basis of theory because the design concepts in RURAL HOUSING houses in the Red River Delta are closely related to the customs, daily activities, habits and lifestyles of local people. Although the current urbanization influences the habits in everyday life of rural people in the Red River Delta to a certain degree, indigenous elements of culture and customs still show significant values with regard to architectural solutions towards sustainability as far as criteria are concerned.

These conclusions are also clearly demonstrated in the on-site survey of daily behavior of building occupants in two projects carried out by the research team.

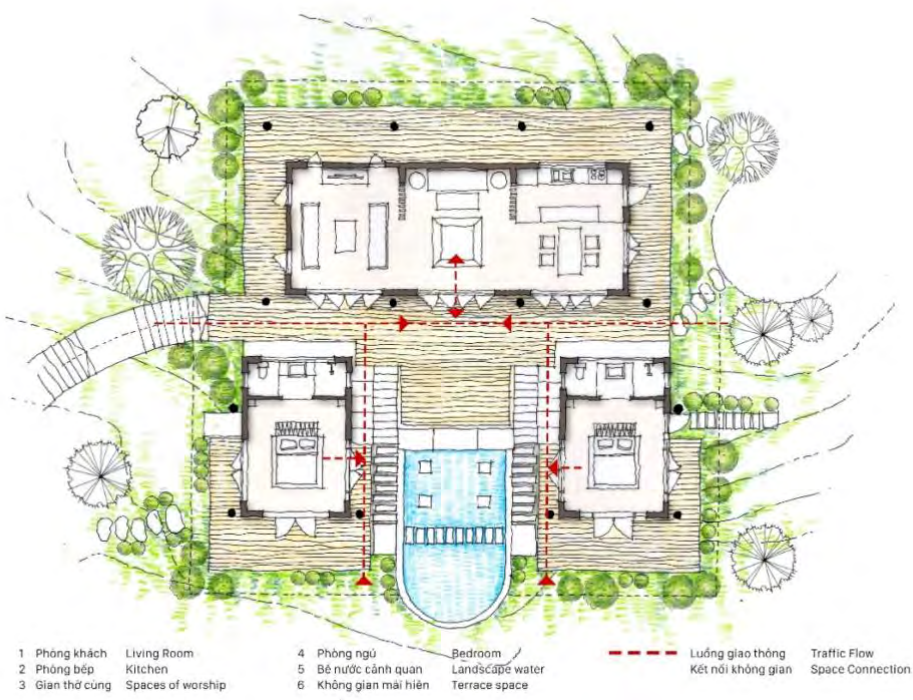


Figure 9. Large roof building ground plan (Atelier dubosc et Associes, 2022)

Through surveying the frequency of use, the spaces under the existing roof, also known as semi-open spaces, were used with the highest frequency by family members with a frequency of use of over 50% of the time in the day.

Table 6.
Survey of the time of use for spaces in the building was conducted on 20 people directly using the building.

Space	Rate of time in use (within 24h) (%)
Living room	3.25
Kitchen	6.25
Bedroom and bathroom	27.1
Common space (porch, outdoor dining room)	51.4
Garden, landscape	12

Figure 10. Illustration of semi-open space in a large roof building (Atelier dubosc et Associes, 2022)

3.3. Solutions to modernizing indigenous architecture in terms of materials and construction technology in consideration of economic requirements for sustainable development in the new era.

From the results shown in the scorecard, it is vital to find out that solutions for materials and construction technology are supposed to meet well the economic criteria of sustainable development in the future. Indeed, theories of vernacular architecture address the economical view of using local materials, combined with vernacular construction technologies. Today, thanks to the progress of technology it is possible to combine and integrate elements of modern construction technology with traditional technologies to ensure both economic and environmental factors in achieving sustainable development for the future.

Practical evidence can also be found in two projects carried out by the research team. Materials and architectural forms are suitable for the new era, while honoring traditional values. The space and form are modern but recall the "traditional" lines, using materials and structures that are completely opposite to the old block: Steel structure - brick structure, Glass - wood. Actual surveys show that the use of new modern materials, glass and iron, allows the total cost (building construction, operating costs and maintenance costs throughout the building's life cycle) to be 30% lower compared to conventional concrete and brick materials.

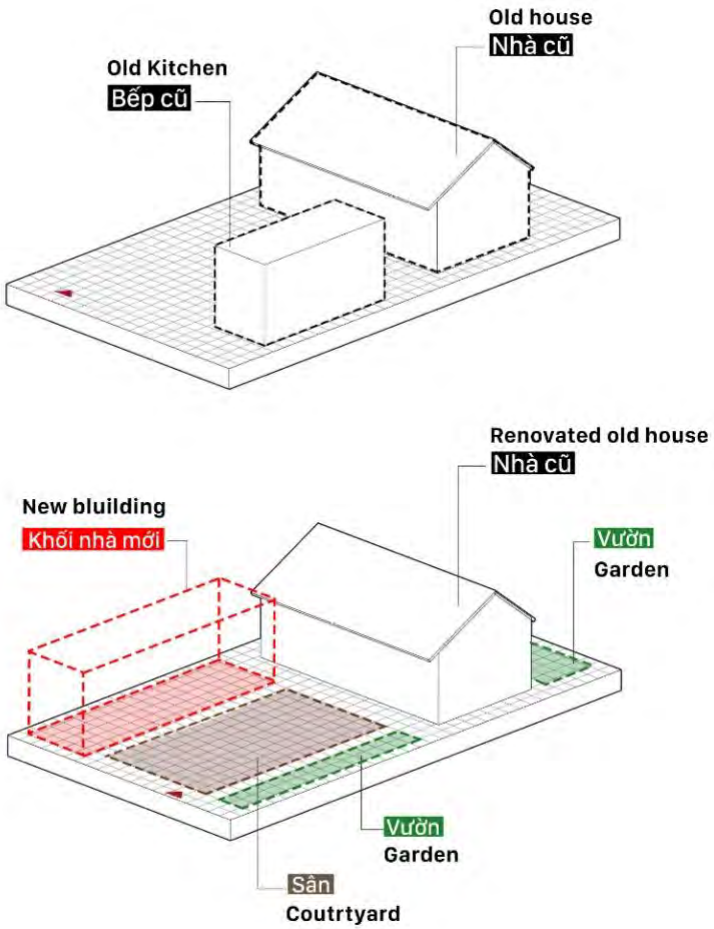


Figure 11. Construction layout ideas in the master plan of Doan Vien house

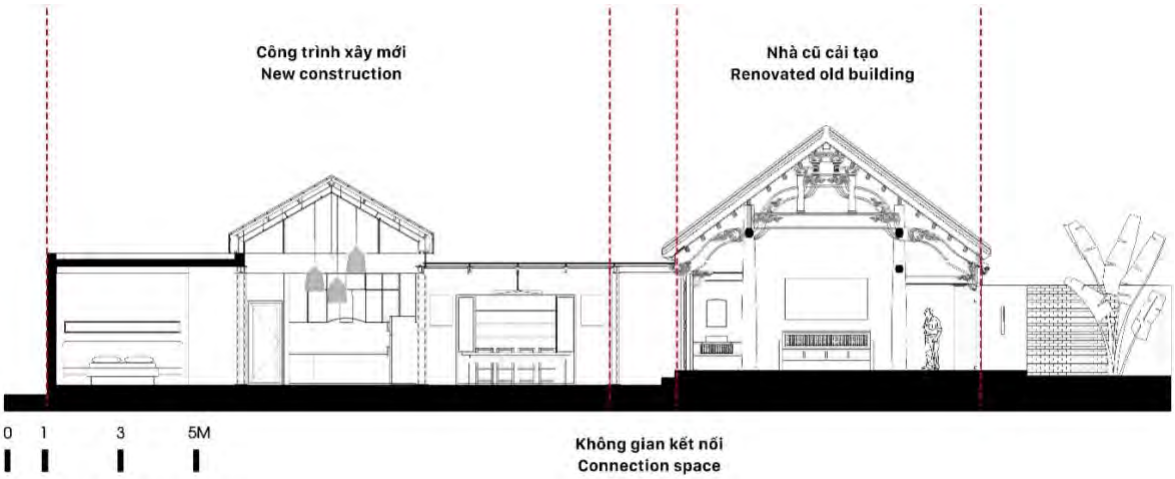


Figure 12. The cross section shows the connection in space, materials and architectural details between the two new constructions and the renovated ancient construction.

4. Conclusion

In the context of vigorous urbanization, the rapid transformations in form, scale, function, structure, materials etc. of rural housing has resulted in a major change in the landscape of traditional villages. This change is not strictly controlled today and go without an appropriate orientation policy,

consequently causing rural housing architecture to develop out of all expectations.
The hypotheses to be posed here include changes in building function, modernity of the building, and continuation as well as promotion of traditional architectural features, such as large-roof systems and semi-open spaces with eaves and terraces combined with the use of locally available materials. These solutions can also be developed into basic principles of modernizing vernacular architecture. Regarding climate change and sustainable design, it is necessary to keep the terrain intact, as much as possible, and not to choose levelling because it often requires a large amount of backfilling or excavation. In addition, it is advised to apply new technologies to help save energy by using clean energy, circulating water and taking other environment-friendly measures.
The study uses a scoring method for architectural solutions applied on two experimental samples to verify the adaptation of the solutions to the requirements of sustainable development in the new era. This evaluation method can be used to evaluate other architectural solutions that have been implemented on other experimental samples around the world, to demonstrate the adaptation in the new era.
However, the evaluation criteria always change with the development of the times. Therefore, the method is considered the basic foundation, the criteria need to be further researched and developed in the future to be able to evaluate in the most accurate and appropriate way.

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