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The Study of Ecological Site Plan of Toba Batak Traditional Housing

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Abstract This study explores sources related to the Toba Batak vernacular architecture, particularly the concept of an ecological site plan for housing sourced from its indigenous knowledge. By analyzing numerous pieces of literature and *Sait Nihuta* as a specific site, this study describes an ecological site plan derived from the Toba Batak architecture which focuses on two main aspects: site planning, building form and orientation. Considering these unique aspects, the site planning tradition in a form that follows the characteristics of vernacular architecture can be applied as a basis for infilling design solutions of the most common types of site plan occurring in Toba urban areas. Using a qualitative approach, this study provides an in-depth knowledge of the ecological site plan through stages of description, elemental analysis; function, space and form, and interpretation of all three simultaneously. The intrinsic value of this observation is to define the process of adjustment of Toba Batak vernacular dwelling as an ecological site plan model for the purpose of infilling urban development in Toba Regency.

Keywords Housing, Ecological, Indigenous Knowledge, Traditional Architecture, Toba Batak

1. Introduction

Ecological site plans of traditional dwellings in rural areas show the common interrelationship of physical quality of residence in each area, local knowledge and cultural values as well as their economic potencies and condition. Many studies explain that traditional dwellings which are part of the so-called vernacular architecture had been built within the area with climatically suitable built forms, spatial functions, and material [1-3]. A Traditional building does not require resource-intense techniques in site planning, building form, and orientation. Traditional houses of the Toba Batak (TB) community within side the mountains around Lake Toba are a common form of ecological features of architecture tradition in Indonesia. The TB dwellings in Batak Land - Indonesia presents an ecological model of housing in term of site planning, building form and orientation, with its own unique features of socio-cultural and ecologically responsive design [4,5].

Research on the TB vernacular architecture generally reflects the traditional values of the local area. Furthermore, geographical location, socio-cultural aspects customs and habits, and the supply of local materials are often also the concern of several studies for sustainable architecture and ecological architecture [6-10]. It is obvious that isolated traditional houses are integral components of the settlement model they belong to. The lack of research and exploration of the ecological spatial model based on native knowledge requires disclosure mainly related to the traditional dwelling of TB.

In this study, a selected site of vernacular architecture in TB was analyzed mostly in terms of the principles of ecological site planning, how it was designed and built, and the lifestyles of local inhabitants. In particular, this study describes the general life of *Sait Nihuta*, a selected

traditional dwelling with the intention to illustrate the ecological site plan of TB residents in the Toba Regency. Qualitative research was conducted to apprehend and obtain a more holistic insight of the ecological site plan of TB traditional housings: how the site is planned and constructed, how it is accepted, and becomes part of the lifestyle in the native community. The activity of data collection consists of phenomenological observation, interviews on habits, preferences, and motivations of indigenous people, as well as in-site measurement.

This paper contains three parts. The first part introduces the study, with a brief background on traditional TB architecture and its relations with the ecological site plan model. Section two reviews the TB traditional housing and its ecological spatial model, as well as a technique for a more holistic insight into the residential impact of the ecological site plan. The second part of section two describes in detail the methodology used to conduct the study. The last part of section two is the findings and discussion, where we address two important aspects of the residential ecological site plan of TB dwelling; site planning, shape and orientation of building form, both of which play a direct or indirect part in creating ecological site plan of the TBA. In the last part, it draws a conclusion on the issues under investigation.

2. Materials and Methods

2.1. Toba Batak Traditional Housing and Its Ecological Spatial Model

The TB is an ethnic group that settles in the central part of TB area in Toba Regency, North Sumatera. With an area exceeding 202,180 hectares, Toba Regency is on $20^0$03'- $20^0$40' North Latitude and $98^0$56' - $99^0$40' East Longitude (Fig. 1).

The temperature of the whole area varies between 17 to 29 degrees Celsius. This area possesses a tropical climate all year round with two seasons, dry from January to July, while from August to December, it is the wet season which brings heavy rainfall to all regions.

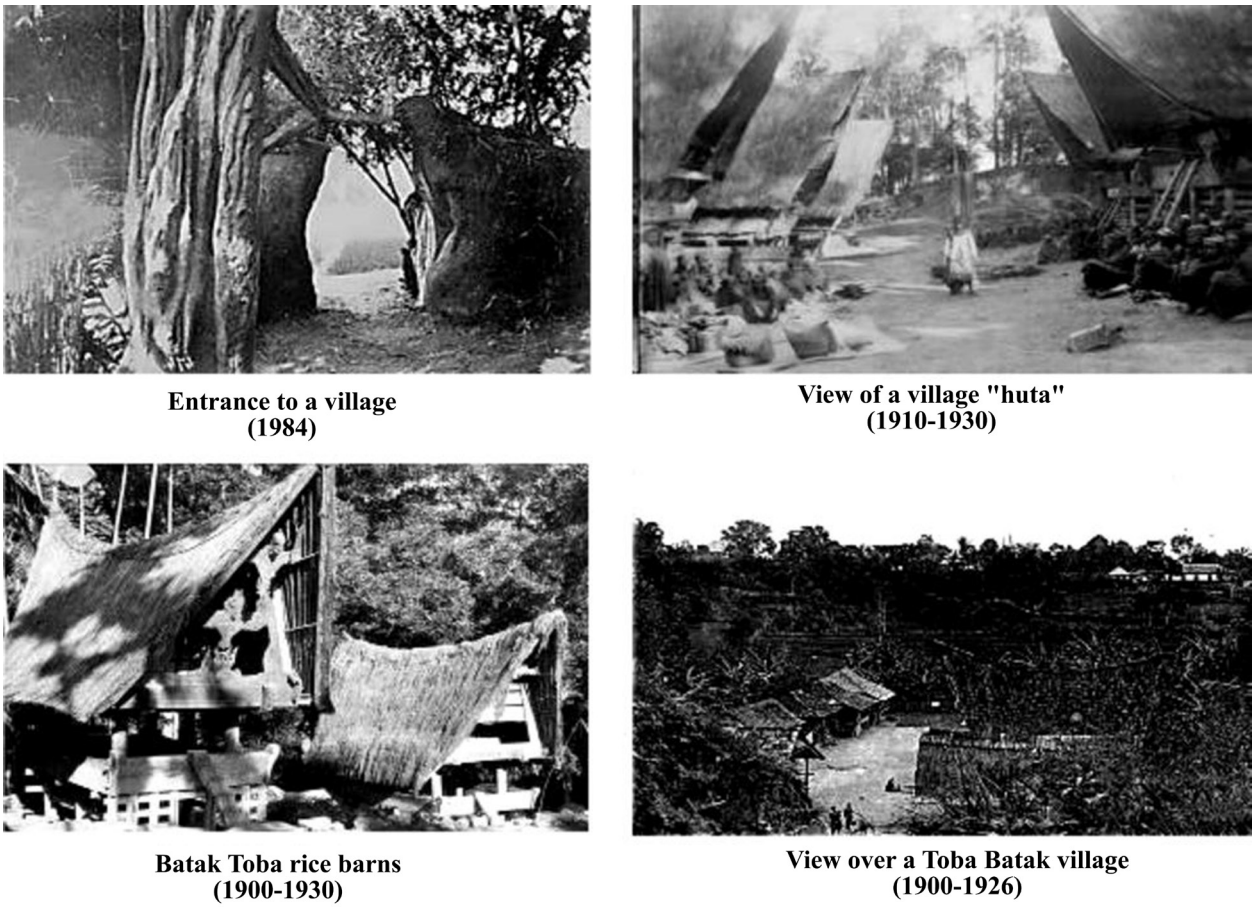
(**Source**: Toba in Figures, 2022)

Figure 1. Map of Toba Regency

Toba lies at an altitude of 900 to 2000 meters above sea level. Mountainous areas occupy almost three-fourths of the area while the remaining areas are lowland valleys (Fig. 2). Over many centuries, the TB occupies namely the Tapanuli region; and develops a vernacular architecture which is then capable of being adjusted as their indigenous housing model to suit locally specific needs. Basically, this architecture is not merely settled by the physical influences; and is also not directed towards aesthetic purposes but rather towards cosmic survival aims [4,11].

In early time, its conventional spatial pattern developed out of an interaction between the residents' relationship system which is called the "*marga*" concepts, and its unique character of a homeland out of natural land, which stands for legitimate territoriality of the family clan. Consequently, a simple expression of its traditional housing demonstrates a direct response to the existing environment within its cultural parameters. The Batak are typically highland people with very limited access to their adjacent areas due to poor communication initially. The TB community built traditional dwellings and organized their houses in different models depending on the farms they worked on. The usual characteristics of TB traditional housing, especially its ecological spatial model, can be identified in terms of site planning, building form, and orientation. Ecologically, TB's traditional dwelling model is adapted from rural customs, whereby the spatial order, materials, and construction technology are modified to suit the local situation.

Figure 2. Some views of Toba Landscape



(**source**: Modigliani' 1980)

Figure 3. Some views of old TB villages

The TB ecological spatial model could be denoted as triple 'S' (separation, synthesis, and style): the act of social 'separation', or blending of the communalism at society and family levels to private conduct; the physical 'synthesis' (or joining together) of the separated ethnic plot shelters into compact rectangular courtyard compounds; and the psychological 'style' of the old lifestyle of self - fulfillment economy. In early times, the site planning, house layouts and courtyard and its surrounding panorama worked together to create an ecological spatial model as a self-fulfillment community (Fig. 3).

The indigenous spatial pattern suggests 'synthesis' of detached buildings into a rectilinear whole that has the courtyard / *alaman* at its core. This *alaman* serves as a mechanism to control communal development, such that the settlements' physical growth has support for regulation. Another aspect that shows the physical manifestation of secondary value that is retained is the rice barn / *sopo*. The development of functional makes use of in particular for TB traditional buildings is very diverse and depends on the structure of society and the cultural development of the existing population in the traditional building location.

Nevertheless, just like modern buildings, traditional TB houses function as shelter / physical shelter from weather or climate, or as a refuge from animal disruption, and certainly as a safe and comfortable resting place. In this paper, a typical vernacular site in the Toba areas is selected to illustrate their ecologically responsive characteristics. The site uses numerous natural means of climatic control such as; managing the site, integrating passive solar design, using locally available materials and using appropriate structure. Evidently, the site represents natural, unwritten information for understanding the value of experiences related to the ecological site plan model. Therefore, lessons learned from this vernacular site plan can help in designing the model of an ecologically built environment.

2.2. Methodology

This research uses the descriptive-analytic method as well as the description technique to identify the ecological characteristics and indicators of the ecological site plan of TB traditional architecture in Toba Regency. For the purposes of this study, we obtained information from literature and conducted an observation of a selected site in the Sait Nihuta – Meat Village, Tampahan District of Toba Regency. For the objectives of this study, we

obtained information from literature and conducted an observation of a selected site in the Sait Nihuta – Meat Village, Tampahan District of Toba Regency. Furthermore, measurements, interviews, and photography were also used as tools for gathering data, and the field methodology was used to analyze the collected information.

The pictures were taken in this place in order to illustrate its features and form in the present day (Fig. 4).

The case study method was performed in order to illustrate the ecological features of the selected site. The use of the case study method allows an in-depth investigation, and allows for a rich description of the intended study. Therefore, for the purpose of the study, the Sait Nihuta site was chosen, as the location has houses that are more than 100 years old, and are still in use. This case study was particularly carried out in order to discover any outstanding ecological issues, for example, compatibility issues with topographic and climatic conditions, use of customary building plans, outdated technology and material, and solar passive features in the vernacular buildings of the region. For this reason, TB vernacular architecture was analyzed for its site planning, building form, and orientation in the context of ecological features.

Findings were reviewed in terms of ecological considerations (Table 1).

Figure 4. The locations of the selected site

Table 1. Ecological site plan parameters

	Element	Sub-Element	Ecological Components	
TB Vernacular Architecture	Site	• Site Specificity • Physical Condition of the site • Function & utilization of space • Linkage of architectural function and traditions of local life	• Material choices • Energy Efficiency • Space flexibility • Contextual Site	Ecological Site Plan of TB Architecture
	Building Form & Orientation	• Building lay-out philosophy • Awareness of environmental preservation • The content of existing historical value • Linkage of architectural function and traditions of local life	• Material choices • Energy Efficiency • Space flexibility • Contextual Site	

Figure 5. The environmentally responsive site plan of TB housing

2.3. Findings and Discussion

The TB traditional architecture grows and develops through the process of creating an adaptation of local architectural building using simple and appropriate technology in the typical form of vernacular and traditional architecture that uses the material suitably and necessarily. An analysis of existing literature on the TB architecture indicates that these vernacular dwellings and their corresponding settlements have ecological site plan characteristics [1,4]. Moreover, this work of the 'people' reflects a society that is wisely familiar with nature, beliefs, and norms. Through this tradition, the ecological site plan model is shaped within a system of perception of space, form, and construction that is identified as a habit respecting the time of change through the process of adaptation of indigenous societies to milieu [3,10,12]. This kind of site plan is climatically applicable because of its heat-resistant tall roof, elevated floor that provides space for mud and flooding during the rainy season, area beneath the floor that increases natural ventilation while lowering humidity, and shaded overhang and lightweight materials for avoiding solar access. This tradition for environmentally responsive conventional housing demonstrates how the TB traditional site plan has had inherently ecological features (Fig. 5).

The TB site plan is well organized with two parallel blocks facing east and west. This layout brings optimized daylight and wind getting into the site and controls the entire housing's micro climate. In addition, this layout actually, clearly separates the occupant into two groups. For instance, the main block of housing with the main facade facing west is designed for the clan as the village owner or landlord. This block then, links with the auxiliary west block facing east to form a courtyard in the center. Generally, the west block is shorter and narrower since it is destined for the son-in-law's family who lives as part of the landlord family to facilitate and strengthen the whole stuff in this village.

As the heart of the whole spaces of the TB housing, the courtyard then brings air flow to living spaces and catches daylight for drying and pounding rice, woven fabric, and clothes. The paddies fields, bamboo trees, *hariara* trees are located within walking distance to the entire house to sustain cool air for the whole site during the dry season. Indoor and outdoor places for worshiping the God of land, or the owner's ancestors reinforce the spiritual values of the occupants (Fig. 6). Water for domestic use originated from different sources with the aid of using traditional techniques. Water from ground wells, rivers, or lakes can be collected in packing containers for storing after with cleansed in tanks that have layers of charcoal, sand, and gravel. Most vernacular TB housing use rainwater collecting technique to deliver water for cooking and drinking. Rain is likewise handled in a similar process as groundwater. However, after being filtered water is boiled or baked beneath daylight to remove bacteria. Ecologically, the TB site plan model is guided by laws

and regulations that guarantee privacy. That is why the TB residence is called; jabu na marampang na marjual, meaning a residence that has laws, rules, size, criteria and taste.

The word used to express the house, in the TB tradition is quite rich. The names of houses in the TB tradition include *Ruma, Jabu, Bagas, Sibaganding Tua*. These words do not only specify to physical buildings; but also denote families or households. Houses as places are thus interpreted as not only pointing to space or simply spatial matters; but also representing living in families. In the TB house, there is no room above but at the front and back, there are small balconies that act as places of cultural, storage, and customary activities. There are no windows or openings on the sidewalls of the houses. At the entrance to the house, there is a space called "the hallway stair" as well as a corridor that prevents external intruders and even noise from infiltrating into the house, appropriately maintaining peace and quiet for its occupants.

Being a part of the environmental system, human habitation — ecological housing— may be taken into account to have its own residential life to support environment system; such as site plan, access, structure and hierarchy, the distance between buildings, drainage, materials, public facilities, social facilities, open space [9].

Within a system, unless it is a perfect closed system, (at least, theoretically), one possible way to introduce an ecological site plan for housing is by optimizing the dweller's flows around and inside various land usage for social, economic, and cultural reasons. Movements happen when there is continuous open space that does not interfere with the speed of passing inhabitants. In relation to the vernacular TB housing, the general approach for movements in land use planning is usually done by circulating centers of activities, public facilities, and social-economic facilities in proximity to houses.

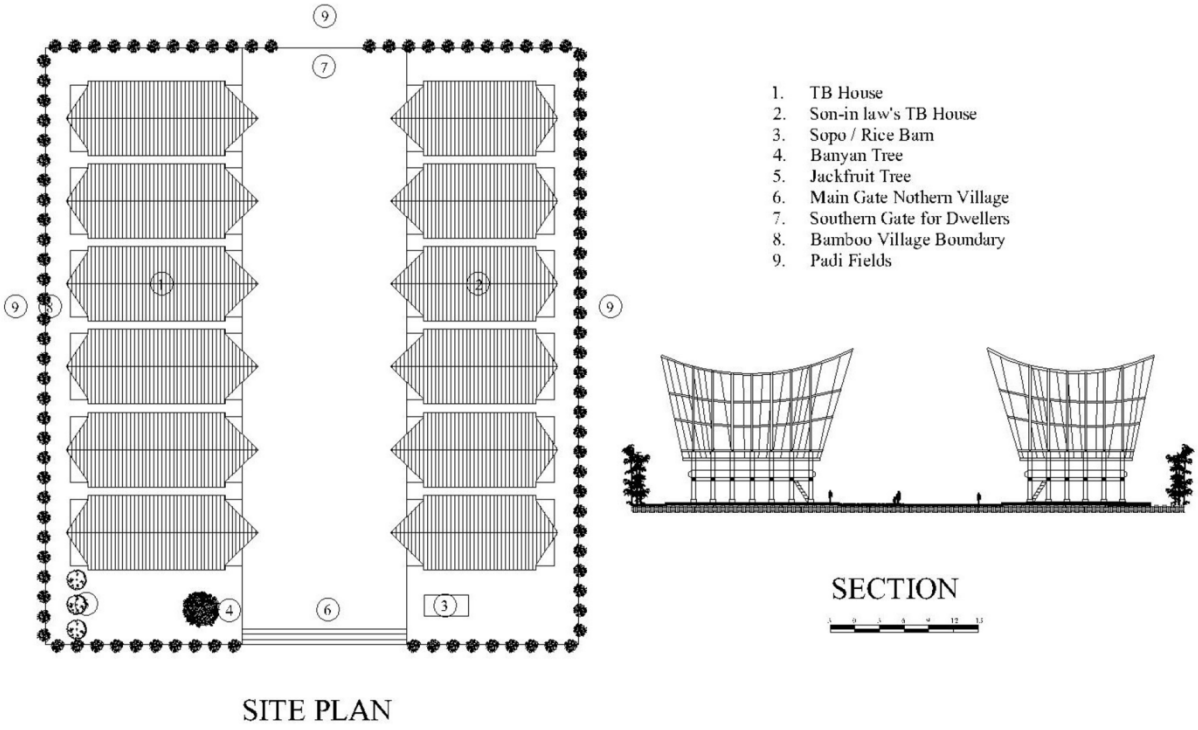


Figure 6. A vernacular ecological site plan of Sait ni Huta in Toba Regency. (*image redrawn by Rahmad H, 2022*)

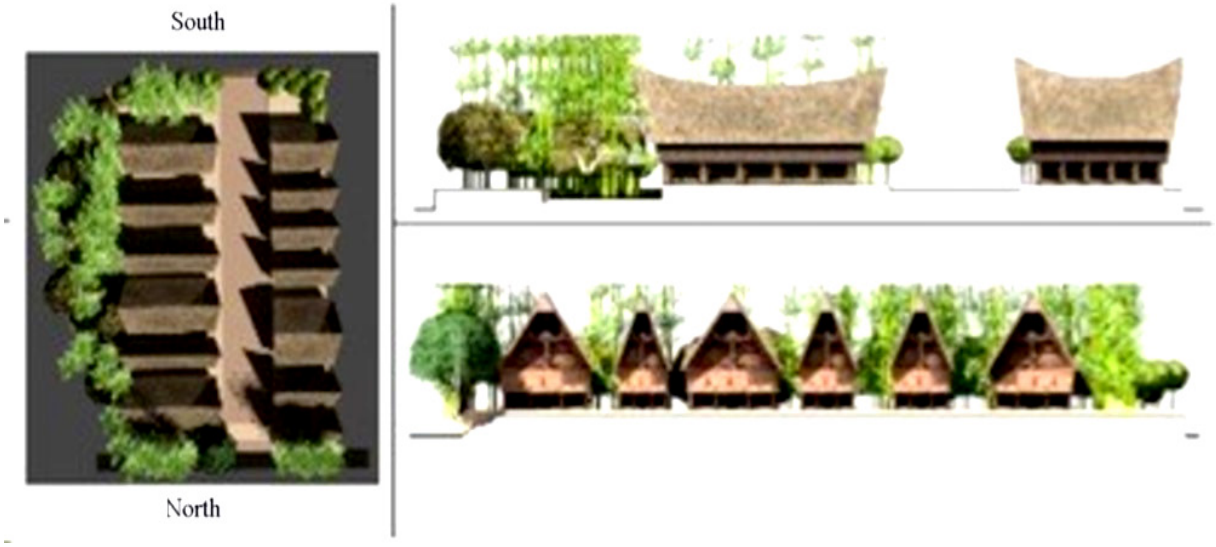


Figure 7. Outer space pattern of "Sait nihuta" in Meat

This study focuses on the degree of utilization of the activity coming in and the success of people in converting this for their own advantage within side the context of Sait Nihuta's vernacular outdoor spatial pattern is a "synthesis" of 12 houses standing parallel to each other with a distance between houses 2.50 - 3.50 meters in an area of approximately 4500 m2, with the courtyard / alaman as the core. *Alaman* functions as a development control mechanism that regulates the physical growth of clan/ family houses. The whole residential land is located at an altitude of 1.50 meters from the road or the surrounding environment surrounded by natural boundaries in the form of bamboo trees and *Hariara* tree which are a locally typical tree that is usually planted properly subsequent to the front gate of the housing. This tree is an image of existence in which after being planted for seven days the living tree means the location is fertile and suitable for housing and farming. Besides that, it is interpreted as an image of "the axis of the universe" (*axis mundi*) which connects humans with ancestral spirits and gods (Fig. 7).

The Sait Nihuta vernacular housing is characteristic of the tropical rural settlement, with its very own uniqueness that has a different culture from the surrounding ethnic groups of Malay culture which were inspired by northern countries of the TB area over the centuries. Subject to the available land, rural houses optimize all parts of the site, which are usually built on small and constrained plots, integrated with nature through a site plan. The houses are usually positioned in a properly well-built area with a north-south orientation adapted to the Toba area which is the north and south direction of the quake. The TB site plan has many common elements such as a courtyard, an open-air worship place, banyan or hariara tree, jackfruit tree, rice pounder, bamboo village boundaries, north-south village gates, and paddies fields which are then integrated with the residences. The courtyard acting as the internal solar courtyard aims to bring breezes and to provide natural lighting. This traditional design is adapted to each specific context to facilitate the amenity and well-being of its occupants.

In the old times, TB housings mostly have an ecological form which has a unique site organization to respond to the environment. The segregated areas designed for private and public activities are the results of cultural and religious influences, leading to “inner” and “outer” parts of the residence. The development of uses in the particular site of Sait Nihuta is very diverse and depends on the structure of the community and the cultural development of the population in this area. However, as is the case with modern housing, traditional dwelling particularly in Sait Nihuta functions as a place to work, trade, customs, shelter / physical protection from the weather or climate, or as a shelter from animal disturbance, and of course also as a resting place which is safe and comfortable.

In this study, *Sait Nihuta*'s traditional housing was chosen to show the site plan, layout, and orientation of the building which has ecologically responsive characteristics. Every component in the site plan has an ecological function, adapting to the climate such as; *Alaman* as a multi-functional outdoor space that integrates with the principle of passive lighting, using locally available materials as shown in table 2. It is believed that the climate of a given region plays a great role in the design of a traditional building form. However, in designing a form responding to the environment in TB areas all factors that affect the external environment, as well as all aspects of the internal environment also played a role in creating the ecological site plan in Sait Nihuta.

Table 2. Ecological Function of the "Sait Nihuta" site

No.	Site Function	Location of Activity	Ideas for ecological housing control
1	Work Place	Rice fields in the backyard of housing, weaving under the house	Backyard as the main access utility
2	Trade	Goods transactions at courtyard / "alaman"	Access only reaches the main gates
3	Customs	Courtyard / "Alaman"	Access from the main gate needs to be divided for easy private and public circulation
4	Shelter / physical protection from the weather or climate	"Alaman" and space under the building	Light and airflow into the "alaman" area easily
5	Children playground	"Alaman" and the room under the house	Light and airflow into the "alaman" area easily
6	Place of death ceremony	"Alaman" and space above and under the house	Access from the main gate needs to be divided for easy private and public circulation
7	A place to welcome guests	Courtyard / "Alaman"	Access only reaches main gates
8	A wedding ceremony place	"Alaman" and space above and under the house	Access from the main gate needs to be divided for easy private and public circulation

Figure 8. Typical the North-South Main Access of TB Housing

The socio-economic conditions of the local culture and climatic conditions affect the shape of buildings and spatial organization. The entrance from the north is the only way to access Sait Nihuta village. The form of a site plan is the result of setting certain spaces needed based on all demands and prerequisites for inherited traditional procedures. The worst orientation is north-south and can be used for non-habitable spaces to form a thermal barrier. With good orientation, the need to support heating and cooling is reduced, resulting in lower energy consumption. Therefore, the best orientation to build TB vernacular architecture exists in the North-South direction (Fig. 8).

Although having proper orientation and a layout that is unified makes the most distinctive organizational features in planning an ecological traditional dwelling, building form shows skill in creating climate-responsive housing. The rectangular design form minimized the impacts of excessive daylight, rain, and wind on the living area. Furthermore, the TB vernacular's characteristic ecological spatial solutions include a courtyard, envelope shading device, mediating space, and surrounding greenery. The courtyard is essential in order to capture fresh air and

adequate natural lighting into the surrounding area. And a courtyard is necessary in a traditional TB site plan. It is in fact more central in the vernacular house, particularly where it is bounded in a location with limited area. A courtyard, being a protected element of the house, orients natural air movement from all wind directions into the house's interior, which results in cooler air in the house.

The most important design parameters that affect the design of the ecological spatial form of Sait Nihuta are the building envelope's thermo-physical properties, the building's form, the architectural elements that affect the building's indoor climate, the building's distance from other buildings, and the building's orientation. In a tropical area, the house can be protected from rain and direct sunlight that fall onto the house walls and external area. The orientation of the housing facades then becomes the basis for selecting appropriate shading devices. For TB traditional housings, the sun would be on the south side, resulting in the north facades being shady all year round. Subsequently, only the south elevation of the houses requires canopies to provide shade and air circulation. However, surrounding overhangs are used instead for protection against both sunlight and rain. The west elevation then becomes important, as it serves as the front of most TB traditional housings.

The TB vernacular architecture describes the housing experiment on simple physics principles on buildings, particularly on knowledge of material use. The skills and experiences that are passed down to multiple generations, local craftsmen, and carpenters provide practical knowledge of ecological use of material. Timber that is logged from local woods is used for housing frames. Non-wood plants such as rattan and bamboo are commonly used for construction in many areas for their cost-efficiency and local availability. Bamboo frames are combined with the inexpensive and ecologically-friendly rice sterns or palm fiber to make the house roof. Moreover, materials from the earth such as river rocks and mountain rocks are used to base poles, and earth walls. As the materials are locally available and simple to hand manufacture, the techniques for using these products have been perfected over the years.

The unique ecological spatial solution in the TB vernacular site plan includes a courtyard as a mediation room, building envelopes, and surrounding greenery. The courtyard plays an important role to capture fresh air and adequate natural lighting throughout the site. The yard needed in traditional Batak Toba housing is even very central, especially as an element that is surrounded and directs the movement of human activities from and into the site, and also the movement of natural air from all wind directions that eventually makes the air in the house cooler. In mountainous areas, occupants could make use of daylight in the courtyard to dry their cultivated rice and woven fabric. In this sense, the courtyard serves as a working place and trading place, as well as place for education, and for bringing a sense of identity to the family. It also serves as a place to conduct ritual activities.

3. Conclusions

The traditional site plan of *Sait Nihuta* may emerge in response to efforts to combine communalism in the community with personal behavior, joining together as an isolated ethnic refuge into a complex and independent housing lifestyle. Various components of the housing support environmental system such as; location, plants, access, structure and hierarchy, distances between buildings, drainage, materials, public facilities, social facilities, and yard; play a direct or indirect role in creating an ecological site plan model for the vernacular architecture of Sait Nihuta dwelling. By establishing a strict policy on construction permits, any changes made will be in accordance with traditional architectural rules, policies, and regulations in designing ecological housing, especially for solutions of the most common contemporary practices of site plan take place in Toba Regency urban areas. Obviously, this then will ensure the continuation of tradition.

This study shows that to realize the ecological site plan model of housing, especially in controlling the design of sustainable housing for the current development of urban growth, especially in Toba Regency based on indigenous knowledge/ traditional knowledge, a number of ecological design principles must be applied - which in some conditions may be very detailed. However, in general, these principles can be grouped into two main objectives, specific location of planning or the contextual design of the surrounding area; and the shape and orientation of the building with flexibility and simple techniques.

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