Understanding Architectural Tectonics to Prevent Extinction: an Empirical Study of Banua Layuk Mamasa, Indonesia

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Abstract

Banua layuk architecture has distinctive characteristics that describe complex architectural tectonics in both technical and artistic aspects. Tectonics is an art in construction that presents aesthetics. Discussion of architectural tectonics in banua layuk in Mamasa has not yet been done. This study aims to reveal the architectural tectonics of banua layuk and understand the value of sustainability in banua layuk's design as documentation of carpentry creativity, a wealth of Indonesian architecture that must be preserved. This study is qualitative research with a naturalistic paradigm. Data analysis was carried out by analyzing the architectural tectonics of banua layuk Mamasa, understanding the coreform and artform, and understanding the value of sustainability in banua layuk. The results of the study indicate that the tectonics of the banua layuk coreform are divided into three independent parts: the lower structure is a bar frame with a rocking construction, the middle structure is a bearing wall with a bearing wall construction, and the upper structure is a bar frame with a tie construction. While the banua layuk art form is integrated with its structural components, either in the form of artistically formed structural elements, carvings with symbolic meanings, or traditional joints that are left exposed to add to the aesthetic value of the building, these ornaments are found in the structural components of badong, paraba'ba, panulak, lentong and palelen as well as the roof frame. In addition, banua layuk Mamasa also has sustainable values, including environmentally friendly materials, structures, and constructions that are by geographical conditions, and the use of ornaments as a cultural identity that can be used in its original form or developed with a new design that is more by changing times.

Keywords: banua layuk Mamasa; coreform; artform; architectural tectonics; sustainability.

Introduction

A world with its beauty, uniqueness, and cultural richness where Indonesian architecture is a symbol of national identity, traditional houses and settlements are a unique cultural heritage based on their characteristics that reflect different climates, environments, and cultures (Waterson, 2012). Indonesia's vernacular architecture is a distinctive cultural heritage, passed down from generation to generation through oral culture without written knowledge (Xian et al., 2024). The focus of this architecture lies in the local aesthetics formed from cultural influences as well as abilities in construction techniques (Kassim et al., 2019). Knowledge of building art has a significant role in the history of architecture, which is an integral part of heritage world culture (Martynenko, 2017).

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Banua layuk is a typical Indonesian architecture in the mountains of Mamasa district, West Sulawesi. In the local language, "banua" means "house," while "layuk" means "high," so literally, banua layuk can be interpreted as "high house." Most the residents of banua layuk are traditional leaders or high nobility (Wasilah & Hildayanti, 2019). This building is a cultural heritage site with an attractive appearance that depicts the creativity of carpentry in the past in Mamasa (Mulyadi & Makkaraka, 2017).

However, the existence of banua layuk is increasingly threatened with extinction, in field observations, the remaining banua layuk are in Rambusaratu village, Orobua village, and Buntukasisi village. The typical Mamasa house with a roof shaped like a sandeq boat is now increasingly rare; Some traditional houses that still maintain their original form can only be found in the interior of the Mamasa Regency (Wasilah et al., 2013). This threat also has the potential to disrupt the continuity of local carpentry practices that are passed down orally from generation to generation. This situation has an impact on the existence of the banua layuk tectonic architecture, which is rich in distinctive characteristics, combining architectural and structural aspects in its construction to create aesthetics (Widjaja et al., 2021) (Al-Alwan & Mahmood, 2020)

The knowledge is a legacy of past architecture in Mamasa, now threatened by extinction. Banua layuk is an example of vernacular architecture that reflects the traditional construction techniques of the Mamasa people, especially for traditional leaders in a region. The local values contained in it are essential but face significant threats. This architectural heritage also has sustainability values in its design, providing solutions and direction from past lives. Therefore, it is necessary to find intelligent and wise answers from this architectural heritage to be utilized by future generations. Tectonic analysis is a careful effort to look at the aesthetics of the core of the building and the art that surrounds the architecture so as not to result in a loss of identity and the essence of Indonesianness.

However, discussions on tectonic architecture, especially in the disclosure of aesthetics resulting from construction methods, materials, and detailed details in the design of banua layuk architecture in Mamasa, have not been fully documented and understood. Previous research has focused more on the general typology of banua in Mamasa, the transformation of the form of banua layuk, the meaning and philosophy of buildings based on cultural studies, and the function and image of banua design. Therefore, this study aims to fill the gap in previous research on banua layuk architectural tectonics, especially in identifying technical aspects (coreform) and artistic aspects (artform) in banua layuk design. Studying vernacular architectural tectonics is very important to understand the typical techniques in design principles used by people in the past in creating aesthetic and functional designs (Schwarzer, 1993) (Schwartz, 2016) (Al-Alwan & Mahmood, 2020) (Widjaja et al., 2021)

Thus, this knowledge can enrich our understanding of the art of past construction and can also be used as information for future architectural design practices. The Contemporary Vision of Architectural Tectonics (Beim, 2013) Architectural tectonics has a contemporary vision to investigate the possibilities of new materials, structural technology, and construction practices. Tectonics in architectural studies continues to develop over time by integrating classical tectonic factors and digital tectonics to create new formulations (Liu & Lim, 2006). The carpenter's understanding of tectonics helps the creative process in producing artistic products by understanding skills, materials, methods, and concepts (Hürol, 2014). Ultimately, preserving the architectural tectonics of banua layuk is an appreciation of the creativity of the indigenous people and is essential to maintaining the identity and heritage of Mamasa.

Vernacular architecture is an integral part of the architectural heritage that reveals the richness and diversity of world cultures. Experience and knowledge of vernacular building art play an essential role in the history of architecture (Martynenko, 2017).

Methods

This research uses a qualitative approach that focuses on understanding and exploring meaning, revealing the sense of a phenomenon in a particular context (Edmonds & Kennedy, 2017). This study uses an empirical study with a naturalistic paradigm by studying and understanding natural conditions in the field to interpret the architectural tectonic phenomena based on empirical studies (Denzin & Lincoln, 1998). The object of analysis of this study is the physical aspect of banua layuk in Mamasa, which includes the core aspects of the building (coreform) in the form of structure and construction, materials, logic of force, and aspects of building art in the form of ornaments in the banua layuk design that create aesthetics and sustainable values in the banua layuk design. The stages of the banua layuk Mamasa architectural tectonic study include data collection, identifying data based on coreform and artform categories, organizing data according to its classification, and drawing conclusions (Miles, Huberman, & Saldana, 2018). The stages of data collection from documents and archives about Mamasa architecture were used as secondary data; then conducting participant observation on banua layuk objects in Rambusaratu village, in-depth interviews were conducted with traditional Mamasa craftsmen (to manarang) as key informants, traditional leaders, and nobles who inhabit banua layuk, and cultural figures who have experience and knowledge about banua layuk. Direct observation was conducted to understand the design of banua layuk and measurements of physical artifacts, which were continued with 3-dimensional depictions to obtain images that were measured digitally. Data processing in this study was done by creating categories and coding the identification results from primary and secondary sources. Conclusions were drawn from the synthesis of research results in the field.

Results

Banua layuk Mamasa is a vernacular architecture located in the mountains of Mamasa, and this building is used as a residence for traditional leaders in a customary area. One of the remaining banua layuk is in Rambusaratu village, Mamasa Regency, a customary area of Limbong kalua, which means a large pond. Geographically, Rambusaratu village is located at the coordinates of 02° 55' 33.5" S and 119° 23' 52" E with an altitude of 1210 meters above sea level (Fig.1)

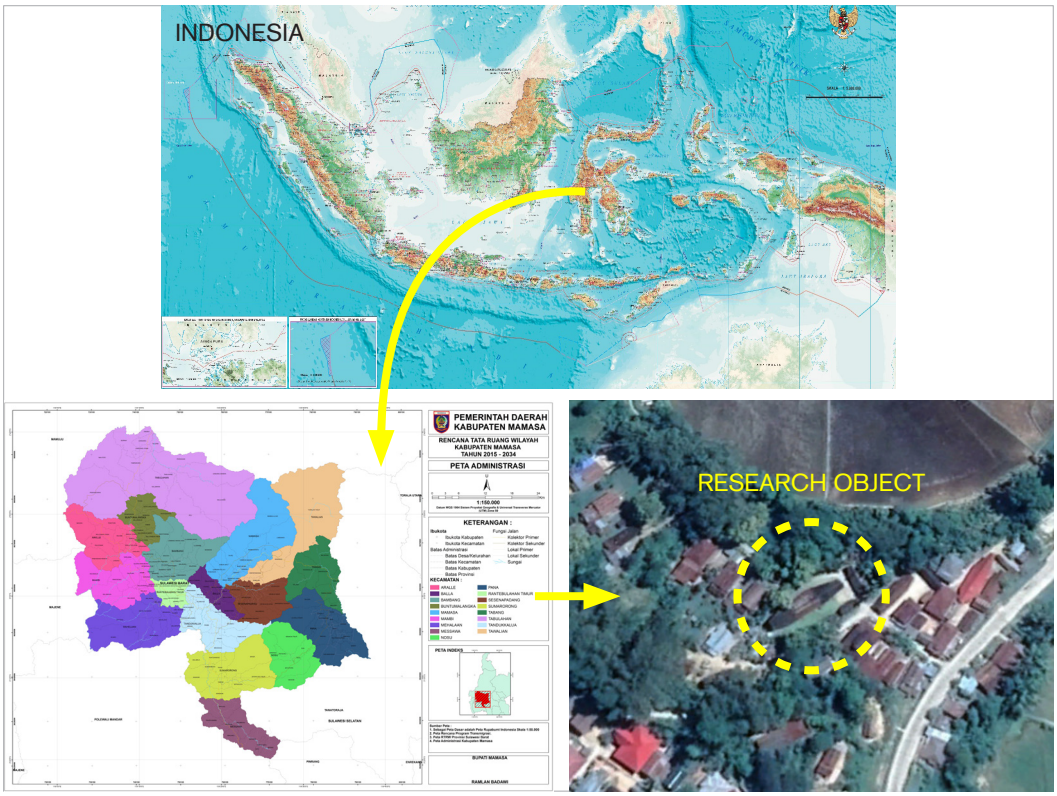


Fig. 1

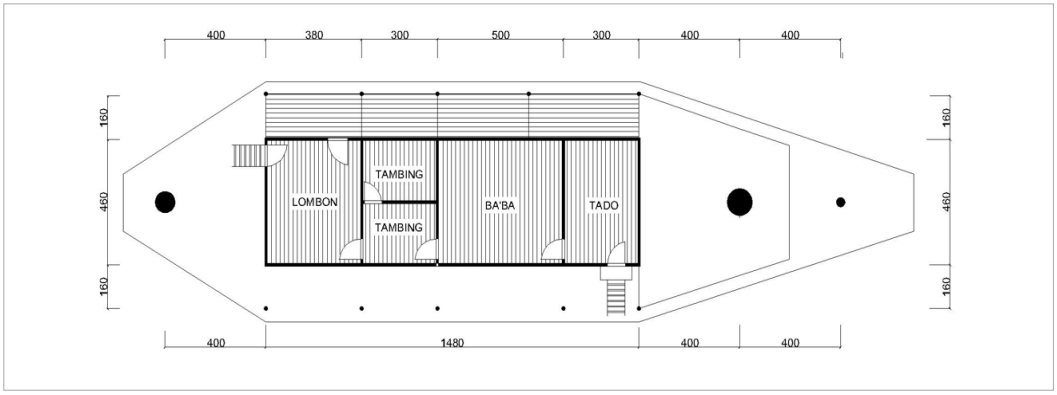
The location of the withered banua layuk in Rambusaratu village, Mamasa regency

The withered banua in Rambusaratu village was designated as a Cultural Heritage in West Sulawesi Province through the Decree of the Governor of West Sulawesi Number 188.4/756/SULBAR/XI/2015 dated November 10, 2015. This withered banua is more than 400 years old and still survives to this day, inherited from generation to generation until the 21st generation. The architecture of the withered banua has a unique shape: a large rectangular building body size with a towering front roof resembling a boat with an asymmetrical shape. The front protrudes upwards, using columns that are tight with natural materials (Fig. 2).

Fig. 2
Banua layuk

The design of banua layuk has four rooms, including: 1) tado, is a living room that also functions as a place to put the body to be buried, 2) ba'ba, which is a room for family members to deliberate and also functions as a guest bedroom and also as a place to bury the body that has just died, 3) tambing, is the bedroom of the residents of the house, 4) lombon, is a kitchen room that functions for cooking, storing food and also places of worship (Fig. 3).

Fig. 3
Layout banua layuk



Banua layuk is a form of local culture and wisdom that is very important for the Mamasa people, not only functioning as a place to live but also as a place to carry out traditional rituals and deliberations, reflecting the community's social identity and cultural values. In the context of architectural tectonics based on Karl Botticher's theory of tectonics, the withered banua displays two essential aspects: coreform and artform. The coreform element refers to the physical structure and function of the building, such as the use of structural systems and building construction, materials, and stylistic logic that work in the design of the withered banua. Meanwhile, the artform aspect can be seen from the details of the ornaments and carvings that decorate the building. As explained in the following discussion:

Tectonic Coreform

Structure and construction

The withered banua is a stilt house consisting of three parts, namely illi banua (under the house), Kalle banua (the body of the house), and papa' banua (the roof/head of the house). The division of the withered banua describes the relationship between humans and nature, which consists of the head, body, and feet as well as the cosmology of the upper world, middle world, and lower world which is reflected in the roof, the body of the house, and poles.

a lower structure (illi' banua)

The lower structure system is a frame system with pillars called lentong and beams called palelen. Lentong is stacked on flat foundation stones not planted into the ground. The components of the lower structure of the withered banua consist of 5 parts with a total of 9 types of forming components. The construction of the lower structure of the withered banua is a rocking construction without using nails with the stacking method on the foundation and mortise and tenon joint on the lentong and palelen parts. As seen in the following image (Fig. 4).

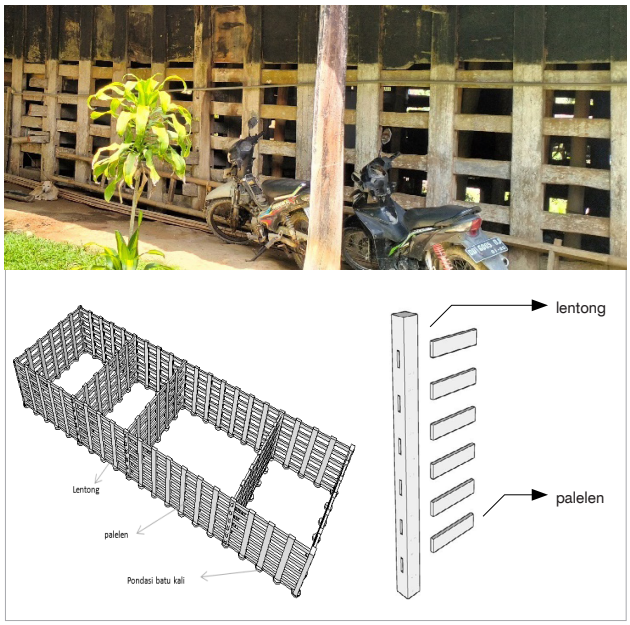


Fig. 4
The lower structure of banua layuk, lentong poles and palelen beams

b Middle structure (kalle banua)

The Middle Structure of the withered banua is a bearing wall system where the banua wall also functions to support the upper part of the structure. Because the lintels only stop at the lower structure, the structural components of the middle of the withered banua consist of 5 parts with 11 forming components. The construction used in the middle structure is a sturdy construction, which in the Mamasa language is called the term dipasikoko, consisting of a wall frame and a wall fill plane (Fig. 5).

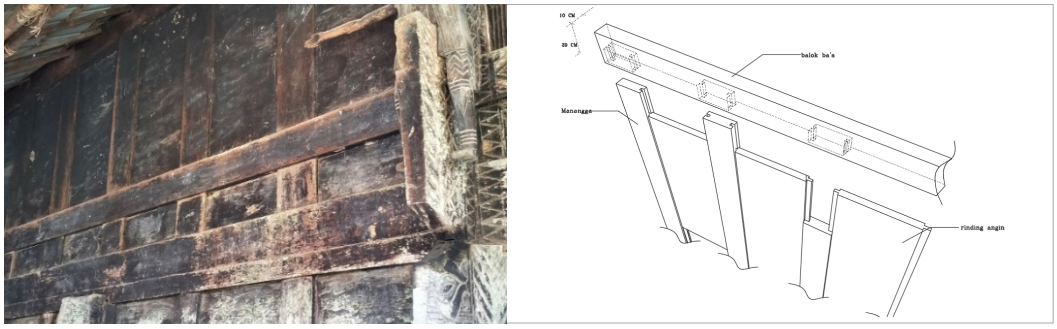
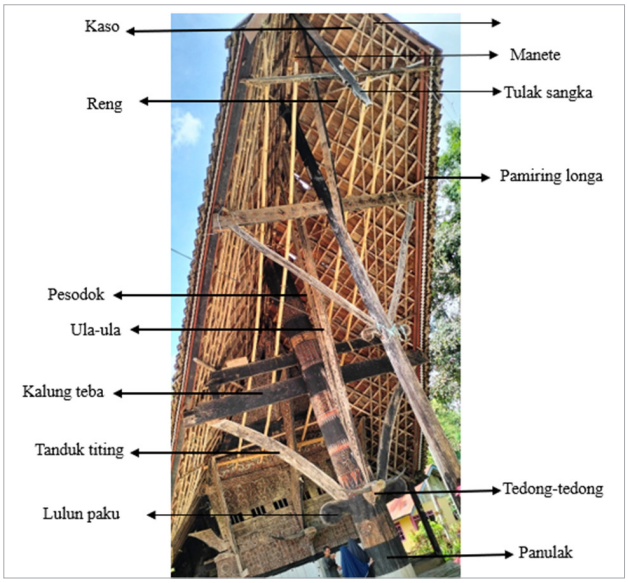


Fig. 5
The wall of the banua layuk

c Upper structure (papa' banua)

The upper structure is a bar frame consisting of horizontal, vertical, and diagonal bar frames interconnected with tie construction. The upper structure of the withered banua consists of 4 parts with 20 forming components. The structural components are assembled to form a parabolic

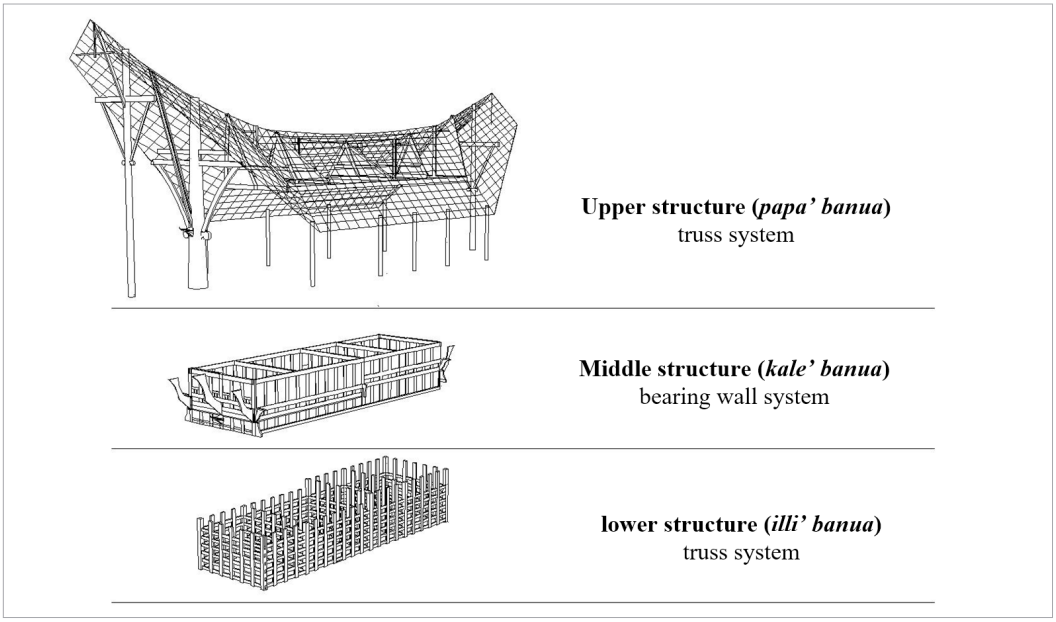
Fig. 6
Banua layuk roof frame



roof where the front roof protrudes upwards, the triangular roof component called paraba'ba is formed obliquely following the longa which is the front roof banua wilted. The withered roof of the banua is supported by the central structure of the banua, which passes the load to the lower structure and unique pillars intended to support the roof, namely the panulak pole and the osak pimiring pole. This pole is in the form of a large whole log timber, especially for the main panulak pole, and has a large size with a diameter of 283 cm and a height of 914 cm.

The Structure System is a series of components that form a system. The withered banua layuk is a stilt house with a separate structural system, which is then connected into a solid whole, consisting of the upper structure called illi' banua, the middle structure called kale' banua, and the lower structure called papa' banua. As seen in the following picture.

Fig. 7
The structure system of banua layuk



Material

The materials used consist of 3 types: wood, stone, and zinc; in the research object, zinc materials are used in part of the roof cover to replace the damage to the roof cover made of wood that is hundreds of years old. Based on the identification data, the banua withered Mamasa is a wooden structure, with a percentage of wood use of 95%. The types of wood materials used in the structure of the banua layuk Mamasa are log wood, timber blocks, and timber boards, with the use of timber blocks as much as 70.6%. The wood material provides a natural, heavy, and warm visual effect. The dominance of material use is explained in the data displayed.

No	Material	Component type	
		Σ	%
1	Stone material	1	2,5%
2	Wood material	38	95%
4	Zinc material	1	2,5%
		40	100%

Table 1
Composition of banua layuk material components

No	Material	Component type	
		Σ	%
1	Log wood	2	5,9%
2	Beam wood	24	70,6%
4	Plank wood	8	23,5%
		34	100%

Table 2
Composition of wood material used in banua layuk

Logic of force

Banua layuk can withstand the shear force that can occur due to earthquake shocks or strong winds because the material and construction of the wood used make it easy to shift because of the light and flexible nature of the wood. The construction of the bottom of the banua layuk is a stacked system that can reduce the vibration effect. While the compressive force that occurs in the banua layuk is resolved by selecting quality load-bearing structural materials, the construction of interlocking lentong poles and palelen beams form a rigid system to support the load of the upper part of the banua. The flow of force that occurs vertically and horizontally is transmitted evenly to the banua layuk structural components, as shown in the following image:

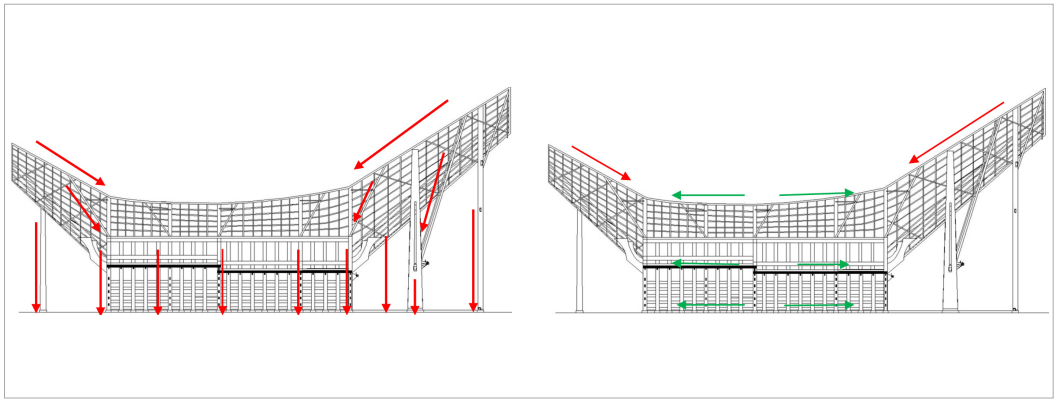


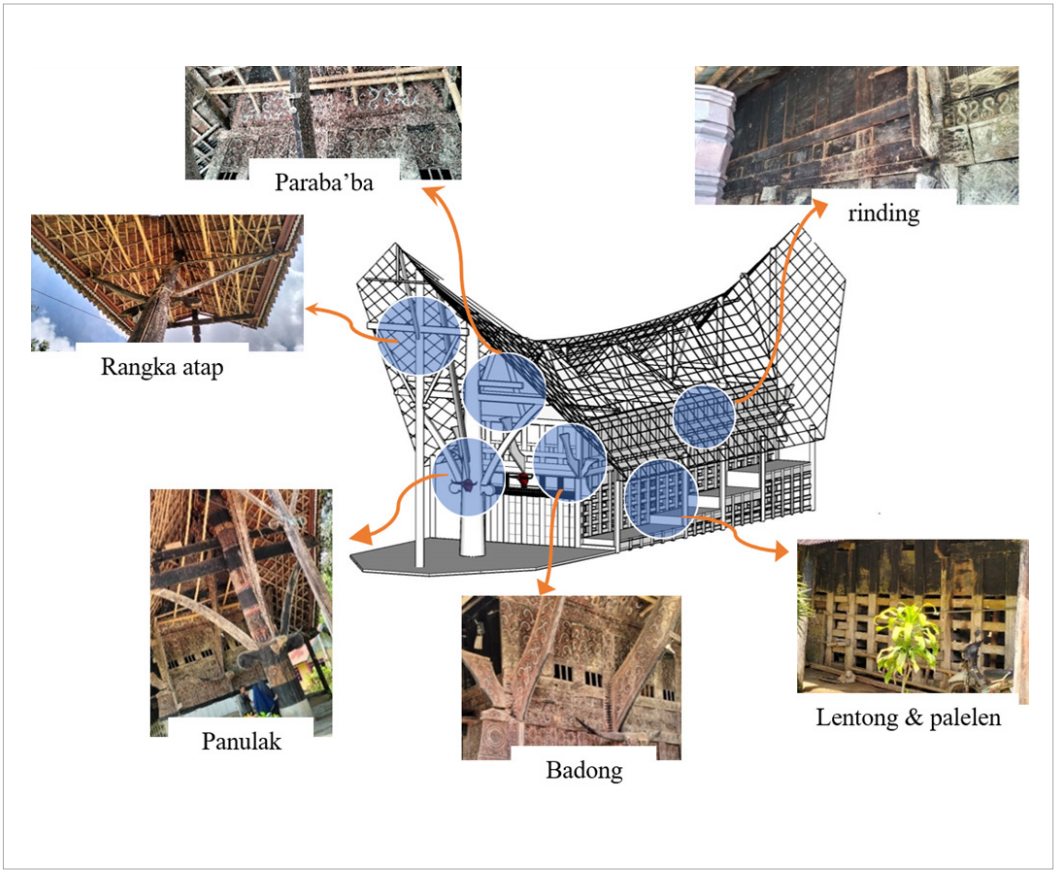
Fig. 8
Vertikal and horizontal force

Tectonic artform (ornament)

Banua Layuk Mamasa has decorative elements in the form of ornaments attached to the components of the structure, which are carved and engraved with specific motifs to become points of interest in several parts of banua layuk. The ornaments found in banua layuk are carved with particular patterns and colored black, red, yellow, and white with specific symbolic meanings. The ornaments on banua layuk consist of carvings attached to the structural elements of the building, the forms of building elements that are deliberately formed specifically because of philosophical goals that ultimately create their aesthetics, as well as ornaments resulting from construction joints that are displayed honestly to add to the aesthetics of the building, in addition, the proportion of banua layuk which uses a traditional scale creates harmony in the proportions of the building.

These ornaments appear in several parts of banua layuk, as seen in the following pictures and tables:

Fig. 9
The structure system of banua layuk



The placement of ornaments on the banua layuk has a specific symbolic meaning based on the philosophy of the beliefs of the ancestors of the Mamasa people using specially shaped carvings, which also have a structural function in the design of the banya layuk as explained in the following table:

Table 3
Placement of ornaments on the banua layuk

Placement of Ornaments	Picture	Symbol	Ornamental motifs	Structure function
Panulak		The panulak on the front symbolizes the head of the family, and the panulak on the back symbolizes the wife in the middle of the banua and becomes the point of interest. There are curved elements that add to the aesthetics of the panulak pillar.	Ornaments are carved with pamilin carvings (security guards), kalodai carvings (symbols of nobility), sora-sora carvings (depicting social stratification in society)	Supporting the roof, as the axis of symmetry on the banua, there is a curved Komsol beam that functions as a console beam called the tanduk titing

Placement of Ornaments	Picture	Symbol	Ornamental motifs	Structure function
Paraba'ba		Depicting the families of both parties in the Mamasa language called rampean, how to establish cooperation and unity	Bareallo carvings, bulintang situru' carvings, tanduk siluang carvings,	Supporting the roof, windbreaker and also room divider on the banua
Badong		Badong is a sign of banua inhabited by nobles and decorated with carvings that symbolize unity and symbols of nobility within one family/ethnic group.	Thick curved boards decorated with bariallo (sun) carvings, bulintang situru carvings	Banua construction locking pin
Lentong dan palelen		Interlocking with each other, which gives meaning to the unity of society through the value of cooperation	The interlocking pillars and beams form a fenced space; there are no carvings, but the construction form provides a distinctive ornament to the banua.	The lower structure forms a transparent space and functions as a visual divider.
Roof truss		The tie construction on the roof frame supports the roof shape used on the banua layuk, which juts out with a symbol pointing towards the worshipped God.	The exposed construction of the roof frame adds to the beauty of banua layuk	It is a banua layuk structure with a tie construction.

Sustainability values in banua layuk

Environmentally friendly materials

The banua layuk Mamasa material uses uru wood, a type of wood only found in the Mamasa forest. Uru wood is known for its strength and resistance to weather, so it can last a long time. It is very suitable for the geographical conditions in Mamasa, which has a high-risk earthquake disaster index.

Traditional structures and construction

The use of structure and construction in banua layuk is to the geographical conditions in Mamasa with traditional joint techniques in banua layuk that connect building elements without using nails so that the construction can sway when an earthquake occurs; some simple conventional

methods used by carpenters or to manarang include: ma'pasikoko (grooved), ma'pasitoe (linked), ma'pasiraka' (hugging each other), ma'pasikala (connected each other), mampunggu (uniting). This is due to the geographical conditions in Mamasa, which is an area with high earthquake potential; this traditional connection can be maintained in its original form or developed into a more modern form.

Ornament

The use of ornaments is a manifestation of the culture and philosophy of life of the Mamasa community, which is still maintained to this day, so the ornaments used in banua layuk are an aspect of art that can be maintained and continue to be sustainable into the future, as can be seen in observations of the environment in Mamasa, where the community still maintains certain types of carvings in their modern house buildings.

Discussion

As time goes by, banua layuk in Mamasa is getting rarer; in the past, every traditional area in Mamasa had one banua layuk inhabited by a traditional leader who led the community; this banua was vital because it not only functioned as a house but also as a place to perform traditional rituals and customary activities. Of the 15 traditional areas in Mamasa, only a few banua layuk remain, located in Orobua village, Rambusaratu village, and Buntukasisi village. The banua layuk in Rambusaratu village has become a protected cultural heritage and is still inhabited by its heirs.

The preservation of banua layuk Mamasa, which is increasingly facing challenges in this era of globalization, has resulted in the loss of past construction methods and technologies, which are valuable architectural heritage. Understanding the concept of architectural tectonics is an effort to preserve the art of construction; past architecture must be interpreted more comprehensively by studying the traditions of carpentry and its historical context, which has a unique local, natural, and cultural environment (Kim & Park, 2017). Theoretically, "tectonics" presents the ontology and essence of architecture and its constituent materials (Schafter, 2003)

Banua layuk architectural tectonics is a dualism of architecture and structure that gives birth to ontology and representation (Hürol, 2014). In this study, the discussion of tectonics is based on the aspects of coreform and artform of banua layuk (Widjaja et al., 2021) (Al-Alwan & Mahmood, 2020), which consist of the concept of structure and construction (Sekler, 1965), material (Zhao and Feng, 2004), ornamentation (Widjaja et al., 2021), logic of force (Widjaja et al., 2021), connections (Liu & Lim, 2006) and details (Hürol, 2014) (Gao, 2022).

The depiction of the tectonic architecture of banua layuk Mamasa can be seen from its very unique structure and construction consisting of a stand-alone structural system in the lower structure (illi' banua), middle structure (kale' banua) and upper structure (papa' banua). The banua layuk Mamasa structural system is a truss structure in the illi' banua and papa' banua sections while the kale' banua section uses a bearing wall system, the construction used in the lower structure of banua layuk is a rocking construction, this can be seen from the placement of the banua layuk pillars which are only stacked on river stones, the use of these pillars aims to avoid wooden foundation pillars from coming into direct contact with the ground surface, according to (Hariyanto et al., 2020) this system acts as a friction damper when an earthquake occurs. The description of the technical aspects of banua layuk above explains that banua layuk was built with a good structure and construction even without technical knowledge that came from the trial and error process by the community (Turan, 1990). This is proven by banua layuk's ability to survive for a long time in the Mamasa area, which is prone to disasters.

Technical and artistic aspects in banua layuk design are integrated. Ornaments in banua are not only decorations but also part of the relationship between structure and architecture; structural components also function as ornaments (Macdonald, 2017), this can be seen from several details

of banua layuk that articulate symbolic meanings with the honesty of structure and use of natural materials found in badong, paraba'ba, panulak, lentong and palelen and roof frames. Badong is technically a locking peg at the connection of the middle and bottom of the banua layuk. In addition to its technical function, badong is also a banua layuk ornament that is curved with an upward rhythm following the towering longa roof and decorated with symbolic carvings that are given natural colors from plants. Paraba'ba is a triangle that supports the banua layuk roof, equipped with carvings. Technically, it is a windbreaker and a divider in each room formed diagonally following the direction of the banua roof. Panulak is the central pillar that becomes the point of interest in banua layuk with its natural material in the form of large diameter whole logs and supported by panulak components, namely tanduk titing that function as consoles, panulak functions to support the roof and provide an axis of symmetry for the front view of Banua Layuk, Lentong, and palelen have a simple construction that is interconnected to form a fenced space that adds aesthetics to banua. At the same time, the roof frame of banua layuk uses bamboo with rattan ropes to form its aesthetics from the exposed construction.

As the observation and literature study on banua layuk Mamasa, it can be concluded that the banua Layuk design has been designed and designed with a sustainable architectural approach. This can be seen in the structure and construction used considering the geographical conditions of Mamasa, which are prone to earthquakes; the construction responds to earthquake forces with reinforcement and frame structures on the lower part of the banua (illi' banua). The binding system on the banua layuk roof construction and the roof frame move during an earthquake without experiencing damage. The umpak foundation is not planted in the ground; it is only stacked on a stone foundation that can reduce lateral forces during an earthquake. Likewise, the materials used in banua layuk Mamasa are processed traditionally. This shows that the concept of sustainability has been considered in the design and structure of the banua layuk Mamasa materials.

Conclusions

The architectural tectonics of banua layuk in Mamasa consist of two main aspects: the coreform and the artform, which are mutually integrated. The core form of the structure and construction is divided into three main parts, namely: 1) lower structure (illi' banua), in the form of a rod frame with a swinging construction, consisting of vertical and horizontal rods, 2) middle structure (kale' banua): in the form of a bearing wall system, 3) upper structure (papa' banua): in the form of a rod frame including vertical, horizontal, and diagonal elements with a tie construction. Artform of banua layuk is a structural component that is artistically formed decorated with distinctive carvings with exposed traditional joints that enrich the aesthetic value of the building, essential elements that function as art forms of banua layuk include badong, paraba'ba, panulak, lentong, palelen, and roof frames

The value of sustainability in the architectural design of banua layuk Mamasa can be seen from the use of environmentally friendly materials, banua layuk uses materials that are widely found in the environment, through processing, coloring to preservation in a traditional way that is friendly to the environment, in addition to the structure and construction of banua layuk, which is designed to respond to the geographical conditions of Mamasa with traditional methods and joints, the ornaments on banua layuk are an essential aspect that describes the identity of Mamasa culture, the carvings found on banua layuk can continue to be maintained both in their original form and in contemporary building designs. This shows that the design of banua layuk is designed and built with the concept of sustainability. The approach to sustainability and the essence of architectural tectonics can be maintained. By paying attention to technical and aesthetic aspects, the banua layuk design not only reflects traditional architectural expertise but also shows the importance of sustainability in facing modern development challenges.

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