

Vernacular Architecture of *San Jerónimo de Tunán*: Colonial Heritage and Conservation Challenges in the Peruvian Andes

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Abstract This study addresses the architectural typology and the state of conservation of vernacular architecture in the monumental area of the district of *San Jerónimo de Tunan*, located in the Peruvian Andes, highlighting its importance as a historical and cultural legacy of the colonial era in the Mantaro Valley. Through this analysis, we seek to make visible the current situation of these heritage buildings, promoting the formulation of restoration and conservation strategies to preserve their architectural and educational value as references of traditional constructive knowledge. In response to the negative effects of modernization and the industrialization of construction processes that have progressively displaced vernacular practices, the research adopts a mixed approach methodology. Non-participant observation sheets were used, designed to record qualitative and quantitative data on vernacular dwellings located in the area delimited by the Urban Development Plan (PDM 2020-2029). This methodological tool made it possible to identify structural, functional, and symbolic elements of the local context, providing useful information both for the technical diagnosis and for training and heritage awareness purposes. The results reveal that most of the buildings present a "Good" state of conservation, which constitutes a favorable opportunity to implement preventive and sustainable conservation actions. However, components with signs of deterioration requiring specialized intervention were also identified. As a complement, a pilot model was developed

using the HBIM methodology in the Jr. Huallaga section, integrating digital tools oriented to the documentation, management, and projection of heritage interventions. It is concluded that the use of HBIM is not only effective in technical terms, but also represents a valuable didactic resource for the training of professionals in the fields of architecture, conservation and heritage education.

Keywords Vernacular Architecture, Building Typology, Cultural Heritage, Building Valuation, Spanish Colonial Architecture, Heritage Urban Planning, HBIM

1. Introduction

The present research focuses on the study of vernacular architecture, understood as the set of styles, techniques, and construction materials developed by indigenous communities over time, in response to their cultural, climatic, and geographical conditions [1]. In the historical context of Peru, the Spanish conquest introduced a new paradigm that significantly transformed the urban and architectural configuration of the territory. This influence was manifested through imported styles such as Renaissance, Baroque, Neoclassical, Mudejar, and Churrigueresque, which were adapted and incorporated in various regions of the country, especially in the coastal and

highland areas, where their presence was more significant [2].

The architectural typology of *San Jerónimo de Tunán*, a district in the central Andes of Peru, is characterized by the adaptation of Spanish construction techniques to local materials and conditions [3]. The buildings have adobe walls and tile roofs, abundant materials in the region, which were used following traditional techniques. This adaptation not only responds to the availability of resources, but also to the need to adapt to the climatic conditions of the Mantaro Valley, demonstrating a deep understanding of the environment and a harmonious integration with the surrounding landscape [4]. The houses are usually arranged around a central courtyard, following the courtyard house model introduced by the Spanish, but adapted to local needs and customs [3]. This design facilitates natural ventilation and the entry of light, creating comfortable and functional living spaces. In addition, the central courtyard serves as a multifunctional space for domestic and social activities, evidencing the importance of community life in the local culture. For this reason, the district stands out as a subject of study in terms of heritage architecture care, due to its background of constructive mixture between two totally different cultures, as well as its adaptability to the environment of the central highlands.

The preservation of vernacular architecture is essential to maintain the cultural identity and historical heritage of the region [5]. However, modernization and urban growth represent significant challenges for the conservation of these traditional buildings [6]. Since the 21st century, the incorporation of new materials and foreign construction techniques has had a direct impact on the continuity of ancestral knowledge, as well as on the homogenization of the architectural landscape [7]. This transformation is evident in the district of *San Jerónimo de Tunán*, where the coexistence of vernacular buildings and modern constructions without contextual integration can be clearly observed in the aerial image presented in Figure 1, which shows the urban center of the district, highlighting the Plaza de Armas and its built environment.

It should be noted that the traditional architecture of the area is distinguished by its high value in terms of sustainability [8], as it derives from community practices and self-construction processes using local materials. This condition not only evidences the efficient adaptation to the environment, but also minimizes the negative environmental impact [9]. In this sense, their maintenance and conservation are not limited to the heritage area, but also generate ecological, social, and cultural benefits. In addition to its architectural and environmental value, the vernacular architecture of *San Jerónimo de Tunán* plays a key role in social cohesion and the intergenerational transmission of knowledge [10]. The active participation of the community in the construction and preservation of their dwellings strengthens the sense of belonging and collective responsibility towards the built environment [11], as

reflected in the spatial and urban organization observable in Figure 1.

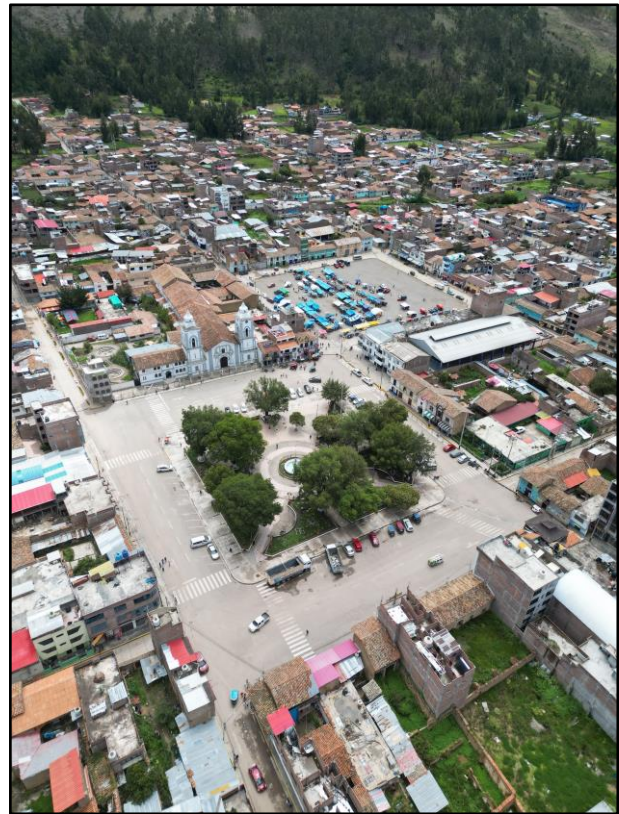


Figure 1. Aerial view of downtown *San Jerónimo de Tunán* district

Therefore, it is crucial to implement conservation policies that promote the use of traditional techniques and materials, as well as raise community awareness of the value of their architectural heritage, in addition to establishing greater rapprochement of these cases to entities such as the Peruvian Ministry of Culture or UNESCO [12].

The preservation of these architectural heritage icons has the additional effect of incorporating sustainable development within the current urban framework and construction systems, by the simple fact of handling materials that do not have a complex industrialization process. As an example, we can have the use of clay in contrast to cement, a material that has a higher degree of environmental impact. It is expected that this idea will help *San Jerónimo* advance in SDG 11 (Sustainable Cities and Communities) [13], by promoting the protection of the cultural heritage of the population as a whole, thus strengthening the bonds of local identity. In addition, the field of objectives that can be addressed with the development of this research is expanded. In the case of SDG 13 (Climate Action) [14], bioarchitecture and energy efficiency [15] can be implemented in restoration or vernacular constructions, while respecting the original form, reaching a balance within the buildings that can be

cataloged as hybrid and resilient.

A complementary part of this article is the inclusion of the HBIM methodology as a contribution within the emerging digital conservation framework that allows to accurately document the geometry, materials and traditional construction techniques through 3D models, facilitating informed and sustainable interventions [16]. In addition, it anticipates deterioration processes and prioritizes maintenance actions, which is essential when using fragile materials such as adobe or quincha. HBIM also promotes interdisciplinary collaboration among professionals and provides educational and cultural value by allowing interactive visualizations for heritage dissemination. Although it faces challenges such as cost and the lack of specific regulations, its implementation is considered strategic to protect local heritage, connect technical knowledge, and strengthen territorial identity.

2. Literature Review

2.1. Previous Studies

The architectural colonial remnants are already part of the urban structure established in several cities around the world, and their analysis has been urgent to validate information on the management and evolution of these infrastructures as heritage elements. In the Asian continent [17], we have the example of Java, Malaya, and Singapore, where research on colonial vernacular architecture linked to the indigenous part of the area is constituted, correlating the compositional character and designs to have a more inclusive vision within the architectural interactions today. This research delves into the current integration of historical spaces as elements of integration with the local native culture. In the Latin American panorama, we have the case of Colombia [18], which also stands out for the insertion of the Spanish architectural typology in about 100 cities throughout the Colombian territory, and before this Lopez & Sierra performed an interesting bioclimatic study comparing the native colonial dwellings in two of the most relevant cities, Bogota and Cartagena. From this, it can be mentioned that the Spanish conquerors indiscriminately imposed their constructive style in both cold and warm places, without thoroughly evaluating the response to thermal comfort.

Within the aforementioned research the influence of meteorological phenomena in these two environments is evident, particularly its influence on the house-patio housing style; mentioning this leads to consider that in the study area in *San Jerónimo de Tunán* it is possible to expand the study and complexity of our vernacular houses, as well as to adapt them to a "modern" environment without altering their essence and adapting the internal part to optimize the internal comfort.

Salman [19] argues that sustainability and cultural preservation are fundamental for social development, as they are closely linked to collective identity. In this sense, vernacular architecture arises as a response to the needs of indigenous groups, who, through empirical and millenary knowledge, developed functional constructions adapted to their environment. Tarrad and Umamah [20] emphasize that traditional construction practices linked to vernacular architecture offer significant advantages in terms of sustainability, by using local materials and preserving ancestral techniques, which contributes to maintaining the identity legacy of each territory [14].

Gbran and Ratih [21], in a study of the Lawang Sewu building in Indonesia, highlight the importance of identifying physical attributes such as height, design, and color as essential elements in the preservation of visual identity. Their research, based on the analysis of 27 buildings through photographic records and resident surveys, demonstrated that, although modernization is an inevitable process, it can be integrated in a planned manner in consolidated vernacular contexts, maintaining a balance between the traditional and the contemporary.

The architectural classifications proposed by Maldonado [22] are based on criteria that encompass the physical, historical, and psychological reality of the built environment. These categories consider attributes such as structure, form, ornament, function, style, and space, which constitute tangible manifestations of the culture of a community. Such characteristics are typical of vernacular architecture, which, unlike contemporary academic architecture, is developed empirically and linked to the generational evolution and construction practices of each town or community. The author also points out that urban vernacular housing represents a complex category, since its valuation is usually subject to subjective interpretations. In many cases, these buildings oscillate between the preservation of the traditional style and functional adaptation, giving way to reflections on the viability of hybrid models that articulate modernization and functionality without detracting from the original vernacular character.

From an anthropological perspective, Córdova [12] emphasizes that the Junín region constitutes an important reservoir of cultural expressions and customs, the preservation of which entails a shared responsibility. Within this heritage, vernacular architecture stands out for reflecting both the construction techniques inherited from the Spanish colonizers and the traditional knowledge of the Andean communities. Although there are regulations aimed at protecting the region's immovable heritage, the reality shows a significant gap between these regulations and their effective application. Practices such as the demolition of representative buildings persist, not only in urban centers such as Huancayo, but also in nearby districts and annexes, including *San Jerónimo de Tunán* [3].

3. Study Area and Methodology

3.1. Study Area

San Jerónimo de Tunán is a district belonging to the Peruvian Andes [23], located in the department of Junín, 16 km from the city of Huancayo at 33274 m.a.s.l., between 11°S south latitude and 74°30' west longitude, with an area of 2269.22 hectares. Like other towns in the region, this district has a rich legacy in history, culture, and heritage. One example is the ruins of Unish Kuto, which served as a settlement for the Wankas, an indigenous group that dominated the region [24]. In addition, the area was not alien to the temporal advance, and the Spanish conquest had many repercussions, imposing new social, economic, religious, and architectural visions. Today, the monumental zone of *San Jerónimo* is an example of local identity [10], which, despite the passage of time and the multiple generational changes, maintains its essence in its buildings that must be preserved.

During the initial evaluation of the monumental zone of *San Jerónimo de Tunán*, there was a notable contrast between the contemporary buildings and those that preserve vernacular characteristics. This contrast is manifested in aspects such as morphology, materials and construction techniques. The building shown in Figure 2 exemplifies this rupture, presenting an architectural proposal that bears no formal or symbolic relationship with the local colonial context, omitting even the minimal incorporation of elements typical of the district's traditional style. This situation reflects a growing trend towards modern construction without contextual integration, which contributes to the progressive loss of the urban landscape's identity, even in an area recognized for its heritage value according to the Urban Development Plan (PDM) reflected in Figure 3. These new constructions tend to prioritize criteria of functionality or standardization, ignoring the potential for hybrid proposals that could harmonize the contemporary with the vernacular. In view of this, there is a need to promote architectural interventions that recognize and dialogue with the heritage environment. Integrating constructive or compositional elements of the vernacular style would not only contribute to the conservation of the urban character, but also to the strengthening of the sense of local belonging. It is therefore essential to promote specific regulations and management mechanisms to guide urban growth in a way that is consistent with the existing heritage.

3.2. Method

The research was developed under a mixed methodological approach, which integrates qualitative and quantitative tools to characterize the state of conservation of vernacular architecture in the monumental zone of the district of *San Jerónimo de Tunán*. This approach responds to the need to accurately record both the physical conditions of the buildings and their symbolic and heritage value, as proposed by Hernández, Fernández, and Baptista [25]. To strengthen the record, previous studies and specialized literature were consulted. In particular, the contributions of Burga et al. [26], who detail the typological classification of vernacular housing according to its morphology, use and internal organization, were taken into account, as well as the work of Orellana [27], who systematized the traditional architectural components such as balconies, doorways, and eaves in various districts of the Mantaro Valley. The fieldwork was carried out exclusively within the territory declared as a monumental zone of the district, delimited according to the Urban Development Plan (PDM 2020-2029) [28]. For the collection of information, structured observation sheets were used, designed based on the characteristic elements of colonial vernacular architecture. The model was adapted from the instrument developed by Condori [29] in his study of the Orcotuna district, given its geographic proximity and typological similarity.

The files included two sections: the first with quantitative data such as dimensions, levels, roof slopes and layout of openings; and the second with qualitative data related to architectural style, functional organization, ornaments and state of preservation.

The condition of the architectural elements was assessed using an adapted five-level Likert scale (1 = Deficient to 5 = Excellent), according to the guidelines of Matas [30]. This tool made it possible to transform qualitative observations into systematizable and comparable data, facilitating the classification of the physical condition of walls, roofs, balconies, and other components. Its uniform application allowed the construction of a coherent technical diagnosis, useful for intervention planning. In addition, the Heritage Building Information Modeling (HBIM) methodology was incorporated as an innovative tool for documenting, analyzing, and projecting the state of the built heritage. A pilot model was developed in Jr. Huallaga, by means of photogrammetry processed in Agisoft Metashape, optimization in Autodesk ReCap and modeling in Autodesk Revit.





This experience validated the potential of HBIM as a technical and pedagogical support, in line with Angulo [16] by integrating geometric, material and historical data for the projection of conservation scenarios. The validity of the instruments was verified through a pilot application in the field, which allowed refining the methodological criteria and ensuring the quality of the subsequent analysis. The validation of all the instruments used was carried out through a pilot phase in the field, which made it possible to verify their relevance, adjust their categories and ensure consistency in their application. This previous stage strengthened the reliability of the data obtained and made

it possible to replicate the methodological process in future research in similar heritage contexts. Overall, the application of structured cards, the use of a Likert scale well adapted to the environment and the implementation of the HBIM methodology, provided a robust technical framework for the analysis of the vernacular architectural heritage of *San Jerónimo de Tunán*, allowing not only its rigorous documentation, but also its future projection under criteria of sustainability, cultural relevance and historical continuity, everything studied was processed and captured in the observation sheet (Figure 4).



Figure 2. Difference between vernacular and "modern" buildings

Figure 3. Vernacular buildings identified within the monumental zone of the district of *San Jerónimo de Tunán*

		OBSERVATION SHEET					N° 13
		ENGINEERING FACULTY		PROFESSIONAL SCHOOL OF ARCHITECTURE			DATE: 23 APRIL, 2025
OBSERVATION SHEET - VERNACULAR ARCHITECTURE (DATA COLLECTION)							
Photograph 01 		02. Qualitative data					
		02.01. Colonial architectural style (Approaching trend)					Observations:
Styles		<i>Rococó</i>	<i>Baroque</i>	<i>Renaissance</i>			
		<i>Neoclassical</i>	<i>Mudejar</i>	<i>Churrigueresque</i>			
Photograph 02 	02.02. Typology					Observations	
	Housing types						
		<i>Courtyard House</i>	<i>U-shaped house</i>	<i>Compact House</i>			
		<i>Retablo House</i>	<i>Mixed House</i>	<i>"Cancha" House</i>			
02.03. Building system							
02.03.01 Walls							
Materials		State of deterioration					
<i>Adobe</i>	<i>Tapial</i>	EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)	
Confined masonry	Stone			x			
02.03.02. Coating							
Materials		State of deterioration					
<i>Gypsum</i>	<i>Ground</i>	EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)	
Stone	Concrete			x			
02.03.03. Facade							
Elements		State of deterioration					
		EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)	
<i>Roofs</i>				x			
01. Quantitative data							
01.01. Infrastructure dimensions							
Facade height	8 meters	Frontis width	8.5 meters				
		N° windows	2				
Number of levels	2 levels	N° doors	2				
		N° balconies	2				
Address:		JR. HUALLAGA "SAN JERONIMO DE TUNÁN DISTRICT"			Color: White Chalk - Caramel toffee		
Zone:		SJT - ZM(1D)			02.03.02. Coating		
Land uses according to PDU:		MZ (MONUMENTAL ZONE)			Materials		
Solar incidence:		NORTHEAST TO NORTHWEST			State of deterioration		
		<i>Gypsum</i>	<i>Ground</i>	EXCELLENT (5)	GOOD (4)	REGULAR (3)	
		Stone	Concrete			x	
INFRASTRUCTURE - HOUSING DATA							
Color: Cream, caramel toffee plus aquamarine green and desert brown details							

01.02. Ceilings							Windows						
Material		Slope percentage		N ° falls		Roof tile color	Balconies						
Roof tile	X	0 - 25%		1 fall		COOKED EARTH (Marbled Red)	02.04. Basic services						
Calamine		26 - 50%	X	2 falls	X		List of basic services	State of deterioration					
Concrete		51 - 75%		3 falls				EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)	
Others		76 - 100%		4 falls			Drinking water service		x				
01.03. Windows							Electric power service		x				
Material		N ° OF SHEETS	OPENING FORM	DIMENSIONS			Sewage service		x				
Wood	X	2	Interior	N °	Height	Width	02.05. Characteristics of use of the road						
Metal				2	2.50 m	1.00 m	Type of road	State of deterioration					
Glass				Alfeizer	0.0 m			EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)	
Others				On which floor are they located?	2		Pedestrian		x				
01.04. Doors							Vehicle		x				
Material		N ° OF SHEETS	OPENING FORM	DIMENSIONS			Others						
Wood	X	2	Interior/Exterior	N °	Height	Width	02.06. Access features - external						
Metal				Material on the track	State of deterioration								
With Glass					EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)				
Others				Pavement	Cobblestone		x						
01.05. Balcones							Earth	Transit sidewalk		x			
Material		Balcony type		DIMENSIONS			Outdoor garden						
Wood	X	Continuous balcony		N °	Height	Width	02.07. Rain gutters						
Metal		Drawer balcony		2	1.00 m	1.2 m	Location		State of deterioration				
Forged iron		Cantilevered parapet balcony					Sides	Central	EXCELLENT (5)	GOOD (4)	REGULAR (3)	BAD (2)	DEFICIENT (1)
Others		Balcony with parapet	X							x			

Figure 4. Sample observation sheet used to collect data on current vernacular housing conditions

4. Results

Once the cards were applied, it was identified that the vernacular dwellings have common peculiarities that demonstrate a typological coherence in the monumental area. These include similar structural dimensions such as height, span ratio and depth, as well as the recurrent use of traditional materials such as adobe, wood, Andean tile and stone.

4.1. Walls in Vernacular Housing

In particular, when evaluating the situational state, we can affirm based on Figure 5 that in the evaluation of the walls of the houses, it is observed that most (13 houses) are in a "Good" state, showing an acceptable conservation. However, 11 dwellings have a "Regular" status, indicating moderate damage requiring attention. There is concern that 6 houses have walls in a "Bad" condition, which shows significant deterioration that could affect their stability if not acted upon soon. Only 2 dwellings reach the level of "Excellent", and no walls are recorded in state "Deficient". [15] Although the situation is mostly positive, it is necessary to act on the walls in worse condition to ensure the integral conservation of the patrimonial set.

4.2. Coating in Vernacular Housing

In the analysis of the state of the coatings, it is observed in Figure 6 that most (14 dwellings) have a "Good" status, which reflects an adequate level of conservation. A total of 10 dwellings are in "Regular" condition, indicating the presence of partial deterioration requiring preventive

maintenance. In addition, 6 dwellings are facing "Bad" condition, indicating significant damage that could accelerate the deterioration of the structure if not corrected. Only 2 dwellings have an "Excellent" cladding, and no cases of "Deficient" are recorded [7]. It can be said that a favorable state prevails, and it is necessary to intervene especially, in cases of bad coatings, to avoid major material losses.

4.3. Roofs in Vernacular Housing

In the case of the ceilings shown in Figure 7, the largest number (13 dwellings) is in a "Regular" state, indicating a moderate state of conservation. There are 9 dwellings in state "Good", establishing slightly superficial damages; 7 dwellings are in a condition "Bad", showing considerable damage to the roofs where *quincha* and wood predominates, 2 dwellings in state "Excellent" and 1 in circumstance "Deficient". It can be said that a regularly favorable state prevails, so that it is worthwhile to intervene especially in roofs with significant damage [31].

4.4. Windows in Vernacular Housing

For the windows in Figure 8, it is observed that the largest number (11 dwellings) has a "Good" status, which indicates a level of conservation. There are 10 dwellings in "Regular" condition, establishing lack of care of windows in certain buildings; 6 dwellings are in a "Bad" condition, showing deterioration or cracking in glass, 4 dwellings recorded in "Excellent" condition and 1 in "Poor". It can be said that a favorable state prevails, so that the houses with damaged or neglected windows need to be treated [32].

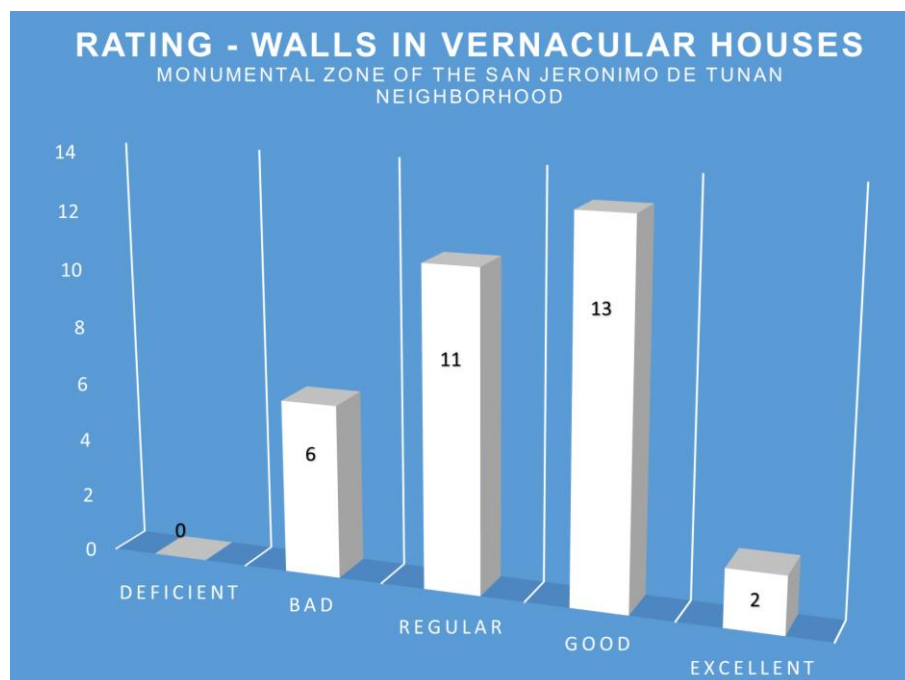


Figure 5. Rating Bar Chart - Walls in Vernacular Housing

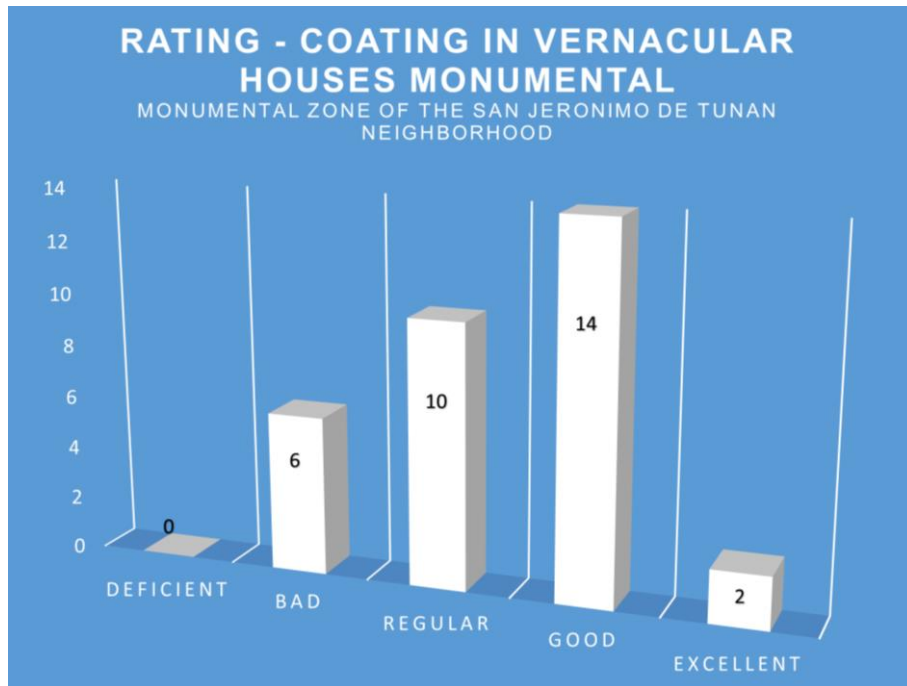


Figure 6. Rating Bar Chart - Coating in Vernacular Housing

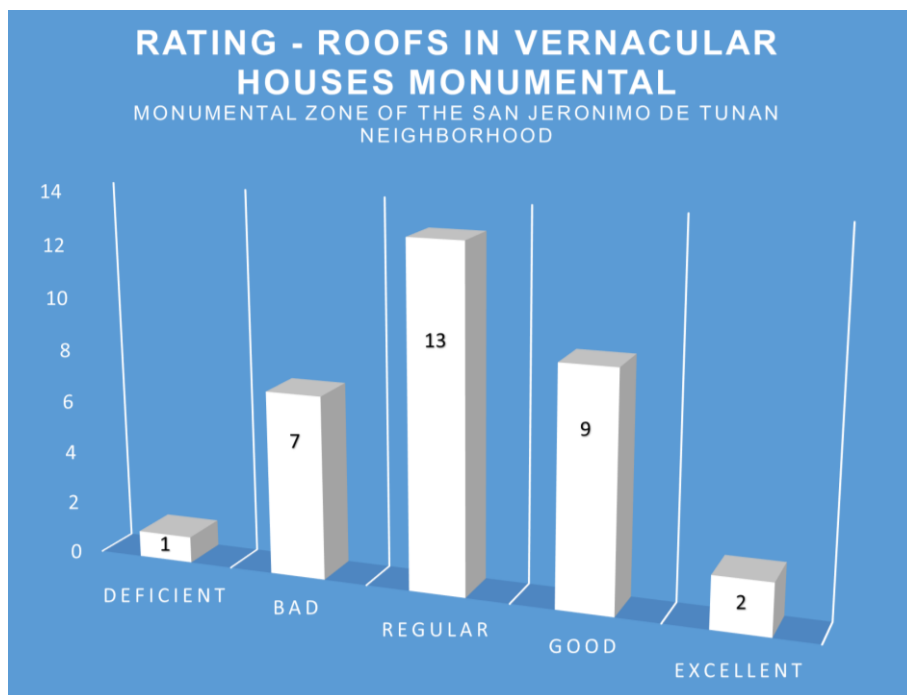


Figure 7. Rating Bar Chart - Roofs in Vernacular Housing

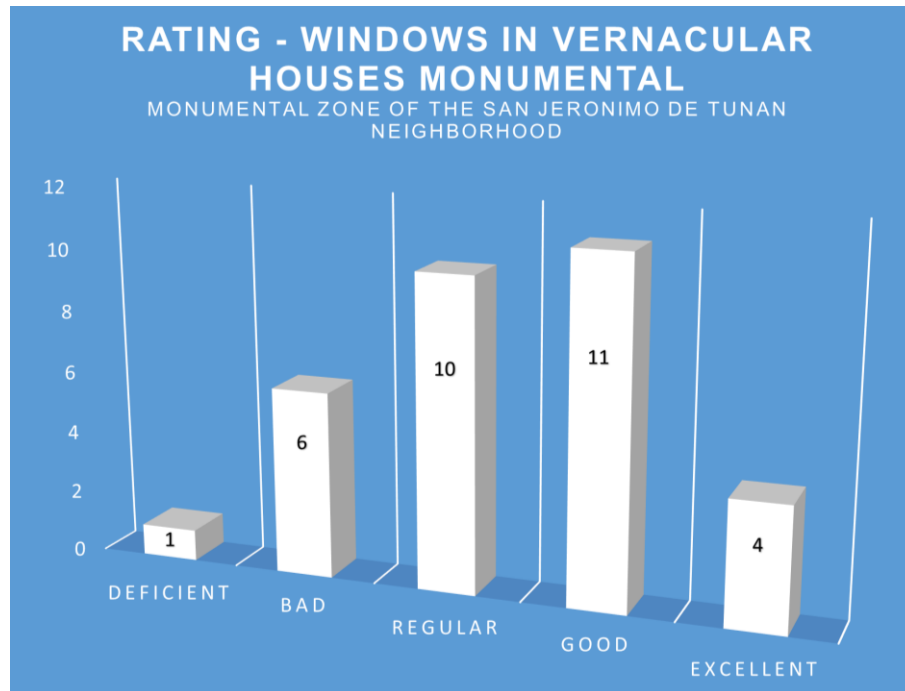


Figure 8. Rating Bar Chart - Windows in Vernacular Housing

4.5. Balconies in Vernacular Housing

Figure 9 shows that there is an equality between a "Regular" and "Deficient" status, which is of concern since balconies are remarkable elements of the colonial style, and they are with mostly null care, which may put at risk the existence of these.

Of the total number of dwellings analyzed, 7 are in a "Good" condition, reflecting acceptable maintenance, especially those close to the main square. In addition, 4 houses were registered in a "Bad" condition, with obvious damage mainly on the balconies, where the wood, the predominant material, shows an advanced deterioration [28]. Finally, 3 houses were classified in "Excellent" status. These data allow us to affirm that the balconies are the most vulnerable elements of the set, due to their direct exposure and the use of fragile materials.

Although housing generally retains its material integrity, there is evidence of a process of progressive degradation, especially in surface elements. Thus, the analysis of the current state not only documents, but also allows for the anticipation of risk scenarios: houses in "Regular" state could descend to "Bad" conditions if not addressed in time, compromising the sustainability of the vernacular set. The orderly handling of this information is key to designing conservation strategies based on real priorities. A gradual intervention is recommended, starting with the "Bad" and "Regular" elements, and reinforcing preventive maintenance in those classified as "Good" or "Excellent", thus ensuring an efficient and sustained conservation of the local architectural heritage.

The assessment of the state of conservation of the 32 vernacular dwellings identified in the monumental area of

the district of *San Jerónimo de Tunán*, carried out using an adapted Likert scale [30] (Figure 10), revealed a predominantly favorable condition. Most of the dwellings evaluated, a total of 14 units, are in the category of "Good" (range from 33 to 43 points). This indicates that although there are some minor interventions or deterioration, the architectural and material integrity of these houses is maintained at a level acceptable for their heritage preservation.

On the other hand, 9 houses were classified as "Excellent" (44-55 points), which represents a significant percentage of buildings that not only have resisted the passage of time, but also retain their traditional construction values. These dwellings can be considered as references within the urban context, serving as models for future restoration and conservation actions [12]. However, it is important to note that 9 dwellings are also located in the range of "Regular" (22-32 points). This group points to buildings that have more obvious deterioration, although they do not yet completely compromise their structure or authenticity. These dwellings require priority interventions to prevent them from falling into more deficient conservation categories in the future [9]. The existence of this number of cases in "Regular" status suggests the need to implement preventive maintenance policies and awareness programs for the local community.

A positive and relevant aspect of the results is that no dwellings were registered in the categories of "Bad" (11-21 points) or "Deficient" (0-10 points). This implies that the district's vernacular heritage has not reached critical levels of deterioration, which is a valuable opportunity to strengthen existing conservation strategies.

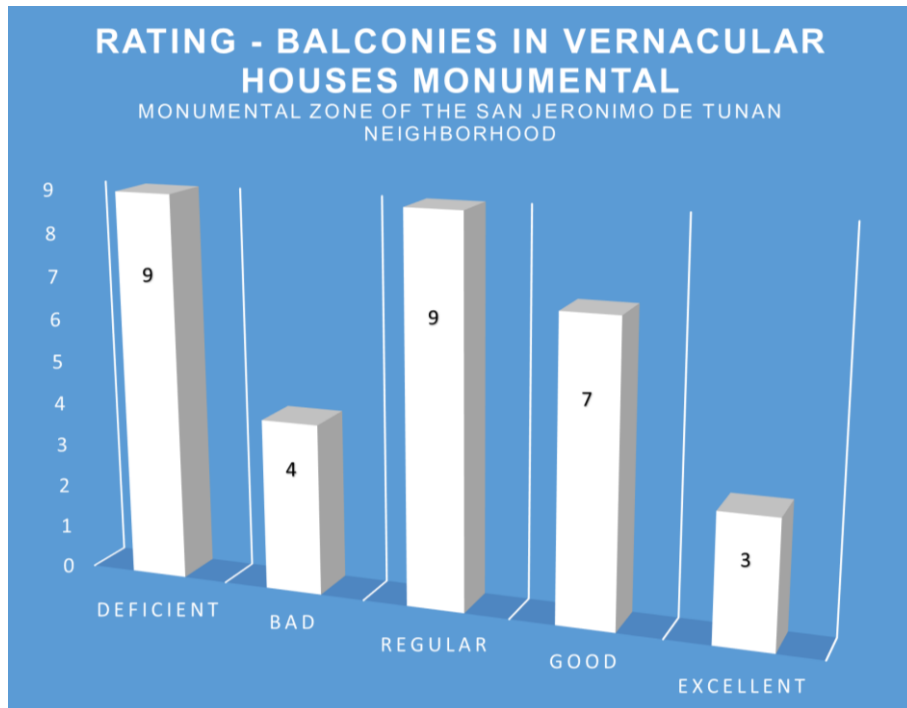


Figure 9. Rating Bar Chart – Balconies in Vernacular Housing

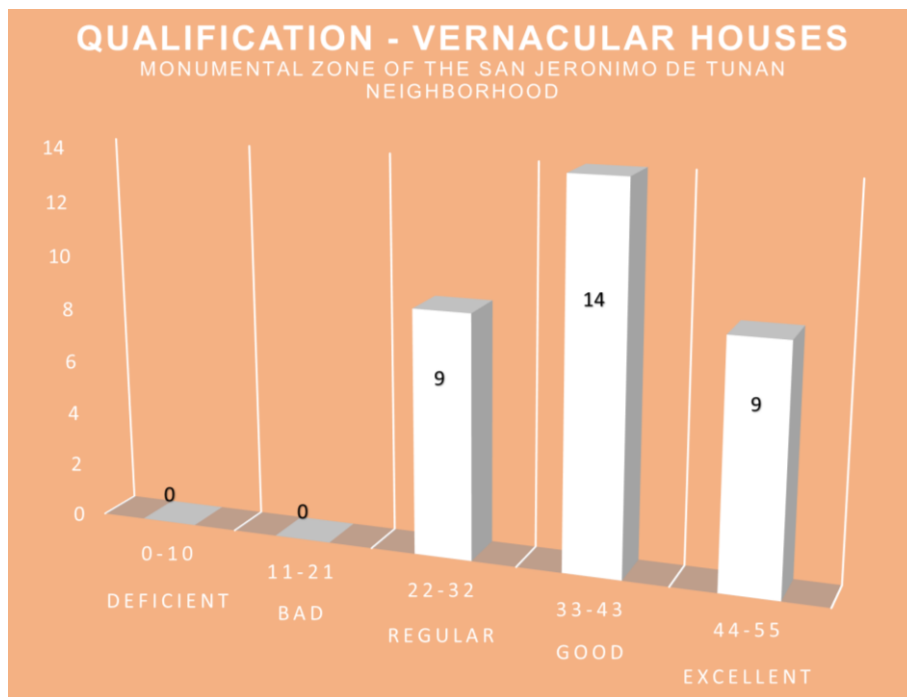


Figure 10. Sample observation sheet used to collect data on current vernacular housing conditions

In summary, the results show that the general state of conservation is favourable, although heterogeneous. While an important part of the heritage site shows optimal or good conditions, there is also a portion that requires immediate attention [33]. The future conservation of this heritage will largely depend on the implementation of technical and management actions that ensure not only the restoration of dwellings in a "Regular" state, but also the maintenance of

the level of dwellings classified as "Good" and "Excellent".

5. Discussion

The results of this research allow establishing relevant links and contrasts with international and national studies that address the conservation of vernacular heritage. In the

case of the city of Nablus, Palestine, Tawayha, Bragança and Mateus [34] analyzed the coexistence of ancient and modern buildings with vernacular characteristics, concluding that the permanence of traditional materials and techniques, such as adobe or stone contributes significantly to the visual identity of the urban environment. In this context, not only was the aesthetic function of these materials valued, but also their thermal properties and sustainability, which reinforces their relevance in cold climates. These findings are comparable to the reality of *San Jerónimo de Tunán*, where the traditional use of adobe and Andean tile remains functionally and symbolically relevant, despite the pressure of modern construction models that tend to disarticulate the coherence of the historic landscape.

In the case of Aden, Yemen, Khan, Hassan and Arab [35] highlight how architectural features inherited from the colonial period profoundly influenced the urban morphology and the perception of the citizenry. Through the mapping of vernacular elements in areas such as Crater and Al-Tawahi, they demonstrated that the revaluation of the traditional is possible through a respectful reading of original forms and proportions. This approach, focused on formal simplicity, can be extrapolated to the context of *San Jerónimo de Tunán*, where vernacular architecture should not be understood as static or purely ancestral, but as a formal and functional system adaptable to contemporary needs, without losing its identity essence. As in Aden, the recovery of colonial elements in facades, balconies or roofs has the potential to enrich the urban fabric with aesthetic, sustainable and culturally relevant solutions.

At the national level, the research developed by Paytan [36] on the Virrey Toledo pedestrian street in Huancavelica shows a common problem: the progressive transformation of heritage environments due to the loss of traditional construction techniques. His analysis of facades by means of collation sheets allowed the identification of coherent typological patterns, but also signs of urban fragmentation due to interventions alien to the context. This same procedure was replicated in *San Jerónimo de Tunán*, showing similarities in both the gradual deterioration and the potential for a structured recovery based on technical criteria and cultural values.

In light of these comparisons, the need to adopt specialized tools such as Heritage Building Information Modeling (HBIM) is reaffirmed, not only as a documentation technology, but also as a strategic support for planning informed and sustainable interventions. As pointed out by Angulo [16] and Penjor et al. [37], HBIM allows the digitization, modeling, and management of built heritage by integrating material, geometric and contextual variables, thus facilitating a more accurate, accessible, and reproducible conservation. In the case of *San Jerónimo de Tunán*, the pilot application of HBIM in Jr. Huallaga represented a first successful effort in the generation of high-fidelity three-dimensional models that faithfully document the vernacular materiality and allow simulating

restoration or deterioration scenarios.

However, this proposal faces significant challenges. Unlike contexts with clear heritage protection policies, in *San Jerónimo* there is a worrying absence of comprehensive documentation systems. This has led to informal interventions and the progressive loss of ancestral building knowledge. A paradigmatic example of this problem is the replacement of traditional dwellings with commercial buildings of generic design, such as the installation of a grocery store of the "Mass" chain in the historic center, which weakens the urban heritage fabric and its formal continuity.

In summary, both the international and national cases reviewed show that the preservation of vernacular architecture requires a rigorous technical approach, accompanied by methodological tools that go beyond mere documentation. The integration of the HBIM in contexts such as *San Jerónimo de Tunán* offers a concrete way to recover urban coherence and protect the symbolic values associated with heritage. This approach must be complemented by local regulations, community participation and heritage education, ensuring that traditional know-how is not only preserved, but evolves in harmony with the current needs of the built environment.

6. Conclusions

The research carried out in the district of *San Jerónimo de Tunán* has made it possible to construct a technical, typological, and contextual diagnosis of the state of conservation of the vernacular architecture present in its monumental zone. This approach has shown that, beyond their material condition, these buildings constitute a living heritage that reflects the historical, social and constructive legacy of an Andean community that, over time, has managed to integrate traditional knowledge with new urban dynamics.

The study shows that vernacular architecture in this district is not in a situation of critical deterioration, as is the case in other similar environments. On the contrary, a considerable percentage of the dwellings analyzed show favorable conservation conditions, mostly rated as "Good" or "Excellent" according to the Likert scale adapted to the study. This finding represents a strategic opportunity to consolidate preventive conservation programs, which, if implemented in time, could guarantee the permanence of this building typology as an articulating element of local identity and urban sustainability.

However, architectural elements were also identified with a "fair" state of conservation or with visible signs of wear, especially in balconies, roofs and cladding, which due to their direct exposure to the environment and because they are made of fragile materials such as wood and adobe, are particularly vulnerable to deterioration. This situation warns of the urgency of designing prioritized technical intervention strategies aimed at preventing such buildings

from falling into more compromised conservation categories.

The mixed methodological approach adopted in the study, which combined structured observation with ordinal assessment tools such as the Likert scale, made it possible to systematize quantitative and qualitative data in a coherent and replicable manner. This methodology not only facilitated the identification of the physical condition of the properties, but also made it possible to interpret the social, symbolic and functional value that these dwellings possess within the urban landscape. Vernacular architecture, in this context, should not be understood only as a form of the past, but as a contemporary model of sustainability that promotes the efficient use of resources, climatic adaptability and cultural continuity.

From a heritage and territorial perspective, the research has shown that the vernacular architecture of San Jerónimo de Tunán constitutes a typology with a high degree of formal coherence, morphological richness and adaptive potential in the face of the challenges of unplanned urban growth. These attributes reinforce its value not only as a property to be preserved, but also as a strategic resource for promoting culturally significant, environmentally responsible and socially inclusive urban development models.

An outstanding contribution of the study has been the incorporation of Heritage Building Information Modeling (HBIM) as a tool for advanced digital documentation of built heritage. The pilot experience demonstrated that HBIM not only facilitates the three-dimensional representation of buildings, but also enables the simulation of intervention scenarios, the detailed analysis of materials, and the generation of technical databases for heritage management purposes. This digital methodology, by integrating photogrammetry, BIM modeling and heritage analysis, strengthens technical and project decision-making in conservation, making it possible to anticipate deterioration processes and propose contextualized solutions.

In addition, the study reaffirms that the use of HBIM, in combination with methodologies such as PRISMA, can contribute to the creation of systematized heritage repositories that strengthen the institutional capacity of local and regional governments to protect, restore and enhance vernacular heritage. In this sense, it is recommended that future heritage interventions in similar contexts incorporate the HBIM as a basic tool, complemented with participatory strategies that involve local communities in the documentation and decision-making process.

More broadly, the findings of this research align with the principles of the Sustainable Development Goals, especially SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action), by demonstrating that the conservation of vernacular architecture can contribute to urban sustainability through the reuse of local materials, the energy efficiency of traditional building systems, and

the recovery of the urban fabric with criteria of identity and functionality.

Finally, the case of *San Jerónimo de Tunán* is consolidated as a methodological and practical reference for the conservation of vernacular architecture in the Peruvian Andes. Its experience demonstrates that it is possible to articulate tradition and technology, past and future, through integrative approaches that consider both the tangible and intangible dimensions of heritage. It thus proposes. This is a replicable model for other districts with similar characteristics, where architectural heritage can become the axis of positive transformation, cultural resilience and sustainable development.

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