SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 4, (2026), pp. 4070-4080
Open Access. Online & Print

DOI: 10.5281/zenodo.12426460

HABITABILITY CONDITIONS IN SOCIAL HOUSING IN ECUADOR: CASE STUDY OF TENA CANTON

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Received: **26/11/2025**
Accepted: **17/01/2026**

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ABSTRACT

The housing deficit in Ecuador underscores the necessity to assess the quality of social housing, particularly in the canton of Tena, where vulnerable populations encounter insecure living conditions. Despite the implementation of national programs designed to mitigate this disparity, there is a paucity of studies that systematically analyze habitability standards. This lacuna in research results in a deficiency in understanding how these homes respond to the real needs of their inhabitants. The present study employed a quantitative, exploratory, and descriptive methodology, adapting the habitability assessment model of Abadi and Martín (2009) to the local context. The fieldwork encompassed the evaluation of 221 dwellings, dispersed across 14 sectors and categorized into eight typologies. The data collection process entailed a multifaceted approach, encompassing structured observation, field surveys, and the implementation of nonparametric statistical tests, including Kruskal–Wallis and Dunn's post-hoc analysis. The findings indicate considerable variability in habitability, with deficiencies in spatial dimensions, ventilation, access to fundamental services, and internal configuration. Certain sectors and types demonstrated a decline in performance, falling below the established minimum standards. Conversely, other sectors and types exhibited the adoption of best practices, setting new benchmarks for excellence. The study provides a contextualized assessment and offers relevant contributions to public policy. It emphasizes the necessity of updating design and construction standards to ensure decent living conditions in future social housing projects.

KEYWORDS: Social housing, habitability, living conditions, quality of life, sustainable design, Tena.

1. INTRODUCTION

The housing deficit is a global problem that affects all countries at different levels, especially in urban areas. It is projected that by 2050, 70% of the world's population will live in cities, with a high percentage of young people, intensifying challenges such as poverty and quality of life. In Latin America and the Caribbean, more than 75% of the population already lives in urban areas, facing social and environmental deterioration (Chavez & Bello, 2022) .

Population growth, estimated at more than 1 billion people in 15 years, together with the construction sector, responsible for 40% of greenhouse gas emissions, raises the need to explore sustainable alternatives in design and construction (Molina Maya, 2020). Social housing has emerged as a response to these problems, addressing both urban densification and basic needs, especially after historical events such as the World Wars (Blázquez de Pineda, 2019) .

In Ecuador, the 2008 Constitution guarantees the right to decent housing as a social good, obliging the State to guarantee this right (CRE, 2008). Social housing must go beyond meeting minimum needs, promoting decent and adequate spaces for human development, avoiding overcrowding and unsanitary conditions. Innovation and research are essential to achieving this goal (Chavez & Bello, 2022).

Considering the Ecuadorian context, there is evidence of a significant housing deficit in terms of both quality and quantity of housing. According to data from the National Institute of Statistics and Census (National Institute of Statistics and Census, 2022) , it is estimated that 14.4% of homes in Ecuador have a housing deficit from a quantitative perspective, while the qualitative deficit reaches 31.8%. This means that approximately 46.2% of the population evaluated faces housing problems. In addition, the Ministry of Urban Development and Housing (2019) reported that the housing deficit in Ecuador exceeds 2.8 million homes, and it is estimated that 351,000 homes have a quantitative deficit, that is, they are homes in irrecoverable conditions that need to be replaced entirely due to their condition and construction materials. These problems have led to the development of programs that seek to offer housing solutions, such as the National Habitat and Housing Plan to provide housing solutions to citizens with limited financial resources, although in many cases the repetitive approaches are not adapted to the real needs of the target populations or the specific climatic conditions of each region (Molina Maya, 2020) .

The housing deficit in Ecuador has led public and private organizations to develop initiatives focused on social housing to serve the most vulnerable population. The Ministry of Urban Development and Housing (MIDUVI) regulates this sector through regulations and policies with the aim of guaranteeing decent housing and complying with the rights established in the Constitution. In the case of the canton of Tena, where many people live in peripheral settlements, problems such as cramped spaces and construction deficiencies in social housing are particularly noteworthy.

Research on living conditions in Tena is relevant both theoretically and practically. It will allow for the evaluation and improvement of housing conditions, generating strategies for future projects in the country. In addition, it will facilitate the implementation of corrective measures by local authorities and other actors to improve the quality of life of residents.

The feasibility of this research is supported by the availability of resources and information, which will allow for field studies and realistic recommendations. Its results will directly impact on the well-being of beneficiaries by improving living conditions and promoting safe and healthy environments. It will also benefit planners and authorities, who will be able to apply the recommendations to ensure adequate standards in future projects.

2. LITERATURE REVIEW

The housing deficit is a global problem that affects both industrialized and developing countries. Various studies have shown that rapid urban population growth and the limitations of states to guarantee adequate housing generate contexts of inequality and exclusion (Chavez & Bello, 2022). Globally, it is estimated that by 2050, nearly 70% of the population will live in cities, intensifying the challenges of access to decent housing, basic services, and environmental sustainability (UN-Habitat, 2021).

In Latin America and the Caribbean, more than 75% of the population lives in urban areas, where there are high rates of overcrowding, poor construction, and a lack of adequate public services (Blázquez de Pineda, 2019) . This situation has led to the proliferation of social housing programs, conceived as a strategy to respond to both urban densification and the satisfaction of basic needs. However, regional research agrees that, in many cases, these solutions reproduce standardized construction models that do not respond to the climatic, cultural, or social conditions of each territory (Chavez & Bello, 2022).

In Ecuador, the 2008 Constitution recognizes housing as a right and obliges the State to guarantee access to it. However, the housing deficit persists, affecting 46.2% of the population, either due to a lack of quantity (quantitative deficit) or inadequate conditions in existing housing (qualitative deficit) as shown by the National Institute of Statistics and Census (2022). According to MIDUVI (2019) , more than 2.8 million homes have infrastructure, material, or habitability problems, which highlights the magnitude of the problem. Recent studies emphasize that many public policies have prioritized the number of units built over the quality of the spaces, generating projects that do not always adapt to the social and environmental particularities of the country (Molina Maya, 2020) .

Academic literature has also addressed the relationship between habitability and quality of life, highlighting that decent housing must consider aspects such as thermal comfort, ventilation, natural lighting, privacy, and integration with the urban environment (Abadi & Martín, 2009). However, evidence in Ecuador is still limited and focuses mainly on large cities, leaving aside Amazonian and rural areas, where problems of access to housing are compounded by extreme climatic conditions and unique cultural dynamics.

This knowledge gap justifies the need for research that analyzes the habitability of social housing in specific contexts such as the Tena canton. By focusing on an Amazonian region, this study contributes to filling an empirical and theoretical gap, while offering guidelines for differentiated and contextualized policies.

3. METHODOLOGY

The methodology should describe in detail how the research was conducted, the approach adopted, the information production techniques used, and the period during which the study was carried out. Depending on the type of research, the sampling procedure or case study selection process should be indicated. It should also clearly describe the data collection strategy, its analysis, and the methodology used.

A brief description of the location or case study may be included to contextualize the research.

3.1 Study site

The Tena canton, located in the province of Napo in northeastern Ecuador, is found in the Very Humid Tropical Rainforest ecosystem. The altitude in the region varies from levels close to sea level to approximately 530 meters, which contributes to a remarkable diversity of landscapes and ecosystems (Pourrut, 1983) .

The climate in Tena is characteristic of tropical areas, with an average annual temperature of around 24°C. However, a distinctive feature of this canton is its high rainfall, which reaches 3000 mm per year. These rains are crucial for maintaining the lush vegetation of the tropical forest and sustaining regional biodiversity (Pourrut, 1995).

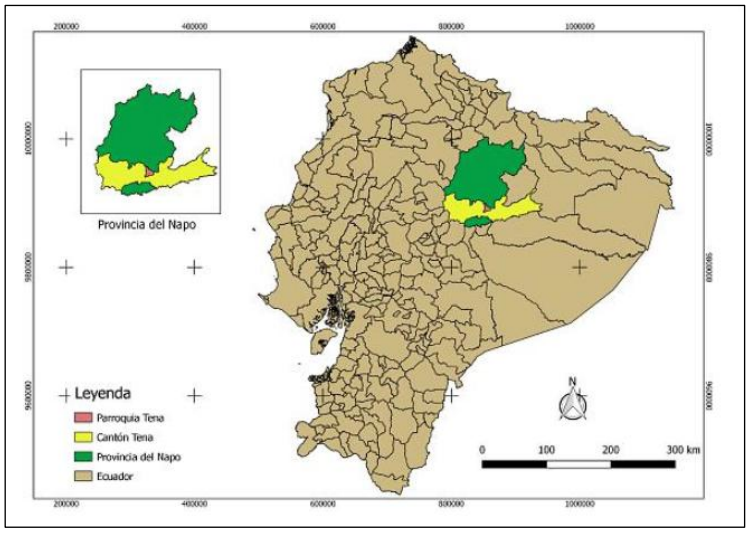

Figure 1. Location of the study site.
Source: Carrión et al. (2023).

3.2 Climate parameters

Table 1 summarizes the results of the analysis of key climate parameters in the study area, such as temperature, humidity, solar radiation, wind speed, precipitation, and cloud cover. This analysis is

essential for planning strategies that optimize habitability conditions, providing a solid basis for implementing bioclimatic solutions adapted to the needs and particularities of the region.

Table 1. Table of results for climatic factors in Tena

Factor	Average result	Impact on climate
Temperature	Annual average of 23.7°C	The study area experiences high temperatures, reaching maximums of up to 33°C, which characterizes the sector as notably warm.
Humidity	Annual average of 89%	In terms of humidity, a high percentage is observed, with values reaching 96%, placing this area outside the typical levels of humidity comfort, which generally range between 30% and 70%.
Solar radiation	Annual average incident radiation of 338.57 and annual average diffuse radiation of 238.52 W/m2	During October, there is significant solar radiation, with levels around 400 W/m2, and there is a notable incidence of radiation from the east and west.
Wind	Annual average of 0.89 m/sec	Wind speed remains at an average of 0.89 m/sec, which is considered within the optimal range for comfort according to Fuentes (2002).
Precipitation	Annual average of 4,193 mm	The region also reports heavy rainfall throughout the year, accumulating more than 4,193 mm. This favors the growth and sustenance of native vegetation, which is essential for the application of bioclimatic strategies in the area, as indicated by Piña (2019).
Source: Heredia and Ballesteros (2025).		

First, existing social housing projects in the canton of Tena were identified. To this end, information provided by the Ministry of Urban Development and Housing (MIDUVI) was analyzed, which recorded the construction of approximately 27 projects, totaling 616 social housing units between 2007 and 2022. This information served as the basis for classifying the homes by area and type of Social Interest Housing (VIS).

MIDUVI provided a preliminary list with the names and approximate sectors of Social Interest Housing (SIH). However, the lack of precise information on their locations made it difficult to locate some projects, which could not be included in the study. In addition, the research focused mainly on sectors close to the urban center of Tena, excluding projects located in more remote areas or with limited road access.

Direct observation of the housing required multiple field visits to determine the exact location of the projects and establish contact with residents willing to participate in the study. During these visits, a detailed inspection of the housing models was carried out using observation sheets that included schematic drawings of the layout of the spaces and photographic records, with the aim of assessing both the physical condition of the housing and the conditions of the subdivision.

3.3 Sectors

Social housing was identified in fourteen specific sectors within the canton of Tena. These sectors, located in the parishes of Tena, Misahuallí, Pano, and Ahuano, include Amadén, 21 de Enero, Alto Ongota, Nuevo Ongota, Muyuna, Tazayaku, San Pedro, Barrio La Unión, Shiripuno, Atahualpa, Ahuano, Pakaichikta, Unión Venecia, Pumayaku, and Buen Pastor. Each of these sectors offers a unique insight into the diversity of housing environments available, from more urbanized areas with well-developed infrastructure and access to basic services, to more peri-urban or rural areas that offer a quieter environment connected to nature.

The study focused on areas with a dense concentration of social housing, excluding isolated dwellings in more remote locations. Table 2 summarizes the sites of interest in the study and the assignment code corresponding to each sector.

Table 2. Sectors and code assignment

Parish	Sector	Code
Tena	January 21	Z01
Tena	Amadén	Z02
Tena	Alto Ongota	Z03
Tena	New Ongota	Z04
Tena	La Unión neighborhood	Z05
San Juan de Muyuna	Muyuna Center	Z06
San Juan de Muyuna	Tazayaku	Z07
San Juan de Muyuna	San Pedro	Z08
Misahuallí Port	Shiripuno	Z09
Ahuano	Pakaichikta	Z10
Ahuano	Ahuano	Z11
Misahuallí Port	Unión Venecia	Z12
Pano	Pumayacu	Z13
Tena	Buen Pastor	Z14
Source: Heredia Frank, 2024.		

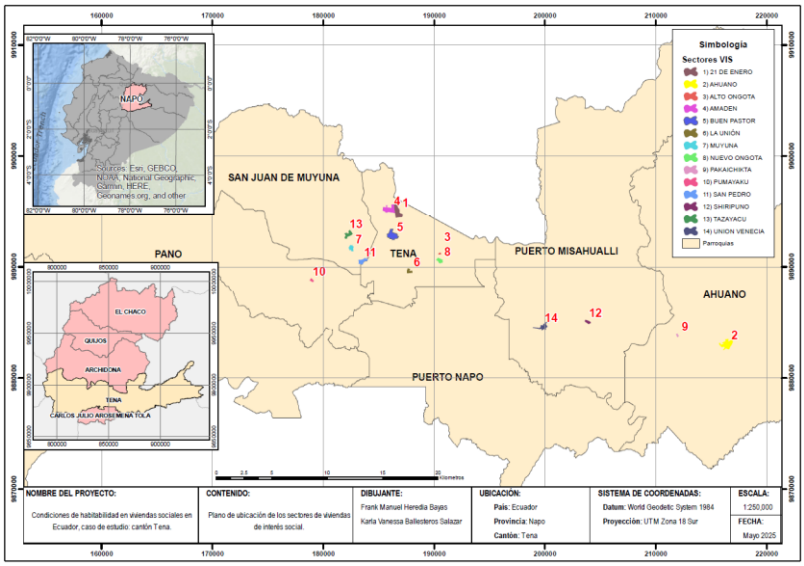

Figure 2. Map of VIS sectors in the canton of Tena.
Source: Heredia and Ballesteros, 2025.

3.4 Types of social housing

Using information provided by the Ministry of Urban Development and Housing (MIDUVI), a series of visits were made to sectors identified as having social housing in the canton of Tena. These visits not only confirmed the data received from MIDUVI, but also revealed the existence of other sectors with social housing that had not been previously registered. During these visits, a meticulous photographic record was made, which allowed for the documentation of the various types of housing observed, identifying a total of eight different types in the fourteen sectors.

The purpose of identifying types of social housing is to provide a visual and descriptive comparison of the dwellings, thus facilitating the identification of common patterns and significant differences between the various existing dwellings.

Each type of social housing has been documented in detail to provide a comprehensive overview of its construction characteristics and aspects relevant to the study in question, generating summary sheets for ease of identification. The sheets include reference images, layout, and dimensions of the spaces, supplemented with relevant notes and observations.

3.5 Habitability conditions sheet

Given the importance of social housing in Ecuador, an applied research design with an exploratory and descriptive approach was chosen. This design allows for the study of the habitability conditions of selected social housing units from various existing projects in the canton of Tena, through the on-site application of quantitative forms, in order to determine their compliance with minimum habitability standards and identify areas for improvement.

There are different methodologies for assessing habitability and addressing social housing. In this case study, the methodology developed by Abadi and Martín(2009) , was adapted and used, which had previously been used in similar studies in Caracas, Venezuela. This method considers both physical aspects of the dwelling and its plot, as well as factors related to the immediate environment and available services. The habitability indicators were reviewed and adjusted, taking into account external factors that significantly impact the well-being of occupants.

Indicators used in the evaluation form:

- Types of housing: detached, semi-detached, or terraced.
- Lot area.
- Lot frontage.
- Housing area.
- Pedestrian access to the dwelling.
- Parking spaces.
- Housing growth.
- Spatial components of the housing.
- Separate living areas for 4, 5, and 6 people.
- Separate dining rooms for 4 and 6 people.
- Integrated living rooms and dining rooms for 4 and 6 people.
- Kitchens.
- Laundry rooms.
- Bedrooms: master, double, and single.
- Bathrooms.

- Internal circulation areas.
- Storage area
- Height of the different spaces in the home.
- Natural lighting in the spaces of the home.
- Sun exposure of the spaces in the home.
- Natural ventilation of the spaces in the home.
- Environmental protection.
- Electrical installations in the home.
- Plumbing installations in the home.
- Rainwater drainage.
- Other services: telephones, direct gas, garbage collection.
- Construction system: efficiency and durability of materials and finishes.
- Internal and external privacy.
- External appearance of the home.
- Treatment of outdoor areas.
- Construction safety and risk.
- Security against theft and vandalism.
- Distance to school services, nurseries, preschools, schools.
- Distance to parks and sports fields.
- Distance to local shops.
- Distance to medical clinic
- Distance to public transportation stops

At the national level, variables related to habitability were defined in accordance with current Ecuadorian regulations and standards, such as the Ecuadorian Construction Standard (NEC). Specific variables adapted to the local context were also incorporated, including aspects such as minimum area and height of spaces, natural lighting, and ventilation, among others. These indicators were adjusted in accordance with the Development and Land Use Plan (PDOT) of the canton of Tena to ensure their relevance and applicability in this study. Due to the lack of specific regulations, general architectural design guides and manuals were used, such as the Dimensional Efficiency Study developed by Abadi and Martín.

Each indicator was evaluated on a four-point scale: 0 for cases that did not meet the minimum conditions or generated habitability problems, 1 for those that met the minimum established by the standards, 2 for those that, in addition to meeting the minimum, proposed additional improvements, and 3 for those that met all parameters, including criteria from general architectural design manuals. The indicators or criteria used in the habitability conditions sheet are weighted according to their level of importance for the calculation of the total habitability score.

4. RESULTS

4.1 General descriptive statistics

To characterize the study sample, the results of the 221 social housing units (VIS) evaluated in the canton of Tena were analyzed. Based on the application of the technical form composed of 37 habitability criteria, a total score per dwelling was obtained, expressed on a quantitative scale. With these results, a descriptive statistical analysis was performed to identify general trends and variations in habitability levels, as shown in Table 3.

Table 3. Descriptive statistics of the total habitability score.

Statistic	Value
Minimum	40
Maximum	65
Range	25
Average	51.74
Median	51
Fashion	51
Standard deviation	5.35
Source: Heredia and Ballesteros, 2025.	

The results indicate that the average habitability score is 51.74 points, with a standard deviation of 5.35, suggesting moderate dispersion among the values. The minimum score recorded was 40 and the maximum was 65, presenting a total range of 25 points. The median and mode coincided at 51 points, reflecting a relatively balanced central distribution around that value. In general, most homes have average habitability levels, with no extreme outliers, suggesting a certain homogeneity in the housing conditions of the sample evaluated.

4.2 Nonparametric statistical analysis for group comparison

To assess whether habitability conditions differ significantly between the different types of social housing and between the geographical sectors of the Tena canton, non-parametric statistical tests were used, which do not require the assumption of normality or homogeneity of variances in the data. First, the Kruskal–Wallis test was applied separately to the total habitability scores, taking the 11 housing types as the grouping factor and, in a second analysis, the 14 sectors. As an alternative to single-factor ANOVA, this test ranks all habitability values from lowest to highest and calculates the H statistic on the average ranges of each group, contrasting the null hypothesis (H_0) of equality of medians against the alternative hypothesis (H_1) that at least one category has a distinct med . A significance level of $\alpha = 0.05$

was set to determine the statistical relevance of the findings (Conover, 1999) .

If the Kruskal–Wallis statistic is significant ($p < 0.05$), the groups that differ from each other will be identified using Dunn's post-hoc test with Bonferroni correction. This stage allows for paired comparisons while controlling for the increase in the type I error rate that could result from multiple contrasts (Dunn, 1964) . In this way, the pairs of typologies or sectors whose habitability levels show true differences, beyond the variations inherent in the sampling, will be identified.

4.3 Sector as a grouping factor

The Kruskal–Wallis test applied to the weighted habitability scores according to the 14 geographical areas yielded a statistical value (H) of 178.23 and a p-value of 3.90×10^{-31}.

Given that the p-value is much lower than the commonly used significance level ($\alpha = 0.05$), the null hypothesis that there are no differences in the distribution of habitability scores between sectors is rejected.

Figure 3. Box plot of habitability scores by sector.
Source: Heredia and Ballesteros, 2025.

The results confirm that there are statistically significant differences ($p < 0.001$) in habitability levels among the 14 sectors evaluated. This finding demonstrates that the quality of social housing is not uniform, but varies substantially according to its geographical location. Sectors Z07, Z03, and Z11 stand out for having the highest habitability scores, with medians of 61, 60, and 58.5, respectively, suggesting that these areas may be better designed, built, or maintained compared to others.

In contrast, sectors Z10, Z12, and Z02 show the lowest performance, with medians between 44 and 47 points, indicating critical problems that require immediate attention. Dunn's post-hoc test confirmed statistically significant differences between the VIS of these sectors and those with the best performance (p-adjusted < 0.001), confirming the need to establish improvement measures.

Finally, sectors Z04 (median = 52.0) and Z13 (median = 51.0) are close to the overall median, suggesting intermediate performance and the possibility of improvement in specific areas.

These disparities have important implications for public policy. Sectors with low scores should be prioritized in housing improvement programs, as their deficiencies could be directly affecting the quality of life of their residents. Meanwhile, sectors with better results, such as Z07, could serve as models to be replicated in future projects. However, it is important to recognize that this analysis does not identify the specific causes behind these differences. Factors such as the age of housing, access to basic services, or even socioeconomic aspects could be influencing these results.

4.4 Typology as a grouping factor

The Kruskal–Wallis statistic H =187.77 compared to the critical value $X^2_{0.05,10}$ =18.31 indicates that the observed result far exceeds the threshold necessary to reject the null hypothesis at the 5% significance level.

In practical terms, this means that it is not plausible that the 11 housing typologies come from the same distribution of habitability scores. The fact that H is so much higher than the critical value implies an extremely low p-value ($p < 0.001$), which reinforces the certainty that there are significant differences in the medians of the habitability scores between at least two types. Therefore, at least one pair of types differs statistically significantly in their level of habitability.

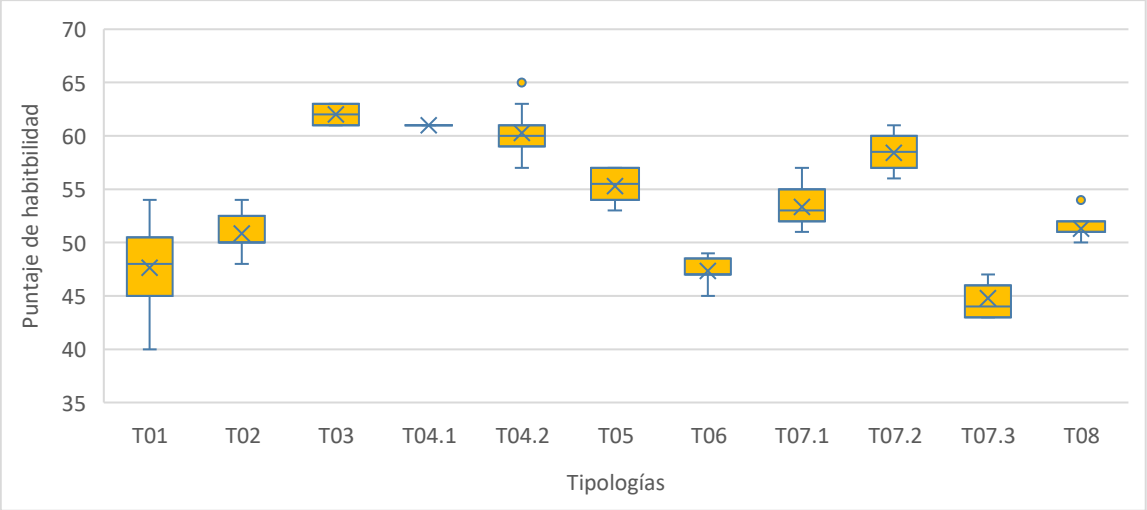

Figure 4. Box plot of habitability scores by type.
Sources: Heredia and Ballesteros, 2025.

Considering the results of the Kruskal-Wallis test, using typologies as the grouping factor, a Dunn post-hoc test (with Bonferroni or Holm post- action) is performed to identify exactly which typologies exhibit these specific differences.

The results reveal that types T03 and T04.1 stand out for having the highest weighted habitability medians, with 62.0 and 61.0 respectively, accompanied by narrow interquartile ranges that indicate a homogeneous distribution of high scores. These configurations reflect favorable and consistent performance in most of the criteria evaluated, constituting benchmarks of good practice in terms of habitability.

Similarly, types T04.2 (median = 60.0) and T07.2 (median = 58.5) show high scores above the overall median (51.0), with a distribution of values that shows few negative outliers. These characteristics suggest adequate and sustained conditions in key components, positioning them as efficient housing configurations.

At an intermediate level are types T05 (median = 55.5) and T07.1 (median = 53.0), whose central values exceed the average for the set of dwellings evaluated, but which exhibit greater dispersion in the results. This variability suggests that, although they perform acceptably overall, there are internal differences that could be due to variations in construction, maintenance, or use of the dwelling, so it would be advisable to review in detail the specific criteria that generate this dispersion.

On the other hand, types T01, T06, and T07.3 reflect the lowest habitability scores, with medians of 48.0, 47.0, and 44.0, respectively. These configurations are not only below the overall median but also have more pronounced lower tails in their distributions, indicating the presence of housing units with poor conditions. Dunn's post-hoc test confirmed statistically significant differences between these typologies and those with the best performance (p-adjusted < 0.001), reinforcing the need to establish specific corrective measures. Finally, types T02 (median = 50.0) and T08 (median = 51.0) are close to the overall median, suggesting moderate but improvable performance. These configurations could benefit from specific interventions to reinforce those criteria that have not yet reached optimal levels.

4.5 Habitability patterns

The assessment using the habitability conditions checklist has revealed important data on the diversity of housing types and has provided a solid quantitative basis for understanding how these structures meet the needs of residents.

Table 3 and Table 4 highlight the critical aspects of social housing in the canton of Tena, focusing on criteria that do not meet or barely meet the minimum desirable standards. This approach aims to identify the most urgent points of intervention which, once improved, could have a significant impact on the quality of life of the inhabitants.

Both tables are composed of the average scores obtained for each criterion listed in the Methodology section**Error! Reference source not found.** . In these tables, the cells highlighted in red indicate the criteria that do not meet the recommended minimum habitability standards, the yellow cells indicate the types that just meet the minimum, and the green cells indicate those that exceed these standards.

It is important to note that the absence of scores in certain areas of the matrix is because certain criteria

are not applicable to the homes evaluated. For example, all homes have an integrated living and dining room space, so criteria 9 and 10, which assume separate areas, are not relevant in this context.

Table 4. Average score by type and number of criteria (16-32).

Type/Criterion	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14.a	C14.b	C14.c	C15
T01	3.0	6.0	5.3	0.0	2.1	0.9	1.0	1.0			0.0	0.0	0.0	0.0	0.0	3.0	1.0
T02	3.0	6.0	6.0	0.0	2.0	1.2	1.0	1.0			0.0	0.0	0.0	0.0	0.0	1.0	0.0
T03	3.0	6.0	5.3	0.0	2.0	1.0	1.0	1.0			2.0	3.0	0.0	1.0	1.0		3.0
T04.1	3.0	6.0	4.0	0.0	3.0	1.0	1.0	1.0			0.0	3.0	2.0	1.0	2.0		3.0
T04.2	3.0	6.0	5.9	0.0	3.0	0.9	1.0	2.0			0.0	2.7	1.0	0.0	0.0	1.0	3.0
T05	3.0	6.0	6.0	0.0	2.0	1.5	1.0	1.0			0.0	0.4	0.0	0.0	0.0	2.0	0.0
T06	3.0	6.0	6.0	0.0	2.9	1.0	1.0	1.0			0.0	0.0	0.0	0.0	0.0	2.0	0.0
T07.1	3.0	6.0	6.0	0.0	3.0	0.8	2.0	1.0			0.0	0.2	0.0	0.0	0.0	2.0	0.0
T07.2	3.0	6.0	2.0	0.0	3.0	0.0	2.0	1.0			0.0	0.5	1.0	0.0	0.0	2.0	0.0
T07.3	3.0	2.0	2.0	0.0	3.0	0.0	2.0	1.0			0.0	0.3	0.0	0.0	0.0	2.0	0.0
T08	3.0	6.0	6.0	0.0	2.0	0.1	1.0	1.0			0.0	0.6	0.0	0.0	0.0	1.0	0.0
MIN	1.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
MAX	3.0	6.0	6.0	6.0	3.0	2.0	2.0	3.0	6.0	3.0	3.0	3.0	3.0	9.0	9.0	9.0	3.0
Average	3.0	5.6	5.0	0.0	2.5	0.8	1.3	1.1			0.2	1.0	0.4	0.2	0.3	1.8	0.9
Type/Criterion	**C16**	**C17**	**C18**	**C19**	**C20**	**C21**	**C22**	**C23**	**C24**	**C25**	**C26**	**C27**	**C28**	**C29**	**C30**	**C31**	**C32**
T01	0.0	0.0	0.0	1.0	1.2	0.0	1.0	1.0	1.7	0.0	1.8	1.0	1.6	0.0	0.0	1.4	0.0
T02	3.0	0.0	0.0	2.0	0.3	0.0	1.0	0.0	1.4	0.0	2.0	1.0	0.2	0.0	0.0	1.2	2.0
T03	3.0	0.0	0.0	2.0	1.3	0.0	1.0	0.0	2.0	0.0	1.7	1.0	1.0	0.0	0.0	1.0	2.0
T04.1	3.0	0.0	0.0	2.0	2.0	0.0	1.0	0.0	1.0	1.0	3.0	1.0	1.0	1.0	0.0	1.0	0.0
T04.2	3.0	0.0	0.0	2.0	1.6	0.0	1.0	0.0	1.4	1.0	1.9	1.0	0.6	1.0	0.0	1.2	0.0
T05	3.0	0.0	0.0	2.0	0.5	0.0	1.0	0.0	2.0	0.0	2.4	1.0	1.1	0.0	0.0	1.0	2.0
T06	0.0	0.0	0.0	2.0	1.0	0.0	1.0	0.0	2.0	0.0	1.1	1.0	1.9	0.0	0.0	0.0	0.0
T07.1	1.0	0.0	0.0	2.0	1.0	0.0	0.0	0.0	2.0	1.0	1.4	2.0	3.0	1.0	0.0	1.8	2.0
T07.2	1.0	0.0	0.0	2.0	1.0	0.0	1.0	0.0	2.0	1.0	2.4	2.0	0.0	1.0	2.0	1.5	2.0
T07.3	1.0	0.0	0.0	2.0	0.0	0.0	1.0	0.0	2.0	1.0	1.6	2.0	0.0	1.0	0.0	1.0	2.0
T08	3.0	0.0	0.0	2.0	1.0	0.0	1.0	0.0	2.0	0.0	1.6	1.0	0.8	0.0	0.0	1.1	2.0
MIN	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
MAX	3.0	3.0	2.0	2.0	2.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	4.0
Average	1.9	0.0	0.0	1.9	1.0	0.0	0.9	0.1	1.8	0.5	1.9	1.3	1.0	0.5	0.2	1.1	1.3
Source: Heredia and Ballesteros, 2025																	

The evaluation results reveal persistent problems affecting all or most of the types analyzed, highlighting critical areas that require urgent intervention.

One of the most significant challenges is the insufficient amount of space in the dwellings, as reflected in criterion 4 of Table 4, where no typology even achieves the minimum required score. In addition, specific typologies such as T07.2, T07.3, and T08 face restrictions that prevent vehicle parking (C6) due to factors such as the layout of the dwelling, insufficient setbacks, slopes of the land, and lot size.

5. DISCUSSION

The results obtained in this study confirm that social housing in the canton of Tena shows marked heterogeneity in its habitability conditions. This variability is expressed both between geographic sectors and between construction types, as evidenced by statistically significant differences in habitability scores. While some models achieve values close to acceptable standards, others fall below the minimum threshold, reflecting inequality in the quality of the projects and their construction processes.

These findings are consistent with previous studies in Latin America, which point to the reproduction of standardized social housing schemes that are insensitive to the climatic and cultural particularities of each region (Chavez & Bello, 2022; Blázquez de Pineda, 2019). In the case of Tena, the application of designs conceived for Andean or coastal urban contexts has resulted in homes with problems of thermal comfort, poor ventilation, and spatial limitations. This pattern reproduces the gap identified by Molina (Molina Maya, 2020), who highlights that housing policies in Ecuador have prioritized the quantity of units built to the detriment of quality and socio-environmental relevance.

The analysis by typology showed that configurations T01, T06, and T07.3 have the most critical conditions, with scores well below the overall median. These results suggest deficiencies in architectural planning and property adaptation, which directly affect the well-being of residents. The presence of small spaces, lack of cross ventilation, and deficiencies in basic services increase the h l

vulnerability of these families, especially in an Amazonian context characterized by high temperatures, extreme humidity, and heavy rainfall.

In contrast, types T03 and T04.2 performed remarkably well, with above-average habitability levels. These configurations incorporate better ventilation solutions, greater flexibility in internal layout, and dimensions that are more suited to family needs. These results can be considered benchmarks for good practice, as they demonstrate that it is possible to design social housing projects that are better adapted to local conditions. The challenge lies in replicating these lessons and establishing regulatory guidelines that consolidate them as a standard in future housing programs.

The discussion of these findings should be framed within the debate on the right to decent housing, recognized by the Ecuadorian Constitution (CRE, 2008) . Evidence shows that, although there are institutional efforts to reduce the housing deficit, inequalities persist that compromise the quality of life of large sectors of the population. As international studies point out , social housing should not be conceived solely as a physical asset, but as an integral space that guarantees well-being, security, and human development.

In methodological terms, the use of the Abadi and Martín framework (2009) allowed to capture critical dimensions of habitability and adapt them to the Amazonian context. The application of nonparametric tests such as Kruskal–Wallis and Dunn strengthened the validity of the findings by confirming significant differences between groups. However, one limitation of this study is the exclusion of certain housing projects due to difficulties in access and location, which prevents the results from being generalized to the entire canton. Future research should incorporate probabilistic sampling techniques and consider the socioeconomic factors of residents to enrich the analysis.

In practice, the results underscore the need for differentiated housing policies that recognize Ecuador's territorial diversity. In the case of Tena, adapting architectural designs to the humid tropical climate is essential to ensure thermal comfort and the durability of buildings. The incorporation of bioclimatic strategies, such as ventilated roofs, cross ventilation, and rainwater harvesting, could significantly improve living conditions without increasing costs.

Likewise, it was identified that the lack of access to community services, especially health services, represents a structural limitation that goes beyond the scope of housing. This implies the need for comprehensive urban planning that articulates the provision of housing with health, education, recreation, and transportation facilities. In this sense, public policy should go beyond the delivery of isolated housing units and focus on the consolidation of comprehensive settlements, with basic infrastructure and services that promote social cohesion and local development.

Finally, the results offer theoretical contributions to the field of habitability studies by demonstrating the relevance of a territorial and contextualized approach. While much of the literature focuses on consolidated urban contexts, this study shows how Amazonian conditions pose specific challenges that must be considered in the formulation of public policies. Thus, it reinforces the idea that there is no single model of social housing applicable to all territories, but rather that it is necessary to promote flexible and culturally sensitive solutions.

The discussion of the results reaffirms that the challenge of social housing in Ecuador is not only quantitative but also qualitative. Overcoming the identified deficiencies requires updating design and construction regulations, strengthening territorial planning, and ensuring that projects respond to the particularities of each region. Only then will it be possible to comply with the constitutional mandate of decent housing and move toward more equitable and sustainable urban and rural development.

6. CONCLUSIONS

The results of the study confirm that the habitability of social housing in the canton of Tena varies considerably, both between sectors and between types of construction. This variability, evidenced by statistical analysis, shows that while some types of housing meet conditions close to acceptable standards, others fall below the minimum requirements, compromising the quality of life of their inhabitants. The results show that the housing evaluated is still far from an ideal standard, barely exceeding the minimum threshold of what is considered habitable.

In relation to the objectives set, the research made it possible to accurately identify the most recurrent deficiencies in space, ventilation, internal configuration, and access to basic services, which validates the relevance of applying contextualized evaluation methodologies, such as the adaptation of the Abadi and Martín form (2009) to the Amazonian environment. At the same time, the relevance of considering territorial and climatic factors that directly condition housing performance in this region was confirmed.

From a theoretical point of view, the study contributes to the debate on habitability in social housing by demonstrating that there are no universal models applicable to all contexts, but rather that it is essential to promote differentiated designs that respond to the social, environmental, and cultural particularities of each territory. This conclusion reinforces the need to move towards a housing policy approach that integrates criteria of sustainability, territorial equity, and cultural relevance.

On a practical level, the findings provide input for updating design and construction regulations in the country, promoting minimum standards of thermal comfort, ventilation, and basic infrastructure. They also highlight the importance of linking the provision of housing with community services, especially health and education, as a prerequisite for ensuring real improvements in the quality of life of beneficiary families.

Finally, although the research focused on 221 housing units in 14 sectors of Tena, its results provide a solid basis for comparative studies in other Amazonian and rural areas of Ecuador. Future research should delve deeper into the link between habitability, socioeconomic conditions, and environmental sustainability, expanding the empirical evidence that can guide public policies toward fairer and more adequate housing solutions.

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