

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico

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Prologue

To inhabit a place is to establish a relationship with its physical conditions, its history, and the people who share it. A dwelling may offer shelter while remaining uncomfortable during the hottest months. A familiar neighbourhood may preserve a strong sense of belonging even as its public spaces deteriorate. A traditional building may carry memories that extend beyond its walls, connecting everyday life with generations of work, adaptation, and cultural continuity. These experiences reveal why habitability cannot be understood through architectural characteristics alone.

Across northwestern Mexico, the relationship between people and their built environments takes shape under particular climatic, economic, and social conditions. Coastal heat, changing housing patterns, traditional construction practices, neighbourhood relationships, and the transformation of urban spaces influence how residents experience their surroundings. Understanding these circumstances requires attention to measurable environmental conditions and to the perceptions through which individuals interpret safety, comfort, identity, and well-being.

The seventeen chapters gathered in this volume approach these relationships through a collection of exploratory investigations conducted primarily in Sinaloa. Their subjects range from hygrothermal comfort in social housing and the psychological experience of urban heat to collective memory in former mining communities, gendered experiences of domestic space, and the relationship between productive activities and family life. Other contributions consider classroom environments, pedestrian experiences, acoustic conditions, seismic preparedness, residential tourism, and the continued significance of traditional architecture.

A shared concern connects these different settings: how can the experience of inhabiting a place be translated into forms of evidence that support a more comprehensive understanding of the built environment? The development and preliminary examination of measurement scales offer one response to this question. These instruments seek to capture dimensions of habitability that conventional physical assessments may overlook, while also exposing the methodological challenges involved in measuring complex human experiences.

The investigations presented here remain at different stages of refinement. Their preliminary findings invite careful interpretation, particularly where limited samples, inconsistent responses, or unresolved questions of measurement restrict the conclusions that can be drawn. Such limitations are part of the research process and deserve explicit recognition.

This volume is intended for researchers, educators, architects, urban planners, and readers interested in the relationship between human experience and spatial conditions. Its contribution lies in bringing together diverse perspectives on habitability while preserving the particular circumstances of the communities under examination.

Ultimately, the chapters encourage a simple but demanding shift in perspective: to understand inhabited environments, we must attend not only to how spaces are designed and constructed, but also to how they are remembered, negotiated, experienced, and valued by those who live within them.

Introduction

Habitability is often associated with the physical adequacy of buildings: sufficient space, protection from the climate, access to services, and conditions that support everyday activities. Although these characteristics remain fundamental, they cannot fully explain why individuals experience similar environments differently. Comfort, safety, belonging, privacy, and control over domestic or public space introduce dimensions that extend beyond conventional architectural assessment.

In the cities and communities of Sinaloa, these relationships are especially visible. High temperatures influence domestic routines and pedestrian mobility, while patterns of residential development reshape the experience of neighbourhood life. Traditional architecture continues to express local identity and climatic adaptation, even as contemporary construction changes the appearance and functioning of urban landscapes. At the same time, economic activities, gender relations, collective memory, and environmental perceptions reveal how the meaning of habitability varies across social contexts.

The studies collected in this volume examine these questions through seventeen investigations focused on the relationship between built environments and human experience. Their geographical emphasis falls primarily on Mazatlán and southern Sinaloa, with contributions concerning Culiacán, Concordia, and other settings in northwestern Mexico. This regional concentration offers an opportunity to consider diverse expressions of habitability within a relatively coherent environmental and cultural context.

Several chapters examine the residential environment from complementary perspectives. Hygrothermal comfort, acoustic experience, privacy, territoriality, and the perceived abandonment of housing developments illustrate how domestic well-being depends on interactions between physical conditions and social relationships. The investigations concerning women's experiences of housing introduce further questions about personal space, safety, and control over everyday environments. Together, these contributions suggest that housing quality cannot be reduced to construction standards or spatial dimensions.

Another group of chapters considers the relationship between architectural heritage, local identity, and environmental adaptation. Research on traditional buildings in Mazatlán, adobe housing in southern Sinaloa, and post-mining collective memory in Concordia explores how material environments preserve cultural meanings while responding to present-day living conditions. These cases invite reflection on the tension between architectural continuity, maintenance requirements, and changing expectations of comfort.

The scope of the volume also extends beyond conventional residential settings. The experiences of brickmaking and fishing households illustrate the difficulties that arise when living and working activities occupy the same space. Research on classroom environments examines the relationship between physical conditions and educational activities. Investigations concerning the Pino Suárez Market, pedestrian routes, and residential tourism consider how environmental quality and urban transformation influence the experience of shared spaces.

Seismic risk perception and household preparedness introduce a further dimension of habitability: the relationship between perceived vulnerability and the actions through which occupants respond to potential hazards. This perspective connects the physical characteristics of buildings with human knowledge, expectations, and preparedness.

Methodologically, the volume is distinguished by its emphasis on the preliminary development and examination of measurement instruments. Most chapters employ exploratory, cross-sectional approaches

and analyse early survey responses to assess item behaviour, internal consistency, and relationships between proposed dimensions. These procedures represent an initial stage in the construction of tools intended to describe experiences that are often difficult to observe directly.

The methodological limitations require particular attention. The preliminary samples are generally small, and several investigations report difficulties in estimating or interpreting their proposed measurement structures. Consequently, the findings should not be understood as definitive evidence of instrument validity or as representative descriptions of the wider populations concerned. They identify patterns, inconsistencies, and questions that can inform subsequent stages of data collection and instrument refinement.

Despite these restrictions, the collective significance of the investigations lies in their effort to connect architectural and environmental analysis with the perspectives of inhabitants. The chapters treat personal experience as a legitimate subject of systematic examination, while acknowledging that its measurement demands conceptual precision and continuing empirical scrutiny.

The reader will encounter a diverse collection of settings rather than a single explanatory model of habitability. This diversity reflects the circumstances in which people establish relationships with their surroundings. A house affected by excessive heat, a classroom with inadequate environmental conditions, a street perceived as unsafe, or a historic building valued for its cultural associations may each reveal a different aspect of the same broader concern.

By bringing these perspectives into conversation, the volume contributes to an understanding of habitability as a relationship between material environments, social practices, environmental conditions, and human perceptions. It also establishes a starting point for further research capable of connecting the evaluation of built spaces with the lived realities of the communities they serve.

Abstract

Habitability emerges from the relationship between built environments, environmental conditions, social practices, and the meanings individuals attribute to the places they occupy. Understanding this relationship requires approaches that consider physical characteristics alongside perceptions of comfort, safety, identity, belonging, and well-being. Bringing together seventeen exploratory investigations conducted primarily in Sinaloa, Mexico, this volume examines multiple dimensions of residential, urban, educational, and productive environments. Its contributions address hygrothermal and acoustic comfort, urban heat, architectural heritage, collective memory, privacy, gendered experiences of housing, neighbourhood conditions, pedestrian stress, seismic preparedness, and the transformation of coastal communities through residential tourism. Particular attention is given to the preliminary development and assessment of measurement scales designed to capture subjective experiences of habitability. Through descriptive analysis, internal consistency estimates, and exploratory examinations of relationships between dimensions, the chapters identify promising conceptual approaches alongside methodological difficulties requiring further investigation. Small preliminary samples and limitations in measurement structure restrict the interpretation and generalisation of the findings, underscoring the need for continued instrument refinement and broader empirical assessment. Rather than presenting a unified or definitive model, the volume offers complementary perspectives on how people perceive, negotiate, and value their surroundings. Its regional focus reveals the connections between climatic adaptation, architectural practices, social relationships, and everyday experiences of space. The collection contributes to interdisciplinary conversations on architecture, environmental psychology, urban studies, and housing research, encouraging approaches to habitability that recognise both the material qualities of places and the experiences of those who inhabit them.

Keywords: Habitability; Built environment; Environmental psychology; Residential comfort; Urban living conditions; Psychometric assessment

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Chapter 1 / Capítulo 1

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Habitability and post-mining collective memory in Concordia, Sinaloa: Preliminary psychometric properties of a scale of memory, heritage and living conditions

Habitabilidad y memoria colectiva post-minería en Concordia, Sinaloa: propiedades psicométricas preliminares de una escala de memoria, patrimonio y condiciones de vida

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ABSTRACT

Mining has shaped the settlement, architecture and everyday life of many localities in western Mexico, and its traces persist in buildings, landscape and residents' memory. This instrumental, cross-sectional and exploratory study examined the preliminary psychometric properties of a fifteen-item scale with three dimensions, shared memory of mining, appraisal of mining heritage and living conditions, administered in the pilot survey of project FZ-HAB-0022 of the Factoriza UAS platform among adults living in Concordia, Sinaloa, Mexico. A preliminary cut of 10 cases, out of a target of 100, was analyzed with descriptive statistics, item analysis, Cronbach's alpha and McDonald's omega, Pearson inter-item and Spearman inter-dimension correlations; exploratory factor analysis was run but could not be interpreted because the correlation matrix was not of full rank. Pride in the mining past received the most favorable ratings (M = 4.10), while the wish to move to another city, street safety and job opportunities received the least favorable ones. Internal consistency was acceptable for heritage appraisal (α = .713) and low for shared memory (α = .462) and living conditions (α = .542); omega could not be interpreted in any dimension because the recoded reverse-worded item correlated negatively with the rest of its dimension. Memory and heritage appraisal were positively related (ρ = .617), with an interval that included zero. The reverse-worded items must be revised and the structure examined with the final cut.

Keywords: mining heritage; collective memory; habitability; psychometric properties

RESUMEN

La minería ha modelado el poblamiento, la arquitectura y la vida cotidiana de numerosas localidades del occidente de México, y sus huellas permanecen en los edificios, el paisaje y la memoria de sus habitantes. Este estudio instrumental, transversal y exploratorio examinó las propiedades psicométricas preliminares de una escala de quince reactivos, con tres dimensiones, Memoria compartida de la minería, Valoración del patrimonio minero y Condiciones de vida en Concordia, aplicada en el levantamiento piloto del proyecto FZ-HAB-0022 de Factoriza UAS a personas adultas residentes en Concordia, Sinaloa. Se analizó un corte preliminar de 10 casos, de una meta de 100, con estadísticos descriptivos, análisis de reactivos, alfa de Cronbach y omega de McDonald, correlaciones de Pearson entre reactivos y de Spearman entre dimensiones; el análisis factorial exploratorio se ejecutó, pero no pudo interpretarse porque la matriz de correlaciones no es de rango completo. El orgullo por el pasado minero obtuvo la valoración más favorable (M = 4.10), y el deseo de irse a otra ciudad, la seguridad en las calles y las oportunidades de trabajo, las menos favorables. La consistencia interna fue aceptable en Valoración del patrimonio minero (α = .713) y baja en Memoria compartida (α = .462) y Condiciones de vida (α = .542); el omega no fue interpretable en ninguna dimensión, porque el reactivo inverso recodificado se correlacionó en negativo con el resto. La memoria y la valoración del patrimonio se relacionaron en positivo (ρ = .617), con un intervalo que incluyó el cero. Los reactivos inversos deberán revisarse y la estructura examinarse con el corte final.

Palabras clave: patrimonio minero; memoria colectiva; habitabilidad; propiedades psicométricas

INTRODUCTION

For centuries, mining has shaped the settlement patterns, architecture and everyday life of many localities in western and northern Mexico. When extractive activity declines or changes form, its traces remain in the buildings, in the landscape and in the memory of the people who live in these places, and they raise questions about the relationship between the industrial past and present-day quality of life.

Research on post-industrial territories has shown that the identity of mining communities can be organized around a shared past even when the industry that defined them has disappeared (Walker, 2021), and that mining heritage can become a resource for community participation (Ordaz Bulos and Sánchez Fonseca, 2024) or an instrument of protest against the loss of memory and landscape associated with mining (Arista Castillo and Barrera Fernández, 2022).

Concordia, in southern Sinaloa, is one such locality. Regional historiography documents that the Compañía Minera de Pánuco, founded in 1877, reached its peak during the Porfiriato and declined toward the mid-twentieth century, in a period marked by revolutionary conflicts, international economic crises and labor stoppages; it also records that some mines in the municipality, such as those of Santa Lucía, were later organized as cooperatives (Rodríguez Pérez, 2019).

This history is part of the built landscape and of local identity, but its presence in the experience of current residents has not been systematically studied.

The relationship between the mining past and livability is not straightforward. In a peripheral industrial region of Germany, residents expressed positive views of their family ties to industry and of its role in regional history, yet described the factories and production complexes through an “eyesore” narrative, without connecting these positive associations to the physical remains (Bockelmann, 2023).

In Chuquicamata, Chile, the official heritage narrative of the mining camp centered on the figure of the male miner and rendered invisible the memories of women and their spaces of care and organization (Olivares Contreras and Cornejo Nieto, 2025).

In Minas de Riotinto, Spain, residents showed favorable affective attitudes toward mining tourism, although they differed in their cognitive and behavioral attitudes (Porras Bueno et al., 2024). The memory of the mining past, the appreciation of its heritage, and satisfaction with current living conditions can therefore vary independently.

In Sinaloa, research on heritage and habitability has focused on Mazatlán, where studies have documented the effects of tourism on the built heritage of the Historic Center (Castillo Romero, 2023) and the processes of touristification and tourism gentrification in the city (Mendieta Vega and Roldán Clarà, 2024).

Mountain communities with a mining past, such as Concordia, have received less attention, and no instruments are available for jointly recording mining memory, heritage valuation, and the perception of living conditions among their inhabitants. Before such an instrument can be used to describe the population or to relate its dimensions to other variables, it requires evidence of its psychometric functioning.

For this purpose, project FZ-HAB-0022 of the Factoriza UAS platform, classified under the psychometric track of the article workshop, designed the Scale of Mining Memory, Heritage and Habitability in Concordia. Its fifteen items are organized into three dimensions: Shared Memory of Mining, Valuation of Mining Heritage, and Living Conditions in Concordia. This article presents the results of its pilot survey, based on a preliminary data cutoff of 10 cases.

The overall objective was to examine the preliminary psychometric properties of the scale in adults residing in Concordia, Sinaloa. The specific objectives were: (a) to describe the distribution of responses to each item; (b) to estimate the internal consistency of each dimension using alpha and omega coefficients and to identify items that behaved discrepantly; (c) to assess the feasibility of an exploratory factor analysis with the available sample size; (d) to describe the correlations among the items within each dimension and among the three dimensions; and (e) to identify the aspects of the instrument that should be revised before the final data cut. The project did not state any hypotheses, so the study is exploratory in scope.

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DEVELOPMENT

COLLECTIVE MEMORY IN POST-MINING COMMUNITIES

Collective memory refers to the representations of the past that a group shares and transmits, and in mining communities it tends to be organized around work, family, and place.

In a former coal-mining village in the South Wales valleys, Walker (2021) found that everyday relationships rested on an assumed shared history, tied to an idealized image of a "typical" mining community that presented the past as uniform, and that these imagined histories were used to draw social boundaries between those who belong and those who do not.

In that analysis, memory takes both material and immaterial forms, is emotional as well as verbal, and is at once shared and imagined.

Mining memory is not homogeneous. In Chuquicamata, the recovery of women's affective counter-memories showed that officially recognized heritage may omit spaces and experiences that the community itself considers meaningful (Olivares Contreras and Cornejo Nieto, 2025).

El Bordo, in Pachuca, is a landscape where mining has operated for more than five centuries and whose heritage elements have historically been undervalued. There, a participatory process involving local residents led to the resignification of this heritage through a citizen laboratory and an architecture-for-memory project (Ordaz Bulos and Sánchez Fonseca, 2024).

These experiences suggest that the shared memory of mining combines family narratives, recognition of community history, knowledge of places, and the perception that this history is being preserved or lost.

The instrument's Shared Memory of Mining dimension captures precisely these components: stories about mining told within the family (R1), the recognition of mining as part of the community's history (R2), the shared recollection of the mining era (R3), the perception that Concordia's mining history is being forgotten (R4, reverse-scored), and knowledge of places linked to mining (R5).

APPRECIATION OF MINING AND INDUSTRIAL HERITAGE

Residents' valuation of industrial heritage has been studied from the perspectives of environmental psychology and planning. In a survey of 385 visitors to a former factory complex in Changchun, China, repurposed as a cultural district, perceived value, environmental awareness, social identity and perceived government support were associated with willingness to participate in and pay for conservation; place attachment partially mediated these relationships (Fu and Dong, 2025).

In Quanzhou, multisensory perception and involvement with historic buildings were associated with place attachment and with the intention to support the heritage destination (Cai et al., 2025). In the ancient city of Pingyao, research has examined how the emotions and actions of residents in a heritage tourism destination evolve from conflict to co-creation (Xing, 2026).

Appreciation of mining heritage may nevertheless coexist with the rejection of its material remains. In the Vogtland region, Bockelmann (2023) found that the industry's intangible heritage, associated with family history and regional prosperity, was viewed positively, whereas its tangible heritage was perceived mainly as a burden and was described through an "eyesore" narrative.

In Cerro de San Pedro, San Luis Potosí, a cultural festival that originated as a protest forum against the loss of memory, identity and landscape associated with mining drifted toward leisure, and only a minority of attendees were familiar with the town's history or the mining conflict (Arista Castillo and Barrera Fernández, 2022).

The instrument's Valuation of Mining Heritage dimension covers the conservation of mining buildings (R6), pride in the mining past (R7), the perception that mining remains make the town unsightly (R8, reverse-scored), the desire for visitors to learn about the mining history (R9), and the role of mining heritage in Concordia's identity (R10).

PLACE ATTACHMENT AND LIVING CONDITIONS IN MINING TERRITORIES

Place attachment has been defined as the affective, cognitive and behavioral bond that a person or group establishes with a meaningful environment, and its measurement remains a developing field.

Boley et al. (2021) cautioned that the variety of scales and items makes it difficult to compare

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results across communities. A systematic review of research published between 2010 and 2021 likewise concluded that there is no consensus on its measurement and that its dimensions do not behave in the same way with respect to behavioral intentions (Dang and Weiss, 2021).

The review by Kamani Fard and Paydar (2024) noted that social interaction and local features expressing history and culture are associated with a stronger bond. In the Chinese-language literature, Xiang et al. (2022) grouped the components of attachment among residents of a historic neighborhood into emotional, social, and material bonds.

In mining areas, attachment coexists with economic and environmental uncertainty. In an opencast coal mining region in western Germany, a survey of 620 residents and resettled people found high levels of psychological distress, higher still in villages threatened by resettlement. The authors associated the degradation and loss of the home environment with a higher prevalence of depressive, anxiety and somatoform symptoms (Krüger et al., 2022).

Among rural households in hazard-prone areas of China, place dependence was negatively associated with the intention to relocate (Qing et al., 2022).

These results show that the desire to stay or leave depends on the assessment of living conditions as much as on the emotional bond with the place. The instrument's Living Conditions in Concordia dimension captures enjoyment of living in Concordia (R11), the availability of daily necessities (R12), job opportunities (R13), the desire to move to another city (R14, reverse-scored), and perceived safety on the streets (R15).

VALIDITY EVIDENCE AND INTERNAL CONSISTENCY IN SHORT SCALES

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items; McDonald's omega (McDonald, 2013) does not make this assumption, and simulation studies have compared the performance of the two coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis, for which current recommendations call for checking data adequacy and ensuring a sufficient sample size before interpreting its results (Ferrando et al., 2022; Goretzko et al., 2021).

Scales that combine direct and reverse-worded items may show wording-related biases, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022). Identifying these responses may reduce such biases (García-Batista et al., 2021). These references are relevant to an instrument with one reverse-worded item in each dimension, administered in a data cut of ten cases.

METHODOLOGY

DESIGN

An instrumental study with a quantitative approach, a cross-sectional design and an exploratory scope was conducted to examine the preliminary psychometric properties of a scale. Because the design was cross-sectional, the reported relationships are associations and do not allow causal inferences.

POPULATION, SAMPLE AND DATA CUTOFF

The data come from the survey "Piloto Concordia · Memoria minera y habitabilidad" (LEV-0027) of project FZ-HAB-0022 on the Factoriza UAS platform, and from the frozen dataset DST-0046, with a cutoff date of 16 October 2026. The survey population consists of people aged 18 years or older residing in Concordia, Sinaloa, in the municipal seat and in localities selected by the project lead.

Table 1 presents the sample composition. Twenty people opened the questionnaire, 10 completed it, no cases were excluded by the platform's quality control, and 10 cases with 15 items were analyzed. This is a preliminary data cut: n = 10 out of a target of 100, with data collection still open. The results reported in this article describe that data cut and should not be regarded as definitive.

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Table 1. Sample composition.

Indicator	Value
People who opened the questionnaire	20
Completed questionnaires	10
Cases excluded by quality control	0
Cases analyzed	10
Items	15

Note. Survey "Concordia Pilot · Mining Memory and Habitability" (LEV-0027); population: individuals aged 18 years or older residing in Concordia, Sinaloa; territory: municipal seat and localities selected by the project lead. Dataset DST-0046, hash 7b2c2d5b3c3f6018. Source: Factoriza UAS. Preliminary cutoff: n = 10 of a target of 100, with data collection still ongoing.

INSTRUMENT

The Scale of Mining Memory, Heritage, and Livability in Concordia consists of fifteen items with a 5-point response scale ranging from Strongly disagree to Strongly agree. The items are organized into three dimensions of five items each: Shared Memory of Mining (R1 to R5), Appreciation of Mining Heritage (R6 to R10), and Living Conditions in Concordia (R11 to R15).

Each dimension includes one reverse-worded item: the perception that mining history is being forgotten (R4), the perception that the remains of mining make the town unsightly (R8), and the desire to move to another city (R14). These items are already recoded in the data matrix, so a high value indicates a favorable position on every item. Table 2 presents the wording of each item.

Table 2. Structure of the instrument.

Code	Item	Reverse-scored
R1	In my family, stories are told about mining in Concordia	No
R2	Mining is part of my community's history	No
R3	We, the inhabitants of Concordia, remember the mining era	No
R4	The mining history of Concordia is being forgotten	Yes
R5	I know places in Concordia linked to mining	No
R6	The mining buildings of Concordia deserve to be preserved	No
R7	I am proud of Concordia's mining past	No
R8	Mining remnants make the town look ugly	Yes
R9	I would like visitors to learn about the mining history of Concordia	No
R10	Mining heritage gives Concordia its identity	No
R11	I like living in Concordia	No
R12	In Concordia, I find what I need for my daily life	No
R13	Concordia offers job opportunities to its inhabitants	No
R14	I would like to move to another city	Yes
R15	I feel safe on the streets of Concordia	No

Note. R1 to R5 = Shared memory of mining; R6 to R10 = Appreciation of mining heritage; R11 to R15 = Living conditions in Concordia. The dimension column is omitted to preserve the readability of the table. 5-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the supplied data matrix. Source: Factoriza UAS, project FZ-HAB-0022, survey LEV-0027, dataset DST-0046.

PROCEDURE

The questionnaire was administered through the Factoriza UAS platform, which records explicit online informed consent before the first question and does not collect data that could identify individuals. The platform runs a quality control check on completed questionnaires before adding them to the dataset; at this data cut-off, it excluded no cases.

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DATA ANALYSIS

Factoriza UAS calculated the descriptive statistics for each item (mean, standard deviation, skewness, kurtosis, and percentages of responses at the minimum and maximum values). It also calculated the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), the corrected item-total correlation, the alpha if item deleted, and the Pearson correlations among the items of each dimension, with 95% confidence intervals obtained through Fisher's z transformation.

The complementary analyses were run with the program analisis_psicometrico.py, version 1.0, in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The internal consistency of each dimension was estimated with Cronbach's alpha and McDonald's omega total (McDonald, 2013), derived from a one-factor minimum residual model and without reverse-scoring items.

The program also ran the exploratory factor analysis of the 15 items using the 10 complete cases: the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), Bartlett's test of sphericity (Bartlett, 1950), parallel analysis with 100 simulations to determine the number of factors (Horn, 1965), minimum residual extraction, and oblimin rotation.

Relationships between dimensions were estimated using Spearman's correlation coefficient between the mean scores of each dimension, with its 95% confidence interval obtained by the Fisher transformation with the standard error of Bonett and Wright (2000). No items were removed, and no confirmatory factor analysis was performed.

With 10 cases for 15 items, the correlation matrix is not of full rank and cannot be inverted, so the software could not compute the Kaiser-Meyer-Olkin measure or Bartlett's test, which are reported as unavailable in its output log.

Under these conditions, the factor solution cannot be meaningfully interpreted, and methodological recommendations advise against its use (Ferrando et al., 2022; Goretzko et al., 2021). Therefore, the exploratory factor analysis is neither presented nor interpreted in this article; its full output is retained in the reproducibility appendix as a record of the procedure.

ETHICAL CONSIDERATIONS

Participation was voluntary, with express informed consent recorded online through the platform, which does not collect names, addresses or other identifying data. Data were analyzed in aggregate form.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following tools were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive and internal consistency analyses; a Python analysis program with fixed, validated procedures, for the omega coefficient, exploratory factor analysis and the correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

DESCRIPTION OF RESPONSES

Table 3 and Figure 1 present the descriptive statistics for the fifteen items. The Appreciation of *M*ining Heritage dimension had the highest means in the instrument: pride in Concordia's mining past (R7: M = 4.10, *SD* = 1.37), with 60% of responses at the maximum value and an asymmetric distribution concentrated toward the high values (skewness = -1.52); the preservation of the mining buildings (R6: *M* = 3.80, *SD* = 1.32); and the role of mining heritage in Concordia's identity (R10: *M* = 3.70, *SD* = 1.42).

The recoded item on mining remains had a mean of 3.50 and the lowest dispersion in the instrument (R8: *SD* = 0.97), and the desire for visitors to learn about mining history had the lowest mean in the dimension (R9: *M* = 3.10, *SD* = 1.45).

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In the Shared Memory of Mining dimension, the means were close to the midpoint of the scale, ranging from the item on mining stories told within the family (R1: *M* = 3.40, *SD* = 1.58) to the item on recognition of mining as part of the community's history (R2: *M* = 3.00, *SD* = 1.49). Knowledge of places linked to mining showed the greatest dispersion in the instrument (R5: *M* = 3.20, *SD* = 1.81), with 30% of responses at the minimum value and 40% at the maximum. The shared memory of the mining era had an equally polarized distribution (R3: *M* = 3.10, *SD* = 1.73).

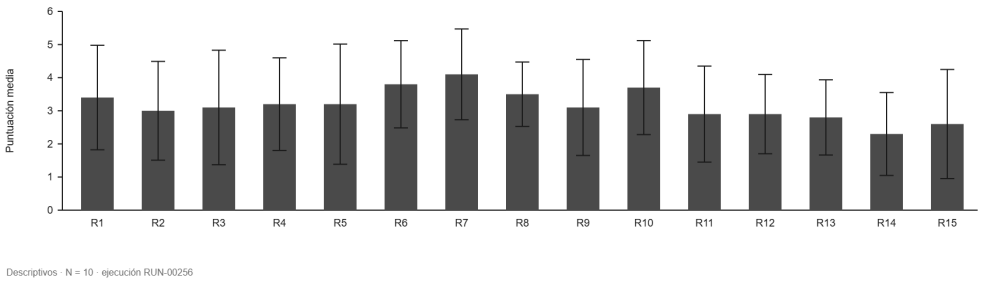
Living conditions in Concordia contained the lowest means. The desire to move to another city, in its recoded version, had the lowest mean on the instrument (R14: *M* = 2.30, *SD* = 1.25), indicating that responses leaned toward agreement with that desire. It was followed by street safety (R15: *M* = 2.60, *SD* = 1.65), with 40% of responses at the minimum value, job opportunities (R13: *M* = 2.80, *SD* = 1.14), and enjoyment of living in Concordia and the availability of what is needed for daily life (R11 and R12: *M* = 2.90).

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.40	1.58	-0.62	-1.16	20%	30%
R2	3.00	1.49	0.00	-1.33	20%	20%
R3	3.10	1.73	-0.19	-1.89	30%	30%
R4	3.20	1.40	0.17	-0.97	10%	30%
R5	3.20	1.81	-0.23	-2.02	30%	40%
R6	3.80	1.32	-1.37	1.34	10%	30%
R7	4.10	1.37	-1.52	1.80	10%	60%
R8	3.50	0.97	0.45	-0.52	10%	20%
R9	3.10	1.45	-0.21	-0.99	20%	20%
R10	3.70	1.42	-0.80	-0.38	10%	40%
R11	2.90	1.45	-0.33	-1.22	30%	10%
R12	2.90	1.20	-0.74	-0.88	20%	40%
R13	2.80	1.14	0.48	0.55	10%	10%
R14	2.30	1.25	0.99	1.21	30%	10%
R15	2.60	1.65	0.43	-1.47	40%	20%

Note.N = 10. R1 to R5 = Shared memory of mining; R6 to R10 = Appreciation of mining heritage; R11 to R15 = Living conditions in Concordia. Reverse-scored items R4, R8 and R14 are shown recoded, so that a high value always indicates a favorable position. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item–total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated from the total of each dimension. Factoriza UAS run RUN-00256. Preliminary cutoff: n = 10 out of a target of 100, with data collection still open.

Figure 1. Mean item scores with one-standard-deviation bars.



ITEM ANALYSIS AND INTERNAL CONSISTENCY

Table 4 presents the item analysis for each dimension. For Shared Memory of Mining, alpha was .462.

Recognition of mining as part of the community's history (R2: .742), knowledge of places linked to mining (R5: .605), and family histories (R1: .498) had the highest corrected item-total correlations; shared recollection of the mining era had a low correlation (R3: .279), and the recoded item on forgetting mining history had a negative correlation (R4: -.573).

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Removing R4 would raise the alpha to .789.

For Appreciation of Mining Heritage, alpha was .713. The role of heritage in Concordia's identity (R10: .902), pride in the mining past (R7: .871), and the conservation of mining buildings (R6: .796) had high corrected item-total correlations; the desire for visitors to learn about mining history had a moderate correlation (R9: .437).

The recoded item on the remnants of mining had a negative correlation (R8: -.481), and its deletion would raise alpha to .901.

For Living Conditions in Concordia, alpha was .542. Enjoying living in Concordia (R11: .795), the availability of what is needed for daily life (R12: .677), and safety on the streets (R15: .499) showed the highest correlations; job opportunities had a near-zero correlation (R13: .089), and the recoded item on the desire to move to another city had a negative one (R14: -.289). Removing R14 would raise alpha to .760.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Memory	R1	.498	.218
Memory	R2	.742	.032
Memory	R3	.279	.382
Memory	R4	-.573	.789
Memory	R5	.605	.075
Assessment	R6	.796	.521
Assessment	R7	.871	.475
Assessment	R8	-.481	.901
Assessment	R9	.437	.682
Assessment	R10	.902	.451
Living conditions	R11	.795	.105
Living conditions	R12	.677	.269
Living conditions	R13	.089	.590
Living conditions	R14	-.289	.760
Living conditions	R15	.499	.336

Note.N = 10. Scale from 1 to 5; reverse-scored items R4, R8, and R14 are shown recoded. Factoriza UAS run RUN-00256. Preliminary data cut: n = 10 out of a target of 100, with data collection still open.

Table 5 presents the internal consistency estimated by the complementary analysis program. The alpha values match those obtained with Factoriza (.462, .713, and .542).

Omega is not reported for any of the three dimensions because, in each one, the reverse-scored item correlates negatively with the rest, and under these conditions the coefficient is not interpretable. The program warns that this situation signals a problem in the instrument's definition when the item is not flagged as reverse-scored; in this case, all three items are indeed flagged and recoded, so their negative correlation indicates that, once recoded, they still vary in the opposite direction to the other items in their dimension.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω
Memory	5	10	.462	
Assessment	5	10	.713	
Living conditions	5	10	.542	

Note.N = 10. Memory = Shared memory of mining; Valuation = Valuation of mining heritage; Living conditions = Living conditions in Concordia. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Memory = .462 (run RUN-00257); Valuation = .713 (RUN-00259); Living conditions = .542 (RUN-00261). Source: Factoriza UAS, Tables 4, 6, and 8 of the package, compiled without modifying values. Preliminary data cut: n = 10 of a target of 100, with data collection still open.

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INTERNAL STRUCTURE

The exploratory factor analysis could not be interpreted. With 10 cases for 15 items (0.7 cases per item), the correlation matrix was not of full rank, the Kaiser-Meyer-Olkin measure and Bartlett's test could not be computed, and the software warned that the factor results are unstable with that sample size.

For this reason, the loadings, communalities, and explained variance are not reported; they are retained in the reproducibility appendix. The software's item flags (insufficient loading, cross-loading, or opposite sign) derive from that solution and are not interpreted as evidence about the structure of the scale. The internal structure will need to be examined with the final data cut.

CORRELATIONS BETWEEN ITEMS

Table 6 presents the Pearson correlations between the items of each dimension. In the Shared memory of mining dimension, recognition of mining as part of the community's history was strongly related to knowledge of places linked to mining (R2 and R5: r = .822, 95% CI [.399, .957], p = .004), and family stories were related to that same knowledge (R1 and R5: r = .668, 95% CI [.066, .913], p = .035).

The recoded item on forgetting mining history was negatively related to knowledge of places (R4 and R5: r = -.675, 95% CI [-.915, -.078], p = .032) and, with an interval that included zero, to recognition of mining in community history (R2 and R4: r = -.533, 95% CI [-.870, .145], p = .113).

In Valuation of Mining Heritage, pride in the mining past was very strongly related to the conservation of buildings (R6 and R7: r = .875, 95% CI [.545, .970], p < .001) and to the role of heritage in Concordia's identity (R7 and R10: r = .875, 95% CI [.546, .970], p < .001). The latter two aspects were related to each other (R6 and R10: r = .797, 95% CI [.337, .950], p = .006). The recoded item on the remains of mining was negatively related to the desire for visitors to learn about the mining history (R8 and R9: r = -.671, 95% CI [-.914, -.071], p = .034).

In Living Conditions in Concordia, enjoyment of living in Concordia was related to the availability of daily necessities (R11 and R12: r = .826, 95% CI [.410, .958], p = .003) and to street safety (R11 and R15: r = .633, 95% CI [.006, .903], p = .049). By contrast, the recoded item on the desire to leave was not related to enjoyment of living in Concordia (R11 and R14: r = .018) and was negatively related to job opportunities, with an interval that included zero (R13 and R14: r = -.422, 95% CI [-.831, .282], p = .224). With 10 cases, all intervals are wide.

Table 6. Correlations between items within each dimension.

Dimension	Variable pair	r	IC 95%	p
Memory	R1 and R2	.472	[-.224, .849]	.168
Memory	R1 and R3	.065	[-.589, .667]	.858
Memory	R1 and R4	-.191	[-.733, .498]	.596
Memory	R1 and R5	.668	[.066, .913]	.035
Memory	R2 and R3	.560	[-.107, .880]	.092
Memory	R2 and R4	-.533	[-.870, .145]	.113
Memory	R2 and R5	.822	[.399, .957]	.004
Memory	R3 and R4	-.377	[-.813, .331]	.283
Memory	R3 and R5	.347	[-.361, .802]	.325
Memory	R4 and R5	-.675	[-.915, -.078]	.032
Assessment	R6 and R7	.875	[.545, .970]	< .001
Appraisal	R6 and R8	-.347	[-.802, .361]	.325
Assessment	R6 and R9	.478	[-.217, .851]	.163
Assessment	R6 and R10	.797	[.337, .950]	.006
Assessment	R7 and R8	-.375	[-.813, .333]	.285
Assessment	R7 and R9	.554	[-.116, .878]	.097
Assessment	R7 and R10	.875	[.546, .970]	< .001
Assessment	R8 and R9	-.671	[-.914, -.071]	.034
Assessment	R8 and R10	-.282	[-.774, .423]	.430
Assessment	R9 and R10	.611	[-.030, .896]	.061

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Dimension	Variable pair	r	IC 95%	p
Living conditions	R11 and R12	.826	[.410, .958]	.003
Living conditions	R11 and R13	.122	[-.550, .698]	.738
Living conditions	R11 and R14	.018	[-.618, .641]	.960
Living conditions	R11 and R15	.633	[.006, .903]	.049
Living conditions	R12 and R13	.229	[-.468, .750]	.525
Living conditions	R12 and R14	-.200	[-.737, .491]	.579
Living conditions	R12 and R15	.541	[-.134, .873]	.106
Living conditions	R13 and R14	-.422	[-.831, .282]	.224
Living conditions	R13 and R15	.250	[-.451, .760]	.487
Living conditions	R14 and R15	-.313	[-.787, .395]	.379

Note.α = Cronbach's alpha; ω = McDonald's omega total, estimated from a one-factor minimum-residual model without reversing items. Complete cases per dimension. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0046_FZ_HAB_0022. Memory = Shared memory of mining; Appreciation = Appreciation of mining heritage; Living conditions = Living conditions in Concordia. Program observations, transferred to this note: Memory: Items in the opposite direction: R4; ω not interpretable; Appreciation: Items in the opposite direction: R8; ω not interpretable; Living conditions: Items in the opposite direction: R14; ω not interpretable. The three flagged items are the reverse-worded items, already recoded in the matrix. The α matches that obtained with Factoriza. Preliminary cutoff: n = 10 out of a target of 100, with data collection still ongoing.

RELATIONSHIPS BETWEEN DIMENSIONS

Table 7 presents the Spearman correlations between the mean scores of the three dimensions. Shared memory of mining and Valuation of mining heritage were positively related, with a moderate-to-strong magnitude and an interval that included zero (ρ = .617, 95% CI [-.087, .910], *p* = .057). The correlations of Living conditions in Concordia with memory (ρ = .253, 95% CI [-.457, .766], *p* = .480) and with heritage valuation (ρ = -.264, 95% CI [-.771, .449], *p* = .461) were weak and of opposite sign, with very wide intervals. The mean scores include the reverse-scored items, whose divergent behavior was described above; this should be kept in mind when interpreting these correlations.

Table 7. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Memory and Appraisal	10	.617	[-.087, .910]	.057
Memory and Living conditions	10	.253	[-.457, .766]	.480
Assessment and Living conditions	10	-.264	[-.771, .449]	.461

Note.N = 10. Memory = Shared memory of mining; Appreciation = Appreciation of mining heritage; Living conditions = Living conditions in Concordia. Pearson correlation; 95% confidence intervals based on Fisher's z transformation. Cross-sectional design: relationships are associations. Source: Factoriza UAS, Tables 5, 7, and 9 of the package (runs RUN-00258, RUN-00260, and RUN-00262), combined without modifying values. Preliminary data cut: n = 10 of a target of 100, with the survey still open.

DISCUSSION OF RESULTS

This study examined the preliminary psychometric properties of a scale of mining memory, heritage and livability using a data cut of 10 cases in Concordia, Sinaloa. The first finding is descriptive: respondents rated mining heritage more favorably than their memory of mining and, above all, than their current living conditions.

Pride in the mining past was the most highly rated aspect of the instrument, whereas the desire to move to another city, street safety and job opportunities received the least favorable ratings. This contrast between a valued past and a present viewed with reservations is consistent with the literature describing how post-mining communities construct their identity around a shared past (Walker, 2021) and with work cautioning that place attachment in mining territories coexists with uncertainty about living conditions (Krüger et al., 2022; Qing et al., 2022).

The second finding, and the most relevant one for the instrument, concerns the reverse-worded items. In all three dimensions, the reverse-worded item correlated negatively with the remaining items after recoding, which precluded the estimation of omega and lowered alpha. This common pattern is open to two interpretations that the current cross-sectional design does

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not allow us to disentangle. The first is a wording-related bias, documented in scales that combine positively and negatively worded items, in which some respondents answer both types of items inconsistently (García-Batista et al., 2021; Steinmann et al., 2022).

The second is substantive: the reverse-worded items might capture content other than what they are intended to reverse.

The substantive interpretation is supported by the pattern of correlations. Those who knew more mining-related sites agreed most strongly that the mining history of Concordia is being forgotten. R4 therefore appears to capture awareness of a loss, which is greater precisely among those who preserve the memory, rather than an absence of memory. Similarly, those who most wanted visitors to learn about the mining history were the ones who most strongly agreed that the remains of mining make the town unsightly.

This result is consistent with the distinction between a valued intangible heritage and a tangible heritage perceived as a burden (Bockelmann, 2023), and suggests that the valuation dimension brings together two distinct objects: mining history and identity, on the one hand, and the material remains, on the other.

In Living Conditions, the desire to leave was not related to enjoyment of living in Concordia, which indicates that the intention to move away may reflect practical, and not only affective, reasons, as the literature on attachment and relocation suggests (Qing et al., 2022).

The third finding concerns the structure of the dimensions. The direct items of Valuation of Mining Heritage showed very high intercorrelations, ranging from .797 to .875 among pride, conservation and identity. This pattern indicates a homogeneous dimension centered on appreciation of the mining past, with possible redundancy among some of its items. In Shared Memory of Mining, the shared recollection of the mining era made a low contribution, and in Living Conditions, job opportunities made a near-zero contribution. Both items may refer to collective or structural content that is not evaluated from personal experience in the same way as the other items, consistent with the heterogeneity of the components of place attachment described in the literature (Boley et al., 2021; Xiang et al., 2022).

The fourth finding concerns the relationships between dimensions. Shared memory of mining and the valuation of mining heritage were positively related, with an interval that did not exclude zero, whereas living conditions showed no clear relationship with either. If this pattern is confirmed with the final data cut, it would indicate that appreciation of the mining past and evaluation of present life in Concordia are relatively independent, as observed in other mining territories where affective attitudes toward heritage do not correspond to cognitive and behavioral evaluations (Porras Bueno et al., 2024).

In terms of habitability, this independence suggests that mining heritage can be a resource for identity without, by itself, translating into a better evaluation of living conditions. This is consistent with the experience of Cerro de San Pedro (Arista Castillo and Barrera Fernández, 2022) and with the need for participatory processes that link heritage to the needs of residents (Ordaz Bulos and Sánchez Fonseca, 2024).

The results suggest several adjustments for the next stage. For the instrument, it would be advisable to revise the wording of the three reverse-worded items or rephrase them as directly worded items; to distinguish, within the valuation dimension, the items referring to history and identity from those referring to material remains; and to review the possible redundancy of the pride, conservation and identity items. For the procedure, it would be necessary to bring the sample up to the planned target; to document participants' characteristics, such as their family or occupational ties to mining and their years of residence; and to examine the internal structure using exploratory factor analysis and, with an independent sample, confirmatory factor analysis.

CONCLUSIONS

The study examined the preliminary psychometric properties of a fifteen-item scale on the shared memory of mining, the valuation of mining heritage, and living conditions in Concordia, Sinaloa, based on a preliminary data cut of 10 cases out of a target of 100. Respondents rated mining heritage favorably, particularly pride in the mining past, and rated their current living conditions less favorably.

Internal consistency was acceptable for Valuation of mining heritage (α = .713) and low for Shared memory of mining (α = .462) and Living conditions in Concordia (α = .542); omega was not interpretable for any dimension because the three reverse-scored items correlated negatively with the rest of their dimension. The exploratory factor analysis was not interpretable with this

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sample size.

The study has limitations that should be kept in mind when reading all of its results. The first concerns the size and nature of the data cut: 10 cases out of a target of 100, with data collection still open, are insufficient to estimate internal consistency and correlations precisely, and the correlation matrix is not of full rank, which prevented analysis of the internal structure. The second concerns the sample: the localities, the contact procedure, the type of sampling, and the characteristics of the participants have yet to be documented, and the results cannot be generalized.

The third concerns the instrument: the behavior of the reverse-keyed items must be reviewed, as it may reflect a wording bias or content other than that intended, and the recoding of these items must be verified. The fourth is analytical: the floor and ceiling percentages from Factoriza must be checked, and no confirmatory factor analysis was performed. The fifth relates to the design: because the study is cross-sectional, it does not allow causal inferences.

Directions for future work follow from these limitations. Once the final data cutoff is available, it will be advisable to repeat the item analysis and the omega estimation, run the exploratory factor analysis, and examine whether heritage valuation is organized into facets related to history and to material remains.

With an independent sample, confirmatory factor analysis would make it possible to test the structure obtained. The relationship between the dimensions and variables such as years of residence, family ties to mining, or the intention to remain in Concordia would provide validity evidence based on relations to other variables. This information would be useful for heritage and livability policies in the mountain towns of southern Sinaloa, where the mining past appears as a resource for identity that coexists with a guarded assessment of living conditions.

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Chapter 2 / Capítulo 2

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Hygrothermal habitability in social housing in Mazatlán: Preliminary psychometric properties of a scale

Habitabilidad hidrotérmica en vivienda social de Mazatlán: propiedades psicométricas preliminares de una escala

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ABSTRACT

Heat and humidity inside the dwelling are part of what residents of warm coastal cities experience as habitability. This instrumental, cross-sectional and exploratory study examined the preliminary psychometric properties of a twelve-item hygrothermal habitability scale with two dimensions, thermal comfort in the dwelling and humidity control in the dwelling, administered in the pilot survey of project FZ-HAB-0001 of the Factoriza UAS platform among adults living in social housing in Mazatlán, Mexico. A preliminary cut of 13 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha, McDonald's omega, Pearson inter-item correlations, exploratory factor analysis with parallel analysis, and a Spearman correlation between dimensions. Thermal comfort items obtained lower means than humidity items, and coolness during the hottest hours had the lowest mean (M = 2.38). Internal consistency was moderate in both dimensions (α = .684 and .671; ω = .743 and .745); air currents, comfort for sleeping and the two reverse-worded humidity items contributed little to their dimensions. Sampling adequacy was very low (KMO = .190); parallel analysis suggested one factor on which the direct items of both dimensions loaded, while the three reverse-worded items, air currents and bedroom coolness had loadings below .30. The correlation between dimensions was ρ = .302, with a confidence interval that included zero. These results document the initial functioning of the items and must be re-examined with the final data cut.

Keywords: thermal comfort; indoor humidity; social housing; psychometric properties

RESUMEN

El calor y la humedad dentro de la vivienda forman parte de lo que los habitantes de las ciudades costeras cálidas experimentan como habitabilidad. Este estudio instrumental, transversal y exploratorio examinó las propiedades psicométricas preliminares de una escala de habitabilidad higrotérmica de doce reactivos, con dos dimensiones, Confort térmico en la vivienda y Control de la humedad en la vivienda, aplicada en el levantamiento piloto del proyecto FZ-HAB-0001 de Factoriza UAS a personas adultas que habitan vivienda social en Mazatlán. Se analizó un corte preliminar de 13 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach, omega de McDonald, correlaciones de Pearson entre reactivos, análisis factorial exploratorio con análisis paralelo y correlación de Spearman entre dimensiones. Los reactivos de confort térmico obtuvieron medias más bajas que los de humedad, y la frescura en las horas de más calor tuvo la media más baja (M = 2.38). La consistencia interna fue moderada en las dos dimensiones (α = .684 y .671; ω = .743 y .745); las corrientes de aire, la comodidad para dormir y los dos reactivos inversos de humedad contribuyeron poco a su dimensión. La adecuación muestral fue muy baja (KMO = .190); el análisis paralelo sugirió un factor en el que cargaron los reactivos directos de ambas dimensiones, mientras que los tres reactivos inversos, las corrientes de aire y la frescura de las recámaras tuvieron cargas inferiores a .30. La correlación entre dimensiones fue ρ = .302, con un intervalo que incluyó el cero. Estos resultados documentan el funcionamiento inicial de los reactivos y deben revisarse con el corte final.

Palabras clave: confort térmico; humedad interior; vivienda social; propiedades psicométricas

INTRODUCTION

The home is where most people spend the greater part of the day and night; its thermal and humidity conditions are part of what its occupants experience as habitability.

In hot climates, a dwelling's capacity to stay cool during the hottest hours of the day, to allow nighttime rest, and to prevent moisture from building up in the air, walls, and furniture is associated with the well-being, sleep, and respiratory health of its occupants. These two facets, the thermal and the hygrometric, are usually studied separately, the former from the perspective of thermal comfort and the latter from that of environmental health, although in the everyday experience of the inhabitants of hot coastal regions they occur together.

Heat exposure is increasing in Latin America. The 2023 Lancet Countdown report for the region estimated that in 2022 the population was exposed to ambient temperatures that were, on average, 0.38 °C higher than in the period from 1986 to 2005, and that heat-related mortality increased by 140% between the decades 2000 to 2009 and 2013 to 2022 (Hartinger et al., 2024).

A systematic review and meta-analysis of 88 studies found that heatwaves and extremely high temperatures were associated with an increased risk of mental and behavioral disorders (Li et al., 2023).

In humid regions, humidity adds a burden of its own: in Guangdong Province, China, indicators combining temperature and humidity captured the association between humid heat and sleep disorders among school-aged children better than temperature alone did, which led the study authors to recommend incorporating humidity into health studies in such areas (Gao et al., 2025).

Dampness inside the home also has documented health consequences. A synthesis of systematic reviews on housing and health found that all reviews addressing housing exposures associated poor conditions, including dampness and mold, with adverse health effects (Richards et al., 2023). A meta-analysis of 30 studies of children in high-income countries estimated odds ratios ranging from 1.28 for dampness and respiratory infections to 1.76 for mold and respiratory symptoms, with the caveat that the evidence comes mainly from cross-sectional studies (Groot et al., 2023).

However, occupants' perception of humidity does not always reflect environmental conditions: in a field study of rural dwellings in southwest China, the perception of a parameter that remains relatively constant, such as humidity, appeared to be attenuated (Wei et al., 2022).

In Mexico, housing policy during the first decades of this century favored the mass production of social housing, characterized by small dwellings, developments located far from urban centers, and insufficient services (Hernández Ilizaliturri et al., 2025).

In the northwest of the country, residents of a social housing development in Culiacán described their homes as very hot (Barraza-Bracamontes et al., 2022); in Hermosillo, the predominant social housing type showed less favorable energy performance than a dwelling built in accordance with energy efficiency standards (Muñoz López et al., 2023).

During the COVID-19 pandemic lockdown, more than half of the respondents to a nationwide online survey about their homes reported not being thermally comfortable (Jaimes Torres et al., 2021); space cooling has also become one of the main residential energy demands in the country's hot climates (Galindo-Borbón et al., 2024; Treviño Hernández and Hernández Rejón, 2026).

Regional research on thermal experience in social housing has focused on the hot dry climates of the northwest, such as that of Hermosillo (Espinoza Gallego et al., 2014; Muñoz López et al., 2023), and on the analysis of energy performance. In the country's warm subhumid climates, studies have assessed the feasibility of adaptive comfort models using weather files and have concluded that local models are needed to propose strategies with greater regional impact (May-Tzuc et al., 2023).

What is lacking, however, is a brief instrument for recording, from the residents' perspective, how they appraise the thermal performance and humidity of their dwellings, and whose psychometric properties have been examined in social housing in a northwestern coastal city such as Mazatlán.

For this purpose, project FZ-HAB-0001 of the Factoriza UAS platform designed a twelve-item hygrothermal habitability scale organized into two dimensions: Thermal comfort in the dwelling and Humidity control in the dwelling. The title of the project in Factoriza refers to the validation of the scale. However, with a preliminary data cut of 13 cases, this article can offer no more than an initial body of evidence on how the scale performs, which is why the article's title refers to preliminary psychometric properties. Validity is not a property that a scale acquires in a single study but a judgment built on accumulated evidence; this work provides the first such evidence

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for the instrument.

The overall objective was to examine the preliminary psychometric properties of the hygrothermal habitability scale among people living in social housing in Mazatlán. The specific objectives were: (a) to describe the distribution of responses to each item; (b) to estimate the internal consistency of each dimension using Cronbach's alpha and McDonald's omega total, and to analyze the contribution of each item; (c) to explore the internal structure of the item set through exploratory factor analysis; and (d) to estimate the relationship between the scores of the two dimensions. The project did not state any hypotheses; therefore, the study is framed as exploratory.

MAIN BODY

HYGROTHERMAL HABITABILITY OF THE DWELLING

In this work, hygrothermal habitability is understood as the residents' appraisal of the temperature and humidity conditions of their dwelling in relation to their everyday activities: being at home during the day, sleeping at night, breathing comfortably, and keeping their furniture and walls in good condition. The definition does not replace physical measurement of the indoor environment; rather, it records the experience of those who live in it, which depends on the climate, on the dwelling, and also on how people adapt.

For this reason, the project scale combines items on thermal sensation at different times of day, on the coolness of bedrooms and ventilation, and on air humidity, stains on walls, and mold.

The adaptive approach to thermal comfort has shown that the temperature people perceive as neutral varies with context. In rural dwellings in southwestern China, the residents' neutral operative temperature was 29.33 °C, higher than that reported by previous studies in the same climate region; adaptive behaviors improved their ability to tolerate demanding indoor conditions (Wei et al., 2022).

In naturally ventilated rural dwellings in the northern part of China's hot summer and warm winter zone, a study of 251 individuals from 98 households estimated a neutral temperature of 25.34 °C and an acceptable range of 21.69 °C to 30.55 °C; the study also found that older people tolerated heat better than younger adults (Gong et al., 2025).

These findings indicate that a hygrothermal habitability scale does not directly measure temperature, but rather the relationship between the conditions of a dwelling and the adaptive expectations and resources of its occupants.

Adaptive behaviors are part of this relationship. In a village in Guangzhou with a hot, humid climate, older adults adapted in summer mainly by opening windows, using curtains and electric fans, and moving to different spaces. Fan use was not associated with indoor air temperature but was negatively associated with indoor relative humidity. In addition, the proportion of those who left the dwelling to cool off increased with temperature and decreased with relative humidity (Tian et al., 2022).

Ventilation therefore plays a role in both thermal and humidity experience, and occupants' appraisal of it does not necessarily equate to an improvement in indoor temperature.

DAMPNESS, MOLD, AND HEALTH IN THE HOME

Household dampness has two sides for the people who live with it. One is sensory: the feeling that the indoor air is humid or, conversely, light. The other is material: persistent dampness leaves stains on the walls and is accompanied by mold on surfaces and furniture.

The literature on housing and health has consistently associated dampness and mold with adverse health effects (Richards et al., 2023) and, in particular, with respiratory infections and symptoms in children (Groot et al., 2023). These effects are linked to the physical conditions of the dwelling, which do not always match what its occupants perceive.

The relationship between humidity and thermal sensation is not straightforward either. In tropical homes in Padang, Indonesia, more than 80% of individuals in both the community groups and the groups with respiratory symptoms reported feeling too hot; higher temperature, lower humidity, modern housing style and attached housing were positively associated with this sensation (Prima et al., 2026).

The sign of the association with humidity in that study is a reminder that, in environments

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where humidity is usually high, its variation may influence this sensation less than temperature or housing characteristics do, consistent with the attenuated perception of constant parameters described in southwestern China (Wei et al., 2022).

For a scale aimed at residents of a humid coastal area, this implies that items on air humidity might discriminate less than those concerning its visible consequences or overall comfort.

SOCIAL HOUSING AND CLIMATE IN NORTHWESTERN MEXICO

Social housing mass-produced over recent decades follows prototypes that are replicated across very different climates. In northwestern Mexico, the available evidence describes hot dwellings: in Culiacán, residents of a social housing development identified heat as the main characteristic of their homes and kept their air conditioning running (Barraza-Bracamontes et al., 2022); in Hermosillo, the thermal environment of social housing was negatively associated with psychological well-being in summer (Espinoza Gallego et al., 2014).

The cost of cooling dwellings and the implementation of energy efficiency regulations are central issues in the regional debate (Galindo-Borbón et al., 2024; Treviño Hernández and Hernández Rejón, 2026).

Passive strategies are an alternative for reducing this dependence. In the state of Campeche, which has a warm subhumid climate, natural ventilation proved applicable throughout the state, and adaptive comfort models reduced estimated energy consumption compared with the static approach (May-Tzuc et al., 2023).

In a pilot trial involving forty rural African dwellings, those with cool roofs had the lowest indoor heat index both during the day and at night, whereas no differences were observed between dwellings with cross-ventilation and the control dwellings (Abong'o et al., 2026).

In Irbid, Jordan, dwelling type was associated with the perceived effectiveness of passive strategies: residents of apartments rated tree shading and natural ventilation as less effective than did residents of single-family houses (Obeidat, 2026). For measurement purposes, this means that the presence of air movement, perceived coolness, and indoor temperature are related but distinct aspects of the thermal experience.

MEASURING PERCEIVED HABITABILITY USING SCALES

Perceived habitability scales are built from items assumed to be manifestations of one or more latent dimensions. The internal consistency of each dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not make this assumption; simulation studies have compared the performance of the two coefficients under different data conditions (Malkewitz et al., 2023).

The internal structure is examined with exploratory factor analysis, for which current recommendations call for first verifying the adequacy of the data, including at the item level, then determining the number of factors with procedures such as parallel analysis, and treating reference values as guidelines rather than rules (Ferrando et al., 2022; Goretzko et al., 2021; Lorenzo-Seva and Ferrando, 2021).

Two measurement issues are particularly relevant to this scale. The first is mixed item wording: scales with regular and reverse-worded items may show wording-related biases, because some respondents respond inconsistently to positive and negative items within the same dimension (Steinmann et al., 2022); identifying these responses can reduce such biases (García-Batista et al., 2021).

The second is the nature of the indicators: in measurement theory, indicators that make up a construct, rather than reflecting it, are termed formative; their implications for factor analysis and reliability theory differ from those of reflective indicators (Bollen and Diamantopoulos, 2017).

Drafts or damp stains on walls are housing characteristics that might behave more like conditions that make up hygrothermal habitability than like reflections of an overall appraisal; this possibility should be borne in mind when interpreting the structure of the scale.

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METHODOLOGY

DESIGN

An instrumental study with a quantitative approach, a cross-sectional design and an exploratory scope was conducted to examine the preliminary psychometric properties of a scale. Because the design was cross-sectional, the relationships reported are associations and do not permit causal inferences.

POPULATION, SAMPLE, AND DATA CUTOFF

The data come from the survey "Piloto Mazatlán · Habitabilidad higrotérmica" (LEV-0006) of project FZ-HAB-0001 on the Factoriza UAS platform and from the frozen dataset DST-0042, with a data cutoff date of 14 October 2026. The survey population comprises people aged 18 years or older living in social housing developments in Mazatlán, Sinaloa, that were selected by the project lead.

Table 1 presents the composition of the sample. The questionnaire was opened by 22 people and completed by 13; no cases were excluded by the platform's quality control, and 13 cases with 12 items were analyzed. This is a preliminary data cut: n = 13 of a target of 100, with data collection still ongoing. The results in this article describe this cut and should not be regarded as definitive; the analysis will need to be repeated with the final data cut.

Table 1. Sample composition.

Indicator	Value
People who opened the questionnaire	22
Completed questionnaires	13
Cases excluded by quality control	0
Cases analyzed	13
Items	12

Note. Survey "Mazatlán Pilot · Hygrothermal Habitability" (LEV-0006); population: people aged 18 years or older living in social housing in Mazatlán; territory: Mazatlán, Sinaloa, in social housing developments selected by the project lead. Dataset DST-0042, fingerprint 3480c4f0a5fd2743. Source: Factoriza UAS. Preliminary cutoff: n = 13 of a target of 100, with the survey still open.

INSTRUMENT

The hygrothermal habitability scale consists of twelve items rated on a 5-point response scale, ranging from Strongly disagree to Strongly agree, organized into two dimensions of six items each. Thermal comfort in the home (R1 to R6) assesses pleasant temperature during the day, sleeping comfort on summer nights, coolness during the hottest hours, heat in the afternoons, coolness of the bedrooms at night, and air currents that cool the interior.

Humidity control in the home (R7 to R12) assesses the perception of humid air, damp stains on the walls, the sensation of light air, the absence of mold on furniture, ease of breathing, and the pleasantness of the indoor environment during the rainy season. Three items are reverse-worded (R4, R7, and R8) and have been recoded in the data matrix, so that a high value on every item indicates a favorable condition. Table 2 presents the wording of each item.

Table 2. Structure of the instrument.

Code	Item	Reverse-scored
R1	The temperature inside my home is pleasant during the day	No
R2	On summer nights, I can sleep comfortably in my home	No
R3	My home stays cool during the hottest hours of the day	No
R4	In my home, I feel hot in the afternoons	Yes
R5	The bedrooms in my home feel cool at night	No
R6	Air currents cool the interior of my home	No
R7	The air feels humid inside my home	Yes

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Code	Item	Reverse-scored
R8	The walls of my home have damp stains	Yes
R9	Inside my home, the air feels light	No
R10	The furniture in my home is kept free of mold	No
R11	I can breathe comfortably inside my home during the rainy season	No
R12	During the rainy season, the interior of my home feels pleasant	No

Note. R1 to R6 = Thermal comfort in the home; R7 to R12 = Humidity control in the home. The dimension column is omitted to preserve the readability of the table. Response scale: 5-point (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0001, survey LEV-0006, dataset DST-0042.

PROCEDURE

The questionnaire was administered through the Factoriza UAS platform, which records explicit online informed consent before the first question and does not collect data that would allow individuals to be identified. The platform applies quality control to completed questionnaires before incorporating them into the dataset; in this data collection round, it excluded no cases.

DATA ANALYSIS

Factoriza UAS calculated the descriptive statistics for each item (mean, standard deviation, skewness, kurtosis and percentages of responses at the minimum and maximum values); the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951) and the corrected item-total correlation; and the Pearson correlations between the items within each dimension, with 95% confidence intervals obtained by Fisher's z transformation.

In addition, the project's supplementary analysis program, analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020) and pandas 3.0.5. The program estimated the internal consistency of each dimension using Cronbach's alpha and McDonald's omega total (McDonald, 1999/2013), based on a one-factor minimum-residual model and without reverse-scoring items.

The internal structure was examined by exploratory factor analysis of the twelve items, using the Pearson correlation matrix of the 13 complete cases. This analysis was preceded by the Kaiser-Meyer-Olkin measure of sampling adequacy, both overall (Kaiser, 1974) and per item (Lorenzo-Seva and Ferrando, 2021), and by Bartlett's test of sphericity (Bartlett, 1950).

The number of factors was determined by parallel analysis (Horn, 1965) with 100 simulations and a seed of 2026; extraction used the minimum residual method, and the planned rotation, oblimin, which allows correlation between factors, was not applied because a single factor was retained. The relationships between dimensions were estimated using Spearman's coefficient between the mean scores of each dimension, with its 95% confidence interval obtained through Fisher's transformation and the Bonett and Wright standard error (Bonett and Wright, 2000).

The program does not remove items automatically: it flags those with a loading below .30, a cross-loading, an opposite sign, or a measure of sampling adequacy below .50, and leaves the decision to the authors. These values, like the .60 cutoff for the overall measure of sampling adequacy, are used as indicative benchmarks from the methodological literature rather than as rules (Ferrando et al., 2022; Lorenzo-Seva and Ferrando, 2021). No confirmatory factor analysis was performed; with a preliminary data cut and the same sample as the exploratory analysis, it would not be defensible.

With 13 cases for 12 items, the case-to-item ratio is far below what the methodological literature considers adequate for item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021). The factor analysis of this data cut is therefore presented as documentation of how the items initially functioned; its results are not interpreted as evidence of the structure of the scale.

ETHICAL CONSIDERATIONS

Participation was voluntary, with explicit informed consent recorded online through the platform, which does not collect names, addresses, or other identifying data. Data were analyzed

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in aggregate form.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following were used: the Factoriza UAS platform, for data management and the descriptive and internal consistency analyses; a Python analysis program with fixed, validated procedures, for omega, exploratory factor analysis, and the correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, writing a draft, and assembling the document from the results. The authors reviewed, corrected, and approved the entire text, verified every reference, and take full responsibility for the content of the article.

RESULTS

DESCRIPTION OF RESPONSES

Table 3 and Figure 1 present the descriptive statistics for the twelve items. No mean reached a value of 4, which corresponds to Agree. The Thermal comfort items had the lowest means: the coolness of the dwelling during the hottest hours had the lowest mean on the instrument (R3: *M* = 2.38, *SD* = 1.12), followed by the reverse-scored item on afternoon heat (R4: *M* = 2.69, *SD* = 0.95). The recoded mean of R4 indicates that responses leaned toward agreement with feeling hot in the afternoon.

Pleasant daytime temperature and comfort when sleeping on summer nights had the same mean (R1 and R2: *M* = 3.08); the air currents that cool the interior had the highest mean in the dimension (R6: *M* = 3.46, *SD* = 0.88).

Overall, the Humidity Control items showed higher means. The pleasantness of the indoor environment during the rainy season (R12: *M* = 3.77, *SD* = 1.09), breathing comfort during that season (R11: *M* = 3.69, *SD* = 0.95), and the sensation of light air (R9: *M* = 3.62, *SD* = 0.77) had the highest means on the instrument.

The two reverse-scored items of the dimension had means close to the midpoint: the perception of humid air (R7: *M* = 2.85, *SD* = 0.99) and damp stains on the walls (R8: *M* = 3.15, *SD* = 1.21), the latter showing the greatest dispersion on the scale. The distributions of R9 and R11 were the most skewed (skewness = -1.76 and -2.05, respectively). R11 also had a kurtosis of 5.66, indicating a marked concentration of responses at a single value. R9's ceiling of 77% was the highest value observed, as indicated in the table note.

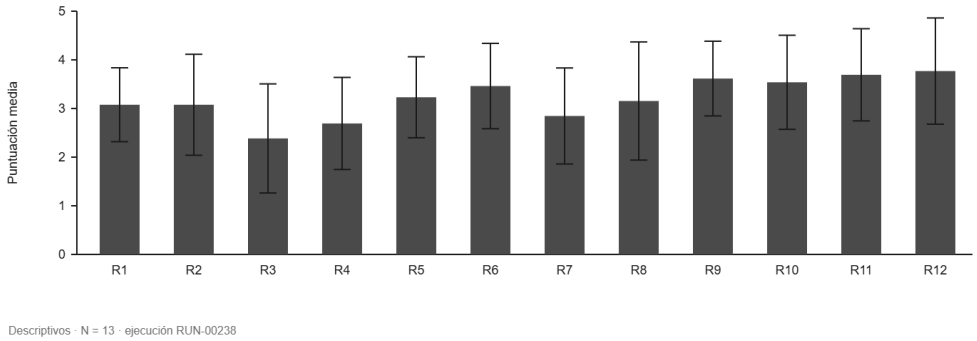
Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.08	0.76	-0.14	-1.05	23%	31%
R2	3.08	1.04	-0.70	-0.72	8%	46%
R3	2.38	1.12	-0.08	-1.39	31%	15%
R4	2.69	0.95	0.04	-0.82	8%	23%
R5	3.23	0.83	-0.50	-1.34	23%	46%
R6	3.46	0.88	-0.30	-0.34	15%	8%
R7	2.85	0.99	-0.26	-0.91	8%	31%
R8	3.15	1.21	-0.34	-1.18	8%	8%
R9	3.62	0.77	-1.76	1.62	15%	77%
R10	3.54	0.97	-0.78	-0.49	23%	8%
R11	3.69	0.95	-2.05	5.66	8%	8%
R12	3.77	1.09	-0.83	-0.41	23%	23%

Note.N = 13. R1 to R6 = Thermal comfort in the home; R7 to R12 = Humidity control in the home. Reverse-scored items R4, R7, and R8 are shown recoded, so that a high value always indicates a favorable condition. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated from the total score of each dimension. Factoriza UAS run RUN-00238. Preliminary cut: n = 13 out of a target of 100, with data collection still open.

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Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 presents the item analysis for each dimension. For Thermal comfort, the dimension's alpha was .684. Pleasant temperature during the day (R1: .767) and coolness during the hottest hours (R3: .723) had the highest corrected item-total correlations, followed by heat in the afternoons (R4: .510) and coolness of the bedrooms at night (R5: .422). Sleeping comfort on summer nights had a low correlation (R2: .209), and the correlation for air currents was practically zero (R6: .006). Removing R6 would raise the alpha to .758, and removing R2 would raise it to .716.

For Humidity Control, alpha was .671. Indoor pleasantness during the rainy season (R12: .710) and breathing comfort (R11: .698) had the highest corrected item-total correlations, followed by the sensation of light air (R9: .498) and the absence of mold on furniture (R10: .386). The two reverse-scored items had low correlations, .168 for damp stains (R8) and .110 for humid air (R7), and deleting either one would raise the dimension's alpha (to .725 without R8 and to .721 without R7).

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Thermal comfort	R1	.767	.544
Thermal comfort	R2	.209	.716
Thermal comfort	R3	.723	.509
Thermal comfort	R4	.510	.609
Thermal comfort	R5	.422	.641
Thermal comfort	R6	.006	.758
Humidity	R7	.110	.721
Humidity	R8	.168	.725
Humidity	R9	.498	.608
Humidity	R10	.386	.634
Humidity	R11	.698	.525
Humidity	R12	.710	.502

Note.N = 13. Scale from 1 to 5; reverse-scored items R4, R7, and R8 are shown recoded. Run RUN-00238 of Factoriza UAS. Preliminary data cut: n = 13 of a target of 100, with data collection ongoing.

Table 5 presents the alpha and total omega estimated by the complementary analysis program. The alpha values match those from Factoriza (.684 and .671). Total omega was .743 for Thermal comfort and .745 for Humidity control, higher than alpha in both cases, which is consistent with unequal loadings across the items of each dimension. No dimension had items with a negative item-rest correlation or a negative loading within its own one-factor model, so the program reported omega for both.

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Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω
Thermal comfort	6	13	.684	.743
Humidity	6	13	.671	.745

Note.N = 13. Thermal comfort = Thermal comfort in the home; Humidity = Humidity control in the home. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each complete dimension (6 items each): Thermal comfort = .684 (run RUN-00239); Humidity = .671 (RUN-00241). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary cutoff: n = 13 of a target of 100, with data collection ongoing.

INTER-ITEM CORRELATIONS

The inter-item correlations within each dimension, calculated with Factoriza (runs RUN-00240 and RUN-00242), show the pattern described above in greater detail. In Thermal Comfort, only two correlations had confidence intervals that excluded zero: one between pleasant daytime temperature and coolness during the hottest hours (R1 and R3: r = .843, 95% CI [.546, .952], p < .001) and one between the latter and bedroom coolness at night (R3 and R5: r = .612, 95% CI [.092, .870], p = .026).

Air drafts showed near-zero or negative correlations with the other items, such as with sleeping comfort (R2 and R6: r = -.317, 95% CI [-.739, .284], p = .291).

In Moisture Control, four correlations excluded zero, all between direct items: between the absence of mold and the pleasantness of the indoor environment during the rainy season (R10 and R12: r = .759, 95% CI [.357, .924], p = .003), between the sensation of light air and both breathing comfort (R9 and R11: r = .740, 95% CI [.319, .917], p = .004) and the pleasantness of the indoor environment during the rainy season (R9 and R12: r = .680, 95% CI [.207, .896], p = .010), and between breathing comfort and the latter (R11 and R12: r = .570, 95% CI [.028, .853], p = .042).

The reverse-scored items had low correlations with the others, with intervals that included zero; the highest was between humid air and breathing comfort (R7 and R11: r = .391, 95% CI [-.204, .775], p = .187), while those of damp stains with light air and with the absence of mold were practically null (R8 and R9: r = -.021; R8 and R10: r = -.005).

INTERNAL STRUCTURE

The overall Kaiser-Meyer-Olkin measure of sampling adequacy was .190, well below the value of .60 commonly cited as a guideline (Ferrando et al., 2022; Lorenzo-Seva and Ferrando, 2021); the item-level measure was below .50 for all twelve items, ranging from .064 (R7) to .471 (R1).

Bartlett's test of sphericity rejected the hypothesis of an identity matrix, $\chi^2(66) = 123.94$, p < .001. Given these values, the correlation matrix for this cohort is poorly suited to factor analysis; the results that follow are reported to document item functioning.

Parallel analysis suggested retaining one factor (Figure 2), which explained 32.92% of the variance, with a sum of squared loadings of 3.95 (Table 6). Table 7 presents the loadings. The factor grouped positively worded items from both dimensions: the highest loadings corresponded to pleasant temperature during the day (R1: .888) and the pleasantness of the indoor environment during the rainy season (R12: .888), followed by coolness during the hottest hours (R3: .802), the sensation of light air (R9: .704), the absence of mold (R10: .649), comfort when sleeping on summer nights (R2: .573), and comfort when breathing (R11: .555).

Five items had loadings below .30: coolness of the bedrooms at night (R5: .296), heat during the afternoons (R4: .244), damp stains (R8: .163), drafts (R6: -.036), and humid air (R7: -.026); for the last two, the software also flagged the opposite sign. Among these five are the instrument's three reverse-scored items. The software did not remove any item; the decision on them rests with the authors at the final cut.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 8 presents the Spearman correlation between the mean scores of the two dimensions. The relationship was positive and moderate, but its confidence interval included zero (ρ = .302, 95% CI [-.311, .738], p = .316; 13 cases). With this sample size, the interval is too wide to determine whether the two dimensions are independent or share a substantial portion of their variance.

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Figure 2. Scree plot with parallel analysis.

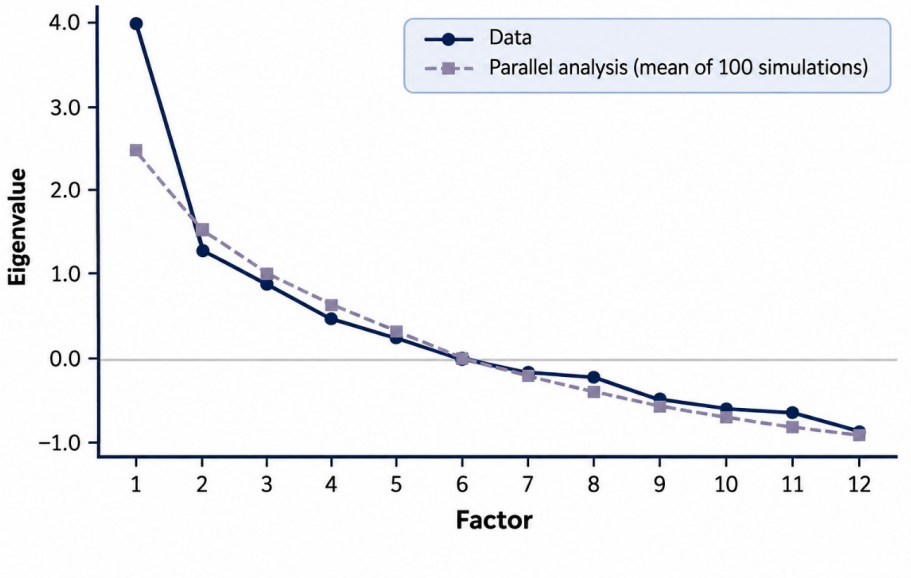


Table 6. Variance explained by the factors.

Factor	Sum of squared loadings	% of variance	Cumulative %
1	3.95	32.92	32.92

Note. Eigenvalues of the reduced data matrix compared with the mean of 100 simulated matrices of the same size (seed 2026). Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0042_FZ_HAB_0001. Preliminary data cut: n = 13 of a target of 100, with data collection ongoing.

Table 7. Factor loadings from the exploratory factor analysis.

	Factor		
Item	1	h^2	MSA
R1	.888	.789	.471
R2	.573	.328	.192
R3	.802	.644	.355
R4	.244	.060	.110
R5	.296	.088	.142
R6	-.036	.001	.077
R7	-.026	.001	.064
R8	.163	.027	.076
R9	.704	.496	.210
R10	.649	.422	.180
R11	.555	.308	.174
R12	.888	.788	.285

Note. KMO = .190; Bartlett's test of sphericity: $\chi^2(66) = 123.94$, $p < .001$. Number of factors by parallel analysis: 1. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0042_FZ_HAB_0001. Preliminary data cut: n = 13 of a target of 100, with data collection still ongoing.

Table 8. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Thermal comfort and Humidity	13	.302	[-.311, .738]	.316

Note. Pattern matrix. Minimum residual extraction and oblimin rotation (γ = 0) on the Pearson correlation matrix; 13 complete cases. h^2 = communality; MSA = measure of sampling adequacy per item. All loadings are shown. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0042_FZ_HAB_0001. R1 to R6 = Thermal comfort in the dwelling; R7 to R12 = Humidity control in the dwelling. With a single retained factor, there is no rotation to apply. The dimension and observation columns are omitted; the program flagged low MSA for all twelve items, insufficient loadings for R4, R5, R6, R7 and R8, and opposite signs for R6 and R7. Preliminary data cut: n = 13 out of a target of 100, with data collection still ongoing.

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DISCUSSION OF RESULTS

This study examined the preliminary psychometric properties of a hygrothermal habitability scale in social housing in Mazatlán, based on a data cut of 13 cases. The first finding is descriptive: respondents rated the thermal performance of their dwellings less favorably than humidity control, and coolness during the hottest hours of the day was the lowest-rated aspect.

This pattern is consistent with residents' own description of social housing in northwestern Mexico as hot (Barraza-Bracamontes et al., 2022) and with evidence of unfavorable energy performance of social-interest housing in the region (Muñoz López et al., 2023). However, with 13 cases from housing developments selected by the project leader, the means cannot be used to estimate the conditions of social housing in the city.

The relatively favorable ratings of humidity, with higher means for ease of breathing and for the pleasantness of the indoor environment during the rainy season, are open to two interpretations. These may be dwellings in which indoor humidity is not perceived as a problem, or the ratings may reflect an attenuated perception of a parameter that remains relatively constant, as described in rural dwellings in southwestern China (Wei et al., 2022). The concentration of responses to R9 and R11 at a single value, with high skewness and kurtosis, is compatible with both interpretations and limits the ability of these items to discriminate between dwellings.

The second finding concerns internal consistency. The two dimensions had alphas of .684 and .671 and omegas of .743 and .745, values that should be interpreted with caution because of the sample size: the simulation literature on alpha and omega has been developed using much larger samples (Malkewitz et al., 2023).

The behavior of each item is more informative than the overall coefficient. In Thermal Comfort, air drafts (R6) were not related to the rest of the dimension, and comfort when sleeping on summer nights (R2) was weakly related; in Humidity Control, the two reverse-scored items (R7 and R8) had the lowest item-total correlations. In all three cases, deleting the item would increase alpha, but that decision cannot be made with 13 cases or on that criterion alone.

The case of drafts illustrates the difference between a characteristic of the dwelling and an appraisal of its environment. Air circulating indoors does not guarantee that the dwelling stays cool: in a trial involving rural African houses, cross-ventilated houses did not differ from controls in indoor heat index, whereas cool-roof houses had the lowest index (Abong'o et al., 2026); in Guangzhou, fan use was associated with indoor relative humidity but not with air temperature (Tian et al., 2022).

Something similar could apply to the damp stains on the walls (R8), which describe visible deterioration of the building rather than a sensation. From a measurement perspective, these items could behave as formative indicators, which make up hygrothermal habitability without having to covary with the overall ratings, and for which internal consistency is not the appropriate criterion (Bollen and Diamantopoulos, 2017).

The third finding is structural. Parallel analysis suggested a single factor, on which the direct items of the two dimensions loaded strongly, whereas the three reverse-worded items and the items on drafts and on the coolness of the bedrooms at night loaded weakly. This pattern admits at least two interpretations.

The first concerns content: the items with high loadings express an overall appraisal of how pleasant the dwelling is during hot weather and the rainy season, whereas those with low loadings refer to specific conditions or to visible deterioration. The second concerns method: that the three reverse-worded items are among those with the lowest loadings is compatible with a wording-related bias, one documented in scales with items keyed in both directions (García-Batista et al., 2021; Steinmann et al., 2022).

With an overall measure of sampling adequacy of .190 and item-level measures below .50 in all cases, neither interpretation can be supported with this data cut, and the one-factor solution should not be read as evidence against the two-dimensional structure proposed by the project.

The correlation between the dimensions likewise points to uncertainty. A coefficient of .302 with an interval from -.311 to .738 is compatible with both nearly independent and strongly related dimensions. In the literature on humid heat, indicators that combine temperature and humidity describe the associations of humid heat with health better than temperature alone does (Gao et al., 2025), and thermal sensation in tropical households has been associated with both air conditions and housing characteristics (Prima et al., 2026). A positive relationship between the two dimensions can therefore be expected; its magnitude will need to be estimated with the final data cut.

The results suggest several adjustments for the next stage. Regarding the instrument, it

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would be advisable to revise the wording of the reverse-worded items or to balance their number in each dimension so that the variance associated with item wording can be modeled. It would also be worth examining whether drafts and damp patches should be retained as indicators of housing conditions, separate from the appraisal of the indoor environment.

For the procedure, it would be useful to supplement the scale with indoor temperature and relative humidity measurements in a subsample of dwellings, as in field studies that combine thermal sensation votes with calculated indices (Gong et al., 2025; Prima et al., 2026); this would make it possible to gather validity evidence based on relations to other variables.

CONCLUSIONS

The study examined the preliminary psychometric properties of a 12-item hygrothermal habitability scale among people living in social housing in Mazatlán, using a preliminary data cut of 13 cases out of a target of 100. Respondents rated the thermal comfort of their homes less favorably than humidity control; coolness during the hottest hours was the lowest-rated aspect.

Both dimensions showed moderate internal consistency (α = .684 and .671; ω = .743 and .745), with low-contributing items in each: drafts and sleeping comfort in Thermal Comfort, and the two reverse-scored items in Humidity Control. Exploratory factor analysis suggested a single factor on which the positively worded items of both dimensions loaded, but sampling adequacy was very low (KMO = .190), and the results document only the initial functioning of the items.

The study has limitations that should be borne in mind when reading all of its results. The first is the size and nature of the data cut: 13 cases out of a target of 100, with data collection still ongoing, are insufficient to estimate internal consistency, correlations and, above all, factor structure with precision; the factor structure results should not be interpreted as evidence regarding the structure of the scale.

The second concerns the sample: the housing developments were selected at the discretion of the project leader, the sampling method has yet to be documented, and the characteristics of the respondents are not available, so the results cannot be generalized to social housing in Mazatlán. The third concerns measurement: the floor and ceiling percentages reported by Factoriza appear to be calculated from the observed values, a point that must be verified, and the scale was not accompanied by physical measurements of the indoor environment. The fourth concerns the design: because the study is cross-sectional, it does not allow causal inferences, and no confirmatory factor analysis was performed.

Directions for future work follow from these limitations. Once the final data cut is available, it will be advisable to repeat the exploratory factor analysis and, if sampling adequacy permits, to examine whether the two-dimensional structure holds; the resulting structure should then be tested by confirmatory factor analysis in an independent sample.

It will also be advisable to decide, on content-based rather than solely statistical grounds, what to do with the low-contribution items, to review the wording of the reverse-keyed items, and to consider separating indicators of housing conditions from appraisals of the dwelling's environment. Finally, combining the scale with indoor temperature and relative humidity recordings would make it possible to gather validity evidence based on relations to other variables and to determine the extent to which occupants' perceptions reflect the conditions of their dwellings; this information would be useful for guiding the design and adaptation of social housing in a warm-climate coastal city.

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Chapter 3 / Capítulo 3

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Urban heat island and psychological comfort in residential subdivisions of Mazatlán

Isla de calor urbana y confort psicológico en fraccionamientos de Mazatlán

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ABSTRACT

Urban heat shapes the habitability of residential subdivisions in hot cities, yet its psychological dimension is rarely measured. Using the preliminary data cut from the pilot survey of project FZ-HAB-0005 on the Factoriza UAS platform, this study described the initial behaviour of a fifteen-item scale with three dimensions, Perceived heat exposure, Well-being in the hot months and Adjustment of activities to heat, among residents of subdivisions in Mazatlán. With a cross-sectional design, 7 cases out of a target of 100 were analysed while data collection remained open; the analysis was limited to the perception component and included no temperature measurements. Descriptive statistics, Cronbach's alpha, McDonald's omega total and Spearman correlations between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was moderate for Perceived exposure (α = .636), higher for Adjustment of activities (α = .729; ω = .743, excluding one invariant item) and negative for Well-being (α = -.153). The factor analysis was not interpretable because the sample had fewer cases than items. Well-being and Adjustment of activities were negatively correlated (ρ = -.896), with a very imprecise estimate. Residents perceived their subdivision as hot, reported low well-being in summer and strongly adjusted their activities. The findings do not yet provide structural validity evidence and point to revisions of the instrument.

Keywords: urban heat island; perceived heat exposure; psychological well-being; heat adaptation

RESUMEN

El calor urbano condiciona la habitabilidad de los fraccionamientos de las ciudades cálidas, pero su dimensión psicológica rara vez se mide. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0005 de Factoriza UAS, el comportamiento inicial de una escala de quince reactivos con tres dimensiones: Exposición percibida al calor, Bienestar en los meses de calor y Ajuste de actividades al calor, en residentes de fraccionamientos de Mazatlán. Con diseño transversal, se analizaron 7 casos de una meta de 100, con el levantamiento abierto; el análisis se limitó al componente de percepción y no incluyó mediciones de temperatura. Se estimaron descriptivos, alfa de Cronbach, omega total y correlaciones de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue moderada en Exposición percibida (α = .636), más alta en Ajuste de actividades (α = .729; ω = .743, sin un reactivo invariante) y negativa en Bienestar (α = -.153). El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos. Bienestar y Ajuste de actividades se correlacionaron en negativo (ρ = -.896), con una estimación muy imprecisa. Los residentes percibieron su fraccionamiento como caluroso, refirieron bajo bienestar en verano y ajustaron intensamente sus actividades. Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento.

Palabras clave: isla de calor urbana; exposición percibida al calor; bienestar psicológico; adaptación al calor

INTRODUCTION

Urban heat is no longer an exclusively climatic issue; it has become an everyday condition of habitability. The replacement of vegetation and natural soil with built surfaces, pavements and roofs alters the energy balance of cities and gives rise to the urban heat island, the phenomenon whereby urbanized areas record higher temperatures than their surroundings. In the hot-climate cities of northwestern Mexico, this condition is felt inside homes, in the streets and in the public spaces of the residential subdivisions where a large share of the population lives.

Research on the human consequences of heat has advanced rapidly. Recent systematic reviews have associated high temperatures and heat waves with an increased risk of mental and behavioral disorders (Li et al., 2023), with mental and neurological conditions in older adults (Byun et al., 2024), and with a decline in sleep quantity and quality (Chevance et al., 2024).

The proposed mechanisms include psychological stress, sleep disruption, fatigue, reduced physical exercise, social isolation, and loss of access to usual coping strategies (Baecker et al., 2025).

Beyond these health effects, the literature has documented that people adjust their daily lives to heat: they change their schedules, reduce outdoor activity and seek out cool spaces, although these responses depend on their resources and their perception of risk (Guzman-Colon et al., 2025; van de Kamp et al., 2026).

In Sinaloa, studies on urban heat have focused mainly on physical measurement. In Culiacán, Borbolla Gaxiola et al. (2024) characterized surface heat islands using satellite imagery and found that their intensity varies with the season and with land uses on the periphery; Barraza-Bracamontes et al. (2022) documented that residents of a social housing development described their homes as very hot.

For Mazatlán, by contrast, no instruments were identified that jointly measure perceived heat exposure in the housing development, well-being during the hot months, and the adjustment of daily activities, which are the three facets of the psychological experience of urban heat.

Project FZ-HAB-0005 of the Factoriza UAS platform set out to study the urban heat island and psychological comfort in residential developments (fraccionamientos) in Mazatlán. The project is registered with a mixed-methods design that envisages combining measurement of the thermal environment with a perception scale. This article reports only the perception component: the results of the first pilot survey of the Perceived Urban Heat and Well-being Scale, which consists of fifteen items organized into three dimensions, from a very small preliminary data cut. Its scope is therefore the initial review of the instrument, not the estimation of population parameters or the measurement of the heat island.

The overall objective was to describe the initial performance of a perceived urban heat and well-being scale in the preliminary data cut of its pilot survey with residents of housing developments in Mazatlán.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of analysing the internal structure with the available sample size; and fourth, to explore the relationship among the scores of the three dimensions. The project did not state any hypotheses; therefore, the study is descriptive and exploratory in scope.

DEVELOPMENT

URBAN HEAT ISLAND AND PERCEIVED EXPOSURE

The urban heat island has been studied mainly with physical data: weather stations, sensor-equipped transects, and land surface temperature estimated by remote sensing. The latter approach can cover entire cities, but it reports the temperature of surfaces rather than that of the air people breathe or the temperature they perceive.

In Culiacán, analysis of satellite images from different seasons showed more intense surface heat islands in spring, owing to scarce rainfall, and, at certain times of the year, cool-island behavior associated with crops on the agricultural periphery; the authors themselves recommended comparing their results with in situ air temperature data and cautioned about the small number of weather stations in the city (Borbolla Gaxiola et al., 2024).

This finding indicates that the heat island does not behave the same way in every city or in

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every season, and that its physical measurement is no substitute for the experience of those who live in it.

Perceived exposure refers to how residents assess the intensity of heat in their immediate surroundings. In Irbid, Jordan, a survey of apartment and single-family house residents covered perception of the neighborhood heat island and found that those living in apartments perceived a more intense heat island and rated tree shade and natural ventilation as less effective (Obeidat, 2026).

In Xi'an, China, most residents surveyed in urban parks felt that hot days affected their daily lives; housing type, occupation, and hours of outdoor work were associated with their perception of high temperatures (Zhang et al., 2023).

The instrument's Perceived Heat Exposure dimension captures this appraisal throughout the day and across the spaces of the housing development: intense heat during the day (R1), heat build-up in the streets in the afternoon (R2), persistence of heat at night (R3), the availability of cool places to spend time outdoors (R4, reverse-scored), and the sensation of heat from the pavement while walking (R5).

Nighttime heat deserves particular attention. Climate change and urbanization are raising both daytime and nighttime temperatures, and disrupted sleep is a plausible pathway linking heat to a range of adverse outcomes (Chevance et al., 2024). In Puerto Rico, a probability-based survey of adults found that exposure to nighttime heat was widespread and strongly associated with heat-related symptoms (Guzman-Colon et al., 2025). The systematic review cited above also showed that higher outdoor or indoor temperatures are generally associated with reduced sleep quantity and quality, with little evidence of rapid adaptation.

HEAT, WELL-BEING AND PSYCHOLOGICAL COMFORT

Psychological comfort in hot conditions encompasses more than thermal sensation: it includes mood, energy for activities, the ability to rest, and a sense of calm within one's own home. Epidemiological evidence supports this broad interpretation. The meta-analysis by Li et al. (2023) associated heatwaves and extreme temperatures with an increased risk of mental and behavioral disorders, and highlighted the usefulness of thermal indices that combine several meteorological factors.

In older adults, the review by Byun et al. (2024) found evidence of adverse effects of high temperatures and heat waves on mental and neurological conditions, with moderate overall certainty.

Studies combining systematic reviews with qualitative research have clarified the underlying mechanisms and vulnerability factors. Baecker et al. (2025) identified limited evidence on activation of the hypothalamic-pituitary-adrenal axis, psychological stress, reduced exercise, and sleep disruption; the focus groups added fatigue, health anxiety, loss of access to usual coping strategies, and social isolation.

In a subsequent study, Baecker et al. (2026) identified good physical health, social support and exposure to green spaces as protective factors, and added behavioral adaptive capacity, personal sensitivity to heat and inequalities in exposure. In Irbid, apartment residents reported greater perceived stress and poorer sleep quality than those living in houses; the author linked these differences more to perceived deficits in shade and ventilation than to housing type per se (Obeidat, 2026).

The Well-being During the Hot Months dimension captures these aspects, framed positively: feeling in good spirits during the hot season (R6), heat-related irritability (R7, reverse-scored), energy for activities in summer (R8), the ability to rest well on hot days (R9), and feeling calm inside the home (R10). After R7 is recoded, a higher score indicates greater well-being during the hot months.

ADJUSTMENT OF DAILY ACTIVITIES TO HEAT

People modify their behavior in response to heat. The most common strategies include using fans and air conditioning, staying indoors, and shifting daily schedules, but their adoption is limited by economic constraints and by risk perception. In Puerto Rico, fewer than half of the respondents perceived heat as a high risk to their health, and access to cooling was restricted by economic factors and by infrastructure instability (Guzman-Colon et al., 2025).

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In the Netherlands, people of lower socioeconomic position adopted more protective behaviors during a heat wave, albeit mainly low-cost ones, whereas risk perception remained low across all groups (van de Kamp et al., 2026).

Adjusting activities is a double-edged strategy. On the one hand, it protects against exposure; on the other, it may reduce physical exercise, social contact and the use of public space, which are themselves resources for well-being (Baecker et al., 2025).

The availability of vegetation and cool spaces in the surrounding environment is associated with lower heat-related morbidity and mortality and with favorable effects on mental health (Nazish et al., 2024); residents of Xi'an recognized the cooling effect of green spaces and water (Zhang et al., 2023).

The Adjustment of activities to heat dimension includes changing the times for going out (R11), avoiding walking around the housing development at midday (R12), engaging in outdoor activities at any time of day (R13, reverse-scored), planning outings according to the temperature (R14), and spending more time indoors during the hot months (R15).

HOUSING AND RESIDENTIAL DEVELOPMENTS IN HOT CLIMATES

In housing developments, urban and architectural design shapes heat exposure through lot size, orientation, materials, vegetation and the proportion of paved surfaces.

In the Urbi Villa del Cedro housing development in Culiacán, Barraza-Bracamontes et al. (2022) combined a questionnaire with thermal, acoustic and lighting measurements and found that most of the dwellings fell within a comfort range calculated for the city, but that their occupants described them as very hot and kept the air conditioning running.

In Hermosillo, which has a hot, dry climate, Muñoz López et al. (2023) compared the energy consumption and emissions of the predominant type of social housing with those of a dwelling built in accordance with energy efficiency standards and found higher emissions in the former.

These findings suggest that the experience of heat in housing developments depends on the outdoor environment as well as on the thermal performance of the dwelling and on each household's resources for cooling or heating it. A perception instrument does not replace physical measurement, but it makes it possible to understand how heat is experienced and how it relates to well-being and to the organization of daily life. Given the cross-sectional design, the relationships between perceived exposure, well-being, and activity adjustment should be understood as associations rather than as dependencies.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data correspond to survey wave LEV-0010, "Piloto fraccionamientos · Calor urbano y bienestar," of project FZ-HAB-0005 on the Factoriza UAS platform, and to the frozen dataset DST-0014, with a data cutoff date of 9 October 2026. This survey wave is an independent sample and the only one in the project. Although the project is registered under a mixed-methods approach, the present analysis is limited to the survey component.

POPULATION, SAMPLE, AND DATA CUTOFF

The survey population was defined as individuals aged 18 years or older living in residential subdivisions (fraccionamientos) of Mazatlán. The subdivisions were selected by the project lead; therefore, the selection was non-probabilistic. According to the Factoriza log, 19 individuals opened the questionnaire and 7 completed it; no cases were excluded on quality-control grounds, so 7 cases were analyzed (Table 2).

The analyzed data cut is preliminary: it comprises 7 cases out of a target of 100, and data collection was still open and in the field as of the cut-off date. With 7 cases for 15 items, the ratio is 0.5 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

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INSTRUMENT

The Perceived Urban Heat and Well-Being Scale was administered. It comprises fifteen items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into three dimensions of five items each: Perceived heat exposure (R1 to R5), Well-being during the hot months (R6 to R10), and Adjustment of activities to heat (R11 to R15).

Three items are reverse-worded: R4 ("In my housing development there are cool places to be outdoors"), R7 ("The heat puts me in a bad mood") and R13 ("I do my outdoor activities at any time of day"). These items are already recoded in the data matrix. After recoding, a higher score indicates greater perceived heat exposure, greater well-being during the hot months and greater adjustment of activities to the heat. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Perceived heat exposure	In my neighborhood, the heat is intense during the day	No
R2	Perceived heat exposure	The streets in my residential subdivision build up heat in the afternoon	No
R3	Perceived heat exposure	At night, my neighborhood remains hot	No
R4	Perceived heat exposure	In my neighborhood there are cool places to spend time outdoors	Yes
R5	Perceived heat exposure	The pavement on my street feels very hot when I walk on it	No
R6	Well-being in the hot months	During the hot season, I feel in good spirits	No
R7	Well-being in the hot months	Heat makes me irritable	Yes
R8	Well-being during the warm months	In summer, I feel energetic enough for my activities	No
R9	Well-being during the hot months	I can rest well on hot days	No
R10	Well-being during the hot months	During the hot season, I feel at ease in my home	No
R11	Adjustment of activities to heat	I change my schedule to go out when it is cooler	No
R12	Adjustment of activities to heat	I avoid walking around my neighborhood at midday	No
R13	Adjustment of activities to heat	I do my outdoor activities at any time of day	Yes
R14	Adjustment of activities to heat	I plan my outings according to the day's temperature	No
R15	Adjustment of activities to heat	I spend more time indoors during the hot months	No

Note. Perceived Urban Heat and Well-Being Scale. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0005, survey LEV-0010, dataset DST-0014.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0014 with a cryptographic hash, generated the matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00066 to RUN-00072). The complementary analyses were performed using the data file and the item dictionary exported from the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), with the corrected item-total correlation and alpha if item deleted; and the Pearson correlations between the items of each dimension, with 95% confidence intervals obtained through Fisher's transformation.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no

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manual intervention in the calculations, and excludes items with no variance from all analyses.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reverse-scoring items; when any item correlates or loads negatively relative to the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable.

It also attempted an exploratory factor analysis of the items that showed variance, preceded by an assessment of overall and per-item sampling adequacy (Lorenzo-Seva and Ferrando, 2021) and a test of sphericity, using parallel analysis to determine the number of factors, minimum residual extraction, and oblimin rotation.

Finally, it estimated the correlation between the mean dimension scores with Spearman's coefficient and its 95% confidence interval, using the Fisher transformation with the standard error from Bonett and Wright (2000).

The reference values for interpreting the psychometric indices are treated as guidelines rather than decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is proposed as future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records express informed consent online and does not collect names, email addresses or any other identifying data.

DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following were used: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and inter-dimension correlations; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, drafting and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS
SAMPLE COMPOSITION

Table 2 summarizes the flow of cases. Of the 19 individuals who opened the questionnaire, 7 completed it and were analyzed, with no exclusions for quality control. More than half of those who started the questionnaire did not complete it, a point that should be reviewed during field administration. All analyzed cases answered all fifteen items.

Table 2. Sample composition.

Indicator	Value
Individuals who opened the questionnaire	19
Completed questionnaires	7
Cases excluded by quality control	0
Cases analyzed	7
Items	15

Note. Survey "Piloto fraccionamientos · Calor urbano y bienestar" [Housing developments pilot · Urban heat and well-being] (LEV-0010); population: persons aged 18 years or older residing in housing developments in Mazatlán; territory: Mazatlán, Sinaloa, in housing developments selected by the project lead. Dataset DST-0014, fingerprint 98dfeee8c72e1b7e. Source: Factoriza UAS. Preliminary cut-off: n = 7 out of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. The dimensions showed very different

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profiles. In Adjustment of activities to heat, all means were high: R15, spending more time indoors during the hot months, received the maximum response in all seven cases (*M* = 5.00, *SD* = 0.00), followed by R11, changing schedules to go out when it is cooler (*M* = 4.86, *SD* = 0.38), with 86% of responses at the maximum value; R12, avoiding walking around the housing development at midday (*M* = 4.57, *SD* = 0.53); R14, planning outings according to the temperature (*M* = 4.57, *SD* = 0.79); and R13 in its recoded version, which indicates that most respondents do not carry out their outdoor activities at just any time of day (*M* = 4.29, *SD* = 0.76).

In the Perceived Heat Exposure dimension, the means were also high for the direct items: R3, heat persisting at night (*M* = 4.29, *SD* = 0.76); R2, heat building up in the streets in the afternoon (*M* = 4.14, *SD* = 1.21); R5, hot pavement when walking (*M* = 4.00, *SD* = 1.41); and R1, intense heat during the day (*M* = 3.86, *SD* = 1.35). The distribution of R1 was skewed toward high values (skewness = -1.95) and showed high kurtosis (4.58), which is attributable to a single case that gave the minimum response.

The reverse-scored item R4 had a low mean in its recoded version (*M* = 2.14, *SD* = 1.35), with 43% of responses at the minimum value, indicating that a large proportion of respondents recognize that there are cool places to spend time outdoors in their neighborhood.

Means for Well-being during the hot months were low. Heat-related bad mood, in its recoded version (R7: *M* = 1.14, *SD* = 0.38), had 86% of responses at the minimum value; that is, most respondents strongly agreed that the heat puts them in a bad mood.

Feeling in good spirits during the hot season (R6: *M* = 1.29, *SD* = 0.49) and having energy for activities in summer (R8: *M* = 1.57, *SD* = 0.53) also received very low ratings, whereas resting well on hot days (R9) and feeling calm at home (R10) had intermediate means (*M* = 2.71 in both cases) and the greatest dispersion in the dimension (*SD* = 1.60 and *SD* = 1.25). Overall, this cross-section describes residents who perceive their housing development as hot, report low well-being during the hot months and substantially adjust their activities.

Table 3. Descriptive statistics for the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.86	1.35	-1.95	4.58	14%	29%
R2	4.14	1.21	-1.15	-0.06	14%	57%
R3	4.29	0.76	-0.60	-0.35	14%	43%
R4	2.14	1.35	0.80	-1.28	43%	29%
R5	4.00	1.41	-0.99	-1.20	29%	57%
R6	1.29	0.49	1.23	-0.84	71%	29%
R7	1.14	0.38	2.65	7.00	86%	14%
R8	1.57	0.53	-0.37	-2.80	43%	57%
R9	2.71	1.60	0.98	-0.86	14%	29%
R10	2.71	1.25	0.74	1.49	14%	14%
R11	4.86	0.38	-2.65	7.00	14%	86%
R12	4.57	0.53	-0.37	-2.80	43%	57%
R13	4.29	0.76	-0.60	-0.35	14%	43%
R14	4.57	0.79	-1.76	2.36	14%	71%
R15	5.00	0.00	—	—	100%	100%

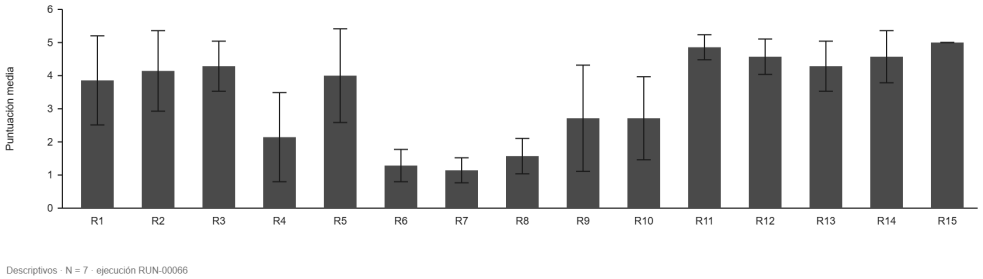
Note.N = 7. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. R15 showed no variation; therefore, its skewness and kurtosis cannot be calculated. The item-total correlation column across the fifteen items is omitted because it combines three dimensions; the item-total correlation by dimension is presented in Table 4. Run RUN-00066 of Factoriza UAS. Preliminary cutoff: n = 7 out of a target of 100, with data collection still open.

INTERNAL CONSISTENCY

Table 4 summarizes the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary software. Perceived heat exposure had α = .636 in both calculations; omega is not reported because R1 correlated negatively with the rest of the dimension (*r* = -.014), and removing this item would raise alpha to .774. R5 (hot pavement) was the most consistent item (.769), followed by R2 (.502) and R3 (.482).

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Figure 1. Mean scores by item with one-standard-deviation bars.



Within the dimension, the highest correlation was between R2 and R5 (*r* = .873, 95% CI [.350, .981], *p* = .010), followed by R3 and R5 (*r* = .780, 95% CI [.064, .966], *p* = .039), which suggests that heat accumulation in the streets, the persistence of heat at night, and hot pavement form a common core of perceived exposure.

Well-being during the hot months showed a negative alpha, α = -.153, in both calculations. Three of its five items correlated negatively with the rest of the dimension: R7, heat-related bad mood (-.455), R10, calmness at home (-.116), and R9, rest on hot days (-.109); R8 (.263) and R6 (.125) had positive but low correlations. None of the correlations among the items of this dimension had a confidence interval that excluded zero. Given this pattern, the total Well-being score does not represent a common attribute in this cohort and should not be interpreted as such.

Adjustment of activities to heat had α = .683 in the Factoriza calculation with all five items, and α = .729 with ω = .743 in the complementary program, which excluded R15 because it lacked variation. That exclusion explains the difference between the two values: the program's value matches the alpha-if-item-deleted for R15 reported by Factoriza (.729). R13 was the most consistent item (.955), followed by R14 (.700) and R12 (.417), whereas R11 (changing schedules for going out) had a low correlation (.104). The correlations of R13 with R14 (r = .801, 95% CI [.120, .969], *p* = .031) and with R12 (*r* = .766, 95% CI [.031, .963], *p* = .045) were the highest in the dimension.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Perceived heat exposure	R1	-.014	.774
Perceived heat exposure	R2	.502	.527
Perceived heat exposure	R3	.482	.575
Perceived heat exposure	R4	.415	.571
Perceived heat exposure	R5	.769	.342
Well-being during the hot months	R6	.125	-.267
Well-being during the hot months	R7	-.455	.065
Well-being during the hot months	R8	.263	-.402
Well-being during the hot months	R9	-.109	.000
Well-being during the hot months	R10	-.116	.000
Adjustment of activities to heat	R11	.104	.734
Adjustment of activities to heat	R12	.417	.642
Adjustment of activities to heat	R13	.955	.286
Adjustment of activities to heat	R14	.700	.485
Adjustment of activities to heat	R15	—	.729

Note.N = 7. Scale from 1 to 5; reverse-scored items R4, R7, and R13 are shown recoded. Run RUN-00066 of Factoriza UAS. Preliminary data cut: n = 7 out of a target of 100, with data collection still open.

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Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Remark
Perceived heat exposure	5	7	.636		Reverse-scored items: R1; ω not interpretable
Well-being during the hot months	5	7	-.153		Items keyed in the opposite direction: R7, R9, R10; ω not interpretable
Adjustment of activities to heat	4	7	.729	.743	

Note.N = 7. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Perceived heat exposure = .636 (run RUN-00067); Well-being during the hot months = -.153 (RUN-00069); Adjustment of activities to heat = .683 (RUN-00071). In Adjustment of activities, R15 showed no variance, so its item-total correlation cannot be calculated. When the mean inter-item covariance is negative, alpha is no longer bounded between 0 and 1, which explains the negative value for Well-being during the hot months. Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary data cut: n = 7 out of a target of 100, with data collection still ongoing.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated in an interpretable manner, and its results are not presented in tables.

With 7 cases and 14 items showing variance, the correlation matrix is not invertible; consequently, the overall measure of sampling adequacy and the item-level sampling adequacy could not be calculated, and the numerical value that the software returns for the sphericity test depends on a near-zero determinant and is not interpretable. Parallel analysis suggested two factors, but with fewer cases than items, this solution is unsupported. These results are reported in the reproducibility appendix, but they provide no evidence about the dimensionality of the instrument and should not be cited as such.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlations among the mean scores of the three dimensions, based on 7 cases. The relationship between Well-being during the hot months and Adjustment of activities to heat was negative, with an interval that excluded zero, ρ = -.896, 95% CI [-.989, -.282], *p* = .006: those who reported greater adjustment of their activities also reported lower well-being.

The intervals for the other two relationships did not exclude zero: Perceived exposure and Activity adjustment, ρ = .648, 95% CI [-.297, .952], *p* = .116, and Perceived exposure and Well-being, ρ = -.639, 95% CI [-.950, .309], *p* = .122. Because the Well-being score had a negative alpha, its correlation with the other dimensions should be interpreted with particular caution, and with 7 cases the width of the intervals indicates a very imprecise estimate.

Table 6. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Perceived heat exposure and well-being during the hot months	7	-.639	[-.950, .309]	.122
Perceived Heat Exposure and Adjustment of Activities to Heat	7	.648	[-.297, .952]	.116
Well-being in the hot months and Adjustment of activities to heat	7	-.896	[-.989, -.282]	.006

Note. α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum residual model, without reverse-scoring items. Complete cases per dimension. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0014_FZ_HAB_0005. R15, which showed no variance in the data cut, was excluded from the calculation; therefore, Adjustment of Activities to Heat was estimated with 4 items. Preliminary data cut: n = 7 of a target of 100, with data collection ongoing.

DISCUSSION OF RESULTS

The purpose of this study was to describe the initial performance of a scale of perceived urban heat and well-being among residents of housing developments in Mazatlán. The central finding is uneven across dimensions.

Perceived Heat Exposure showed moderate internal consistency, which would increase

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without R1; Activity Adjustment to Heat showed the highest consistency of the three, although one of its items had no variance; and Well-being During the Hot Months did not behave as a scale.

With 7 cases, all coefficients are provisional: the simulation literature on alpha and omega coefficients has relied on much larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated.

The descriptive profile is consistent with the literature on the experience of heat in hot cities. The perception of intense heat in the streets, at night, and on the pavement matches Irbid residents' assessment of the heat island in their neighborhood (Obeidat, 2026) and the description of homes in a Culiacán housing development as very hot (Barraza-Bracamontes et al., 2022).

The high ratings given to nighttime heat are relevant because nighttime exposure has been associated with heat-related symptoms (Guzman-Colon et al., 2025) and with poorer sleep quality (Chevance et al., 2024).

That most participants acknowledged the existence of cool places to spend time outdoors, even as they avoided walking at midday, suggests that these places are not sufficient to sustain outdoor activity during the hottest hours of the day. These correspondences are descriptive: the study did not measure the temperature of the housing developments, so perceptions cannot be linked to the physical intensity of the heat island.

The low well-being scores, particularly heat-related irritability and lack of energy in summer, are consistent with the mechanisms described in the literature, such as psychological stress, fatigue, and sleep disruption (Baecker et al., 2025), and with epidemiological evidence linking extreme heat to an increased risk of mental and behavioral disorders (Li et al., 2023).

However, the dimension did not show internal consistency. One possible explanation is that it combines items describing mood states, such as good spirits and bad mood, with items that depend on housing conditions, such as resting well and feeling calm at home, which could vary with the availability of air conditioning.

The literature shows that access to fans and air conditioning depends on economic resources (Guzman-Colon et al., 2025), so two people with the same discomfort from the heat could rest very differently at home. This hypothesis cannot be tested with the available data because the questionnaire did not record home climate control.

The reverse-scored items did not show a single pattern. R13, in Activity Adjustment, was the most consistent item in its dimension. R4, in Perceived Exposure, had a positive item-total correlation (.415), whereas R7, in Well-being, correlated negatively with the remaining items (-.455).

Scales with items keyed in both directions require more careful reading, and a proportion of respondents respond inconsistently to the positively and negatively worded items of the same dimension (Steinmann et al., 2022); detecting these responses can appreciably reduce wording effects (García-Batista et al., 2021).

For R7, almost all responses were concentrated on a single value, which reduces its variance and makes any correlation unstable, so its behavior could reflect this lack of variation more than the reverse wording.

The negative correlation between Well-being and Activity adjustment, the only one with an interval that excluded zero, is consistent with the idea that modifying daily life because of the heat has costs for well-being, through reduced exercise, social contact and use of public space (Baecker et al., 2025), but also with the reverse interpretation, whereby those who feel worst in summer are the ones who shelter the most.

The cross-sectional design does not allow us to distinguish between the two, and the lack of consistency in Well-being means that this correlation must be treated as a signal for the definitive analysis rather than as a finding. The concentration of Activity Adjustment responses at high values, with no variation in R15, also indicates that adjustment to heat is almost universal in this group, which limits the instrument's ability to discriminate between individuals.

Finally, response quality should be reviewed before the final analysis, because in small samples careless or inconsistent response patterns can markedly distort correlations (Ward and Meade, 2023).

CONCLUSIONS

The study met its objective within the scope permitted by a preliminary data cut of 7 cases. In its pilot data collection, the perceived urban heat and well-being scale of project FZ-HAB-0005 showed moderate internal consistency for Perceived heat exposure (α = .636), higher consistency for Adjustment of activities to heat (α = .729 and ω = .743 without the invariant item R15), and a

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negative coefficient for Well-being during the hot months (α = -.153).

The exploratory factor analysis could not be estimated in an interpretable way because the sample had fewer cases than items. The relationship between Well-being and Activity adjustment was negative, with an interval that excluded zero, but the lack of internal consistency of Well-being precludes interpreting this relationship. The results do not yet provide evidence of structural validity, but they describe residents who perceive their housing development as hot, report low well-being during the hot months, and make intensive adjustments to their activities.

The limitations are substantial. The sample of 7 cases, against a target of 100 and with only 0.5 cases per item, precludes estimation of the internal structure and renders all statistics unstable. In addition, data collection was still ongoing, and more than half of those who started the questionnaire did not complete it.

The residential developments were selected by the project lead; no information is available on the respondents, the type of housing, or air conditioning, and one of the items showed no variation. The physical component of the mixed-methods pathway is not part of the analyzed data, so the study did not measure the urban heat island; its results refer only to perception. The cross-sectional design precludes establishing dependence relationships. In addition, no confirmatory factor analysis was performed.

Several decisions for the authors follow from these results. The first is to review the Well-being dimension during the hot months and to assess whether mood states should be separated from conditions of rest and tranquility at home. The second is to review R1 in Perceived exposure and the case with contradictory responses.

The third is to assess whether R15 and R11 retain discriminatory capacity in a larger sample, or whether they should be reworded to reduce the concentration of responses at the maximum value. The fourth is to verify the recoding of R4, R7, and R13. The fifth is to record the type of dwelling, the available climate control, and the administration period. None of these decisions was made in the present analysis, which retains the original fifteen items.

For future work, we propose completing data collection up to the planned target, repeating the exploratory factor analysis when the number of cases permits, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample.

The physical component of the mixed-methods approach, involving measurements of air and surface temperature in the housing developments studied, would make it possible to relate perception to heat island intensity, as recommended by studies that point to the lack of in situ measurements (Borbolla Gaxiola et al., 2024). An instrument with documented validity evidence would allow vegetation, shade and the design of Mazatlán's housing developments to be directed toward the well-being of their residents, in line with the evidence on the role of green spaces in coping with heat (Nazish et al., 2024).

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Chapter 4 / Capítulo 4

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Odours, waste and urban landscape at the Pino Suárez Market: Olfactory and psychological habitability

Olores, Basura y Paisaje Urbano en el Mercado Pino Suárez: habitabilidad olfativa y psicológica

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ABSTRACT

Odour, waste and the state of the urban landscape shape the habitability of traditional public markets, yet they are rarely measured from the users' perspective. Using the preliminary data cut from the pilot survey of project FZ-HAB-0012 on the Factoriza UAS platform, this study described the initial behaviour of a fifteen-item scale with three dimensions, Odour annoyance, Urban landscape and Well-being, at the Pino Suárez Market in Mazatlán, Sinaloa, Mexico. With a cross-sectional design, 12 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and Spearman correlations between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was low for Odour annoyance (α = .397), where items R2 and R3 did not covary with the rest, acceptable for Urban landscape (α = .714), with item R8 running in the opposite direction, and moderate for Well-being (α = .659; ω = .702). The factor analysis was not interpretable because the correlation matrix was singular and the solution showed a Heywood case. Urban landscape and Well-being were positively associated (ρ = .795, 95% CI [.323, .950]); the other correlations had intervals that included zero. The findings do not yet provide structural validity evidence and point to revisions of the instrument, particularly of its odour dimension.

Keywords: smellscape; urban cleanliness; traditional market; psychometric evidence

RESUMEN

El olor, la basura y el estado del paisaje urbano condicionan la habitabilidad de los mercados públicos tradicionales, pero rara vez se miden desde la experiencia de sus usuarios. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0012 de Factoriza UAS, el comportamiento inicial de una escala de quince reactivos con tres dimensiones: Molestia olfativa, Paisaje urbano y Bienestar en el Mercado Pino Suárez de Mazatlán, Sinaloa. Con diseño transversal, se analizaron 12 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y correlaciones de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue baja en Molestia olfativa (α = .397), donde R2 y R3 no covariaron con el resto, aceptable en Paisaje urbano (α = .714), con R8 en sentido contrario, y moderada en Bienestar (α = .659; ω = .702). El análisis factorial no fue interpretable porque la matriz de correlaciones resultó singular y la solución presentó un caso Heywood. Paisaje urbano y Bienestar se asociaron de forma positiva (ρ = .795, IC 95 % [.323, .950]); las demás correlaciones tuvieron intervalos que incluyen el cero. Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento, en especial de su dimensión olfativa.

Palabras clave: paisaje olfativo; limpieza urbana; mercado tradicional; evidencias psicométricas

INTRODUCTION

Traditional public markets are more than food supply facilities. In Mexican cities, they bring together the daily purchase of fresh food, the work of hundreds of stallholders, social encounters, and a recognizable part of urban memory. Their habitability, however, depends on conditions that are not always addressed in planning: ventilation, waste management, the cleanliness of surrounding streets, and the upkeep of the building.

Among these conditions, odor occupies a peculiar place. It is one of the first qualities perceived by anyone entering a market; it can be a source of identity and appetite or of rejection and avoidance, and it is rarely measured systematically.

Research on the olfactory landscape, or smellscape, has grown over the past decade and has shown that odors contribute to place identity, to memory, and to the emotional experience of the built environment, whereas odor pollution from waste, traffic, or food areas can impair quality of life and alter how people behave in the space (Xiao et al., 2021; Xiao et al., 2022).

Studies using multisensory assessments have also documented that odors and sounds interact in the evaluation of public spaces: food odors improved ratings of the acoustic environment of pedestrian streets, whereas pollution odors worsened them (Ba et al., 2023).

In traditional markets, Ling et al. (2022) applied smellwalk methods to zone the smellscape of a market in Kunming and to distinguish areas worth preserving from those requiring improvement.

Waste management is the other side of the problem. Studies on urban cleanliness show that commercial land uses tend to accumulate more litter than residential ones (Farzadkia et al., 2023), although cleanliness in commercial and tourist areas can reach high levels when the service is targeted at them (Guedes et al., 2026). They also show that perceived dirtiness of the surrounding area is associated with residents' negative assessments of the quality of their neighborhood (Giustiniani et al., 2024).

In food markets, the perceived hygiene conditions of facilities, products and food handlers are among the criteria on which consumer trust rests (Verdú et al., 2021).

The Pino Suárez Market, in the historic center of Mazatlán, brings these dimensions together. It is a metal-frame building inaugurated in 1899 and renamed in 1915 after Vice President José María Pino Suárez, and is among the historic buildings described on the city's historic center website (Centro Histórico Mazatlán, n.d.).

It functions as a supply market for the resident population and as an attraction for visitors, and commercial activity, the loading and unloading of goods, and waste generation are concentrated in its adjacent streets. Despite its relevance, no empirical studies were identified that assess the olfactory experience, the perception of the urban landscape, and the well-being of the people who use this market.

In Latin America, research on markets has favored historical, political and ethnographic approaches. In Mexico City, Tellez Contreras (2025) showed that the repair and maintenance of deteriorated public markets are negotiated among stallholders, officials and politicians, and that these practices preserve markets as socially valuable urban infrastructure while also reproducing clientelist relations.

In Acapulco, Leal-Martínez et al. (2026) documented that residents continue to use the market and other public spaces despite their material shortcomings, and that the meaning of these places is constructed in everyday life. These contributions highlight that the material quality of the market and people's attachment to it are distinct dimensions that should be measured separately.

Project FZ-HAB-0012 of the Factoriza UAS platform set out to study the olfactory and psychological habitability of the Pino Suárez Market using a fifteen-item scale organized into three dimensions: Olfactory Annoyance in the Market, Market Urban Landscape, and Well-being in the Market. This article reports the results of the first pilot survey, based on a very small preliminary data cut; its scope is therefore limited to the initial review of the instrument.

The overall objective was to describe the initial behavior of an olfactory and psychological habitability scale in the preliminary data cut of its pilot survey at the Pino Suárez Market in Mazatlán.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to explore the relationship between the scores on the three dimensions. The project did not state any hypotheses, so the study is descriptive and exploratory in scope.

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DEVELOPMENT

THE SMELLSCAPE AS A DIMENSION OF HABITABILITY

The concept of smellscape refers to the relationship between people, odours and the built environment. The review by Xiao et al. (2021) placed the field's challenges in three areas (methodological approaches, artistic design interventions and museum practices, and odour policy-making) and proposed odour archives, social justice in odour control and research on building materials as directions for future research.

In their introduction to a collection of papers on odors and well-being, Xiao et al. (2022) emphasized that odors give places their identity and can connect people emotionally to their surroundings, but that odor pollution from waste, traffic or food areas can compromise quality of life and lead to changes in behavior.

Empirical studies on the urban smellscape have been concentrated in China and have combined smellwalks, questionnaires and social media data.

In the old city centre of Guangzhou, Gao et al. (2022) classified urban odours into eleven categories and found that food odours were the most frequent and that unpleasant odours came mainly from domestic discharges, drains and construction works. They also associated areas with pleasant food and nature odours with more positive emotional scores.

In a park in Beijing, Wang et al. (2024) found that ratings of the visual, olfactory, and overall experience were strongly interrelated, indicating that the multisensory experience functions as a whole. In the Chinese-language literature, Li and Liu (2024) incorporated smell, together with the other senses, into a park design model aimed at psychological well-being.

In the instrument under study, the Olfactory Annoyance in the Market dimension captures this perspective from the negative pole: the presence of unpleasant odors (R1), the perception of the smell of garbage near the stalls (R2), the avoidance of areas because of their odor (R3), the perception that the air smells clean (R4, reverse-scored), and the loss of appetite due to odors (R5).

These items combine an affective evaluation, a source attribution, an avoidance behavior, and a physiological consequence, which the literature treats as related but distinguishable facets of olfactory experience.

LITTER, CLEANLINESS AND THE URBAN LANDSCAPE

The cleanliness of public space is a visible component of urban quality. Farzadkia et al. (2023) proposed a clean environment index to assess litter and found that commercial land use was classified as dirty and residential land use as clean.

In Porto, Guedes et al. (2026) found that commercial, tourist and riverside areas were the cleanest and that citizens' perception of the city's cleanliness was favorable, which suggests that the outcome depends on how the street-cleaning service is oriented. In Buenos Aires, Giustiniani et al. (2024) documented a predominantly negative perception of street cleanliness around a recycling center, attributed to litter scattered next to the containers, and found that it coincided with the lowest cleanliness indices.

The Market Urban Landscape dimension brings together aesthetic assessments of the building (R6), the cleanliness of the surrounding area (R7) and the accumulation of litter in nearby streets (R8, reverse-scored), along with the enjoyment of walking through the market (R9) and its value as a traditional place (R10). As with the olfactory dimension, its composition is heterogeneous: it combines judgments about the building itself, the condition of the surrounding public space and the heritage significance of the place, which could behave differently.

THE MARKET AS PLACE: EVERYDAY HERITAGE AND ATTACHMENT

Traditional markets have been studied as places of attachment and living heritage. Ledesma and Giusti (2021) analyzed Latino vendor markets in California and Texas from the perspective of place attachment. They found that these markets are living spaces where attachment and a sense of belonging are expressed, owing to the combination of economic activity, social interaction and physical setting.

In Dublin, Bonnin and Moore-Cherry (2023) proposed viewing traditional market trade as everyday heritage, worthy of protection against urban renewal that tends to instrumentalize built heritage. In their review of place attachment in urban settings, Kamani Fard and Paydar

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(2024) noted that social interaction and local characteristics expressing history and culture are associated with a stronger bond.

Item R10, which asks whether the market retains its value as a traditional place in the city, introduces this heritage dimension into the urban landscape scale. Its behavior relative to the cleanliness and aesthetics items will make it possible to assess whether the market's symbolic value holds regardless of its material condition, as suggested by studies that describe the continued use of public spaces despite their shortcomings (Leal-Martínez et al., 2026).

PSYCHOLOGICAL WELL-BEING IN FOOD SUPPLY SPACES

The third dimension of the instrument, Well-being at the market, refers to users' affective experience: feeling at ease while shopping (R11), the good mood the visit produces (R12), discomfort inside the market (R13, reverse-scored), enjoyment of spending time there (R14), and willingness to recommend it to a visitor (R15).

The literature on smellscapes and urban cleanliness suggests that these experiences are related to the sensory conditions of the place (Wang et al., 2024; Xiao et al., 2022). Research on markets indicates that consumer trust rests on the perceived hygiene of the facilities and products (Verdú et al., 2021). Given the cross-sectional design, any relationship between olfactory annoyance, urban landscape, and well-being should be understood as an association rather than a relationship of dependence.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data correspond to survey LEV-0017, "Piloto Mercado Pino Suárez · Olores y paisaje," from project FZ-HAB-0012 on the Factoriza UAS platform, and to the frozen dataset DST-0019, with a data cut-off date of 9 October 2026. The survey is an independent sample and the only one in the project.

POPULATION, SAMPLE AND DATA CUT-OFF

The survey population was defined as individuals aged 18 years or older who visit or work at the Pino Suárez Market in Mazatlán. The study area comprises the market and its adjacent streets, and administration was organized according to the locations and time slots of an observation protocol. According to the Factoriza log, 22 individuals opened the questionnaire and 12 completed it; no cases were excluded on quality-control grounds, so 12 cases were analyzed (Table 2).

The analyzed data cut is preliminary: it comprises 12 cases out of a target of 100, and data collection was still open and in the field as of the cut-off date. With 12 cases for 15 items, the ratio is 0.8 cases per item, below what an analysis of internal structure requires; the adequacy of the data and the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021). The population includes both visitors and people who work at the market, but the dataset does not distinguish between them.

INSTRUMENT

A fifteen-item scale was administered, with a five-point response format ranging from Strongly disagree (1) to Strongly agree (5). The items were organized into three dimensions of five items each: Olfactory Annoyance in the Market (R1 to R5), Urban Landscape of the Market (R6 to R10), and Well-Being in the Market (R11 to R15).

Three items are reverse-worded: R4 ("The air in the market smells clean"), R8 ("There is accumulated garbage in the streets near the market") and R13 ("I feel uncomfortable inside the market"); all three have already been recoded in the data matrix. After recoding, a higher score indicates greater olfactory annoyance, a more favorable assessment of the urban landscape and greater well-being, respectively. Table 1 presents the code, dimension, wording and direction of each item.

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Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Olfactory annoyance at the market	There are odors at the market that bother me	No
R2	Olfactory nuisance in the market	The smell of garbage is perceived near the stalls	No
R3	Olfactory annoyance at the market	I avoid certain areas of the market because of their odor	No
R4	Olfactory discomfort at the market	The air in the market smells clean	Yes
R5	Olfactory discomfort at the market	The smells from the market take away my appetite	No
R6	Urban landscape of the market	I find the market building attractive	No
R7	Urban landscape of the market	The surroundings of the market look clean	No
R8	Urban landscape of the market	There is accumulated garbage in the streets near the market	Yes
R9	Urban landscape of the market	I enjoy walking through the market	No
R10	Urban landscape of the market	The market retains its value as a traditional place in the city	No
R11	Well-being at the market	I feel comfortable while doing my shopping at the market	No
R12	Well-being at the market	Visiting the market puts me in a good mood	No
R13	Well-being in the market	I feel uncomfortable in the market	Yes
R14	Well-being at the market	I like spending time at the market	No
R15	Well-being at the market	I would recommend that a visitor get to know the market	No

Note. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0012, survey LEV-0017, dataset DST-0019.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records express online informed consent before the first item and does not collect identifying data. Factoriza froze the DST-0019 dataset with a cryptographic hash, generated the matrix with the reverse-scored items recoded, and produced the descriptive and internal-consistency analyses (runs RUN-00095 to RUN-00101). The supplementary analyses were run on the data file and item dictionary exported by the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values for each item, as well as the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reverse-scoring items; when any item correlates negatively with the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable.

It also attempted an exploratory factor analysis of the fifteen items, preceded by the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), item-level sampling adequacy (Lorenzo-Seva and Ferrando, 2021) and Bartlett's test of sphericity (Bartlett, 1950), with the number of factors determined by parallel analysis, minimum residual extraction and oblimin rotation; the classical indices are cited in their original sources because they are the reference for each procedure.

Finally, it estimated the relationship between the mean dimension scores using Spearman's coefficient and its 95% confidence interval, via the Fisher transformation with the standard error proposed by Bonett and Wright (2000).

The reference values for interpreting the indices are treated as guidelines rather than decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is proposed as future work.

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ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit informed consent online and does not collect names, email addresses or any other identifying data. Anonymity is particularly relevant for people who work in the market, because their opinions about cleanliness or odors could affect their relationship with the management or with other stallholders.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following tools were used in preparing this manuscript: the Factoriza UAS platform, for data management and descriptive and internal consistency analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 22 individuals who opened the questionnaire, 12 completed it and were analyzed, with no quality-control exclusions. The gap between questionnaires opened and completed indicates a high proportion of unfinished questionnaires, an issue that should be reviewed when designing the field administration. All analyzed cases answered all fifteen items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	22
Completed questionnaires	12
Cases excluded by quality control	0
Cases analyzed	12
Items	15

Note. Survey “Piloto Mercado Pino Suárez · Olores y paisaje” [Pino Suárez Market Pilot · Smells and Landscape] (LEV-0017); population: people aged 18 years or older who visit or work at the Mercado Pino Suárez in Mazatlán; area: Mercado Pino Suárez and adjacent streets, Mazatlán, Sinaloa, at the locations and times specified in the observation protocol. Dataset DST-0019, fingerprint 6a6d54350df96142. Source: Factoriza UAS. Preliminary cutoff: n = 12 of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. For Olfactory Annoyance, the highest mean was for R3, avoidance of certain areas of the market because of the odor (*M* = 4.08, *SD* = 1.00), followed by R1, the presence of annoying odors, and R2, the smell of garbage near the stalls, both with *M* = 3.67 (*SD* = 0.98 and 0.89, respectively).

The lowest mean in the dimension was for R4 (recoded), the perception that the air does not smell clean (*M* = 3.33, *SD* = 1.30). Overall, annoyance scores were above the midpoint of the scale.

In Urban Landscape, the highest mean was for R10, the value of the market as a traditional place (*M* = 3.33, *SD* = 0.98), and the lowest were for R7, the cleanliness of the surroundings (*M* = 2.42, *SD* = 1.00), and R9, the enjoyment of walking through the market (*M* = 2.50, *SD* = 0.90); R8, the accumulation of garbage in nearby streets (recoded), had *M* = 2.67 (*SD* = 0.89).

For Well-being, the highest mean was for R15, recommending the market to a visitor (*M* = 3.17, *SD* = 0.72), and the lowest was for R14, enjoying spending time at the market (*M* = 2.25, *SD* = 0.75). The distribution of R1 was markedly skewed and peaked (skewness = -1.93; kurtosis = 5.05), but with 12 cases, these indices are unstable.

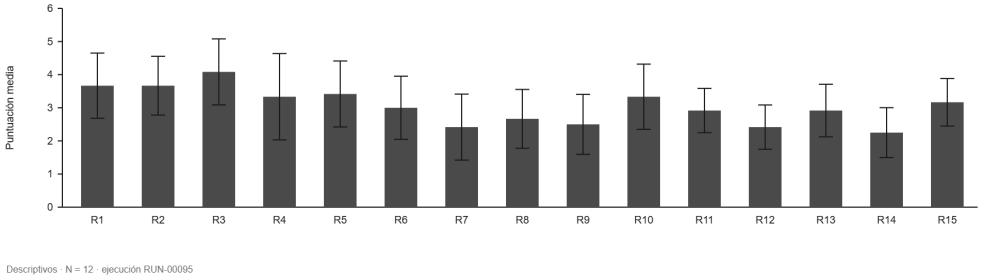
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Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.67	0.98	-1.93	5.05	8%	8%
R2	3.67	0.89	-0.14	-0.25	8%	17%
R3	4.08	1.00	-0.85	-0.01	8%	42%
R4	3.33	1.30	-0.15	-0.77	8%	25%
R5	3.42	1.00	0.27	-0.65	17%	17%
R6	3.00	0.95	-0.76	0.16	8%	33%
R7	2.42	1.00	0.27	-0.65	17%	17%
R8	2.67	0.89	-0.14	-0.25	8%	17%
R9	2.50	0.90	-0.44	-0.33	17%	8%
R10	3.33	0.98	-0.81	2.37	8%	8%
R11	2.92	0.67	0.09	-0.19	25%	17%
R12	2.42	0.67	-0.74	-0.19	8%	50%
R13	2.92	0.79	0.16	-1.26	33%	25%
R14	2.25	0.75	-0.48	-0.87	17%	42%
R15	3.17	0.72	-0.26	-0.69	17%	33%

Note.N = 12. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column across the fifteen items is omitted because it combines three dimensions; the item-total correlation by dimension is presented in Table 4. Run RUN-00095 of Factoriza UAS. Preliminary data cut: n = 12 of a target of 100, with data collection still open.

Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 summarizes the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary program. The alpha values were identical in both calculations. The Well-being in the market dimension had $\alpha = .659$ and $\omega = .702$.

For Urban Landscape of the Market, alpha was .714, but omega is not reported because R8 correlated negatively with the rest of the dimension. For Olfactory Nuisance in the Market, alpha was .397, and omega is likewise not reported because R2 and R3 correlated negatively with the rest of the dimension.

The item-level analysis pinpoints the problems. In Olfactory annoyance, R2 showed a corrected item-total correlation of -.111 and R3 one of -.003, so the perception of garbage odor near the stalls and the avoidance of areas because of their odor did not covary with the rest of the dimension; deleting R2 would raise alpha to .531.

Conversely, R4 had the highest correlation (.490), and its deletion would reduce alpha to .016, indicating that the low consistency of the dimension rests almost entirely on R4 and R5. In Urban landscape, R8 showed a correlation of -.065, and removing it would raise alpha to .843, whereas R6, R9, and R10 had correlations ranging from .686 to .699. In Well-being, R13 (recoded discomfort inside the market) was the least coherent item (.151), and its deletion would raise alpha to .732.

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Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Olfactory annoyance at the market	R1	.228	.325
Odor nuisance at the market	R2	-.111	.531
Odor nuisance at the market	R3	-.003	.485
Odor nuisance at the market	R4	.490	.016
Odor nuisance at the market	R5	.462	.131
Urban landscape of the market	R6	.686	.574
Urban landscape of the market	R7	.466	.670
Urban landscape of the market	R8	-.065	.843
Urban landscape of the market	R9	.693	.577
Urban landscape of the market	R10	.699	.565
Market welfare	R11	.551	.547
Market welfare	R12	.390	.618
Market welfare	R13	.151	.732
Well-being in the market	R14	.660	.477
Market welfare	R15	.384	.620

Note.N = 12. Scale from 1 to 5; reverse-scored items R4, R8 and R13 are shown recoded. Run RUN-00095 of Factoriza UAS. Preliminary cutoff: n = 12 out of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Observation
Olfactory nuisance at the market	5	12	.397		Reverse-worded items: R2, R3; ω not interpretable
Urban landscape of the market	5	12	.714		Reverse-worded items: R8; ω not interpretable
Market well-being	5	12	.659	.702	

Note.N = 12. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for the full dimension, with 5 items each: Olfactory Nuisance in the Market = .397 (run RUN-00096); Urban Landscape of the Market = .714 (RUN-00098); Well-being in the Market = .659 (RUN-00100). Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary cutoff: n = 12 out of a target of 100, with data collection still open.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated in an interpretable way, and its results are not presented in tables. With 12 cases and 15 items, the correlation matrix is not invertible, so the Kaiser-Meyer-Olkin overall measure of sampling adequacy and the item-level sampling adequacy could not be computed.

Bartlett's test yielded a numerical value, but with a singular matrix the determinant is practically zero and the statistic has no meaningful interpretation. Parallel analysis suggested one factor, and the solution showed a communality greater than 1 for R9 (1.001), that is, a Heywood case indicating an improper solution. These results are reported in the reproducibility appendix, but they provide no evidence regarding the dimensionality of the instrument and should not be cited as such.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlations between the mean scores of the three dimensions, based on 12 cases. The relationship between Urban landscape and Well-being in the market was positive and strong, ρ = .795, 95% CI [.323, .950], p = .002; it was the only one whose interval excluded zero.

The relationship between Odor annoyance and Well-being was negative and moderate, ρ = -.509, 95% CI [-.850, .132], p = .091. For Odor annoyance and Urban landscape, the relationship was negative and weak, ρ = -.238, 95% CI [-.719, .397], p = .457. Because the Odor annoyance and Urban

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landscape scores include items that do not covary with their dimension, these correlations should be interpreted with particular caution.

Table 6. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Olfactory annoyance in the market and Urban landscape of the market	12	-.238	[-.719, .397]	.457
Odor annoyance at the market and Well-being at the market	12	-.509	[-.850, .132]	.091
Market Urban Landscape and Market Well-being	12	.795	[.323, .950]	.002

Note.α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum-residual model, without reverse-scoring items. Complete cases per dimension. Source: Own work using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0019_FZ_HAB_0012. Preliminary cutoff: n = 12 of a target of 100, with data collection ongoing.

DISCUSSION OF RESULTS

The purpose of this study was to describe the initial behavior of an olfactory and psychological habitability scale at the Pino Suárez Market. The central finding is that the Olfactory Annoyance dimension, the core of the project, did not behave as a homogeneous scale in this wave: its alpha was low, two of its five items did not covary with the rest, and the consistency it did show depended on two items.

With 12 cases, this pattern may be due in part to sampling error, but it also offers substantive clues worth examining before data collection is closed. The simulation literature on alpha and omega coefficients is based on samples much larger than the one in this data wave (Malkewitz et al., 2023), so all coefficients should be read as provisional.

The lack of covariation of R2 and R3 with the rest of the olfactory dimension is consistent with the content heterogeneity noted in the theoretical framework. R2 describes the attribution of a source, namely the smell of garbage near the stalls, and R3 an avoidance behavior, whereas R1, R4 and R5 express an affective appraisal of the odor and its consequences. The fact that avoiding areas because of their odor had the highest mean in the set, without covarying with general annoyance, suggests that avoiding certain areas may be a habitual part of how the market is used, one that does not necessarily imply an overall negative appraisal.

The review by Xiao et al. (2021) and studies of market smellscapes (Ling et al., 2022) indicate that the odors in a market are not homogeneous and that their evaluation depends on the area. This supports using items that refer to specific areas or sources, not only to the market as a whole.

In the urban landscape dimension, the behavior of R8 warrants technical verification before any substantive interpretation. After recoding, a high score on R8 should indicate less accumulated litter and should therefore covary positively with the cleanliness of the surroundings (R7); its negative correlation with the rest of the dimension may be due to the difficulty of answering reverse-worded items, to incorrect recoding, or to a perception that litter accumulation in the streets is independent of the assessment of the building and its traditional value.

By contrast, the aesthetic and heritage items (R6, R9 and R10) showed high consistency, and the traditional value of the market had the highest mean in the dimension, in line with studies that conceive of markets as everyday heritage and places of attachment (Bonnin and Moore-Cherry, 2023; Ledesma and Giusti, 2021).

The strong association between urban landscape and well-being is the most robust finding in the cross-section, although its confidence interval is wide. It is consistent with evidence that visual, olfactory and overall evaluations of a space are closely interrelated (Wang et al., 2024) and with the perception of markets as places of social value whose appeal coexists with infrastructure shortcomings (Leal-Martínez et al., 2026; Tellez Contreras, 2025).

The negative relationship between odor annoyance and well-being points in the direction expected from the literature on odor pollution (Xiao et al., 2022), but its interval includes zero. In any case, the cross-sectional design precludes establishing the direction of these relationships.

Finally, response quality should be checked before the final analysis. In small samples, careless or invariant response patterns can markedly distort correlations (Ward and Meade, 2023). The mix of visitors and people who work at the market, which the dataset does not distinguish, is another possible source of heterogeneity, because everyday exposure to market odors could alter how these odors are rated.

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CONCLUSIONS

The study achieved its objective to the extent permitted by a preliminary data cut of 12 cases. In its pilot administration, the olfactory and psychological habitability scale of project FZ-HAB-0012 showed low internal consistency for Olfactory Annoyance (α = .397); acceptable consistency for Urban Landscape (α = .714), with one item running in the opposite direction; and moderate consistency for Well-being (α = .659; ω = .702).

The exploratory factor analysis could not be estimated in an interpretable way. The only relationship between dimensions whose interval excluded zero was the positive association between Urban landscape and Well-being. The results do not yet provide evidence of structural validity; their main use is to identify the items that should be revised.

The limitations are substantial. The sample of 12 cases, against a target of 100, with 0.8 cases per item, precludes estimation of the internal structure and renders the statistics unstable; data collection was still ongoing, and a high proportion of the people who opened the questionnaire did not complete it.

No information is available on the observation protocol, the sampling procedure, the proportion of visitors and workers, or the sociodemographic characteristics of the sample. The data matrix contains response patterns that require review. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was conducted.

These results point to several decisions for the authors.

The first is to revisit the Olfactory annoyance dimension, particularly R2 and R3, and to assess whether the affective evaluation of the odor, the attribution of sources, and avoidance behaviors should be separated. The second is to verify the recoding of R8 and, if it is correct, to revise its wording. The third is to revisit R13 in Well-being. The fourth is to record whether the respondent visits or works at the market, as well as the area of the market where the questionnaire is administered. None of these decisions were made in the present analysis, which retains the original fifteen items.

For future work, we propose completing data collection up to the planned target, repeating the exploratory factor analysis with the final dataset, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample.

Measurement could be complemented with smell walks and observational cleanliness indices at the protocol points, such as those used in other urban studies, to contrast perception with the recorded conditions. An instrument with documented validity evidence would make it possible to monitor the habitability of the Mercado Pino Suárez and to inform its management, the cleaning of its adjacent streets, and the conservation of its heritage value.

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Chapter 5 / Capítulo 5

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Privacy, territoriality and neighbourly coexistence in the condominiums of Mazatlán

Privacidad, territorialidad y convivencia vecinal en los condominios de Mazatlán

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ABSTRACT

Vertical condominium housing has grown rapidly in Mazatlán, Sinaloa, Mexico, yet the experience of its residents is rarely measured. Using the preliminary data cut from the pilot survey of project FZ-HAB-0013 on the Factoriza UAS platform, this study described the initial behaviour of a fifteen-item scale with three dimensions: Privacy in the dwelling, Control of shared space and Relationship with neighbours. With a cross-sectional design, 23 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total, exploratory factor analysis and Spearman correlations between dimensions were estimated. Internal consistency was low for Privacy (α = .445) and Control of shared space (α = .287), and negative for Relationship with neighbours (α = -.132); omega was not interpretable in any dimension. The factor analysis, with KMO = .401 and a Heywood case, suggested five factors that did not reproduce the theoretical dimensions, one of them formed by the four reverse-worded items, which is consistent with a wording effect. Privacy and Control of shared space were positively associated (ρ = .514, 95% CI [.101, .775]). The findings do not yet provide structural validity evidence and point to revisions of the instrument.

Keywords: residential privacy; territoriality; neighbour relations; vertical housing

RESUMEN

La vivienda vertical en condominio ha crecido con rapidez en Mazatlán, Sinaloa, pero la experiencia de quienes viven en ella rara vez se mide. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0013 de Factoriza UAS, el comportamiento inicial de una escala de quince reactivos con tres dimensiones: Privacidad en la vivienda, Control del espacio compartido y Relación con los vecinos. Con diseño transversal, se analizaron 23 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total, análisis factorial exploratorio y correlaciones de Spearman entre dimensiones. La consistencia interna fue baja en Privacidad (α = .445) y en Control del espacio compartido (α = .287), y negativa en Relación con los vecinos (α = -.132); el omega no fue interpretable en ninguna dimensión. El análisis factorial, con KMO = .401 y un caso Heywood, sugirió cinco factores que no reproducen las dimensiones teóricas, uno de ellos formado por los cuatro reactivos inversos, lo que es compatible con un efecto de redacción. Privacidad y Control del espacio compartido se asociaron de forma positiva (ρ = .514, IC 95 % [.101, .775]). Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento.

Palabras clave: privacidad residencial; territorialidad; relaciones vecinales; vivienda vertical

INTRODUCTION

Vertical housing under a condominium regime has become one of the most visible forms of growth in Mexican coastal cities. In this type of housing, the boundary between the private and the communal is narrower than in single-family housing: walls, corridors, elevators, swimming pools and parking areas are shared. The quality of everyday life depends as much on the design of the building as on the residents' capacity to regulate contact with others, look after common spaces and reach agreements.

Consequently, the habitability of a condominium is not limited to the floor area or amenities of each apartment; it also encompasses psychosocial dimensions such as privacy, territoriality, and neighborly coexistence.

Mazatlán offers a particularly relevant case. Since 2018, the city has seen a real estate boom geared toward second homes and residential tourism, with a concentration of high-rise developments along the coastal strip and near the malecón (seafront promenade), changes in building regulations, and conflicts with residents of the affected neighborhoods (Mendieta Vega and Roldán Clarà, 2024).

Qualitative studies of this process have documented social tensions in the neighborhoods where the towers are being built and the inadequacy of the drinking water and sewerage infrastructure to serve the new density (Bojorquez Luque et al., 2023). They have also documented the replacement of traditional buildings and uses in the Playa Norte area by second homes, short-stay accommodation, and consumer-oriented businesses (Bojórquez Luque and Osuna Covarrubias, 2025).

These studies describe the condominium from the outside, as an object of urban transformation; the experience of those who live inside it has received far less attention.

International research offers clues about this experience from the inside.

The systematic review by Macedo et al. (2022) showed that privacy in the home is a need that organizes behavior in space and should be studied in its physical, social, and psychological dimensions. In high-rise buildings, anonymity can function as a privacy resource that enables residents to manage social proximity with a live-and-let-live attitude (Arviv and Eizenberg, 2021).

At the same time, noise from neighbors is among the most frequent annoyances in multifamily housing (Wang and Norbäck, 2021), and how it is perceived is associated with the quality of residents' relationships with their own neighbors (Benz et al., 2021).

Neighborhood networks, cohesion, and the use of common spaces, for their part, have been associated with neighborhood attachment and with less loneliness among apartment residents (Kleeman et al., 2023; Nguyen et al., 2025).

No Spanish-language instruments were identified that jointly measure privacy within the apartment, perceived control over shared spaces, and relationships with neighbors in condominiums in Mexican tourist cities. Project FZ-HAB-0013 of the Factoriza UAS platform set out to study these three dimensions in Mazatlán's condominiums using a 15-item scale: Privacy in the Dwelling, Control of Shared Space, and Relationship with Neighbors.

This article reports the results of the first pilot survey, based on a small preliminary data cut; its scope is therefore limited to the initial review of the instrument and not the estimation of population parameters.

The overall objective was to describe the initial performance of a scale of privacy, territoriality, and neighborhood coexistence in the preliminary data cut from its pilot survey in Mazatlán condominiums.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to explore the internal structure of the item set through exploratory factor analysis; and fourth, to examine the relationship among the scores on the three dimensions. The project did not state any hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

PRIVACY IN VERTICAL HOUSING

In the literature, residential privacy is understood as the ability to regulate others' access to oneself, both in what others see and hear and in what one perceives of them.

Macedo et al. (2022) reviewed research on privacy and housing published between 2000 and

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2021 and found that studies are concentrated in American, European and Islamic contexts and have grown in number since 2018. They proposed studying privacy holistically, across its physical, social and psychological dimensions, and with a precise characterization of the context.

They also grouped the instruments into four families: behavioral analysis through questionnaires, interviews and observation; assessment of the built environment; characterization of users; and characterization of participants, including how they personalize space.

Visual privacy has been the most extensively studied facet from a design perspective. The review by Sheikhi Nashalji and Mehdizadeh Saradj (2025) grouped definitions of visual privacy into three domains (psychological, physical-environmental and religious-cultural) and compiled design strategies ranging from the configuration of the urban fabric to the interior layout, façade elements and materials.

Acoustic privacy, in turn, has been studied mainly through noise annoyance. In a national sample of multifamily buildings in Sweden, voices, music or footsteps from neighbors were among the most common sources of annoyance, and noise annoyance was associated with symptoms such as fatigue, headache and difficulty concentrating (Wang and Norbäck, 2021).

The meta-analysis by Gong et al. (2022) also found some evidence of an association between noise annoyance and poorer mental health indicators, albeit based on a small number of studies.

The Privacy in the Home dimension of the instrument under study captures these facets: the possibility of having a conversation without being overheard (R1), visual exposure from other apartments (R2, reverse-scored), the availability of a space to be alone (R3), the intrusion of noise from neighbors (R4, reverse-scored), and the possibility of coming and going without feeling watched (R5).

The composite combines acoustic, visual and spatial privacy; two of its items refer to exposure to the outside of the apartment, whereas R3 refers to the interior layout of the dwelling. The literature suggests that these facets are related but not interchangeable (Macedo et al., 2022; Sheikhi Nashalji and Mehdizadeh Saradj, 2025).

TERRITORIALITY AND CONTROL OF SHARED SPACE

Territoriality refers to the set of behaviors and attitudes through which people delimit, personalize, and defend the spaces they consider their own. In residential complexes, its most relevant expression is found in semi-public spaces, which do not belong to anyone in particular but are not fully public either.

Nowzari et al. (2023) studied four residential complexes in Shiraz, Iran, from the perspective of human territoriality theory and found that spatial configuration was associated with the use of semi-public spaces; that vegetation, lighting, accessibility and furniture in common areas were related to greater social interaction; and that layouts without clearly defined spaces or territories performed worse.

In the Chinese-language literature, Dong (2023) analyzed residents' behavior in community public space from an environmental psychology perspective and noted that functionalist planning tends to overlook the psychological and interaction needs of residents, who expect such spaces to serve aesthetic, social and spiritual purposes in addition to functional ones.

Control of shared space also has an organizational dimension. In social vertical housing in Ciudad Juárez, Rodríguez Sosa et al. (2022) identified difficulties in the social organization needed to ensure the maintenance of multifamily units as a risk to the acceptance of this type of housing.

The instrument's Control of Shared Space dimension brings together items on appropriation, such as feeling that the hallway is one's own (R6) and being able to decorate the apartment entrance (R9); on collective care, such as residents' care of common areas (R7); and on surveillance and access control, such as the uncontrolled use of common areas by outsiders (R8, reverse-scored) and recognizing those who do not live in the condominium (R10). Once again, the content is heterogeneous, combining individual appropriation with collective management and access surveillance.

NEIGHBORLY COEXISTENCE IN APARTMENT BUILDINGS

Relationships among neighbors in the same building combine sociability, familiarity, and anonymity. Felder et al. (2023) analyzed the social networks of four rental apartment buildings in Geneva, Switzerland, using a distance measure that incorporates the accessibility, visibility,

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and audibility arising from the building's layout and materials. They found that spatial proximity increased the likelihood of weak ties, such as greeting one another or chatting casually, and that sociability, familiarity, and anonymity are core dimensions of neighboring even at the scale of a single building.

Along the same lines, in a high-rise complex in Haifa, Israel, Arviv and Eizenberg (2021) showed that the anonymity the literature often treats as a negative feature of high-rise living can offer residents the privacy needed to manage social proximity.

Neighbourly coexistence has been associated with various well-being outcomes. Using structural equation modelling in four high-rise complexes in Hanoi, Vietnam, Nguyen et al. (2025) found that having more neighbours in one's social network was associated with greater social cohesion, and the latter with stronger neighbourhood attachment and fewer feelings of loneliness. They noted that these benefits depend on the urban context and on the availability of common spaces within and around the buildings.

In the study by Kleeman et al. (2023) of apartment developments in Sydney, Melbourne and Perth, use of outdoor common areas was associated with more relationships with neighbors; residents who did not use indoor common areas were more likely to feel lonely; and neighbor relationships acted as a protective factor against loneliness.

Benz et al. (2021), for their part, identified relationships with neighbors and neighborhood satisfaction among the factors associated with annoyance from neighbor noise, a finding that links coexistence with acoustic privacy.

The instrument's Relationship with Neighbors dimension includes everyday sociability behaviors, such as greeting neighbors (R11); perceived support, such as being able to ask for help in an emergency (R12); conflict, such as the frequency of conflicts between neighbors (R13, reverse-scored); compliance with rules, such as respecting the agreements of the building management (R14); and participation, such as attending residents' meetings (R15).

These items cover both one's own behaviors and perceptions of others, and their covariation is not guaranteed: a person may greet all of their neighbors but not attend meetings, or may participate precisely because they perceive conflicts. Given the cross-sectional design, the relationships among privacy, territoriality, and coexistence should be understood as associations rather than as relationships of dependence.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data come from survey LEV-0018, "Piloto condominios Mazatlán · Privacidad y convivencia," of project FZ-HAB-0013 on the Factoriza UAS platform, and from the frozen dataset DST-0020, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only one in the project.

POPULATION, SAMPLE AND DATA CUTOFF

The survey population was defined as individuals aged 18 years or older residing in condominiums in Mazatlán, Sinaloa. The condominiums were selected by the project lead; building selection was therefore non-probabilistic. According to the Factoriza log, 33 individuals opened the questionnaire and 23 completed it; no cases were excluded for quality control, so 23 cases were analyzed (Table 2).

The analyzed dataset is preliminary: it comprises 23 cases out of a target of 100, and data collection was still open (in the field) at the cutoff date. With 23 cases for 15 items, the ratio is 1.5 cases per item, far below the ratio recommended for item factor analysis, whose first requirement is to verify the adequacy of the data and the sample (Ferrando et al., 2022; Goretzko et al., 2021).

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INSTRUMENT

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Privacy in the home	Inside my apartment, I can have a conversation without my neighbors hearing me	No
R2	Privacy in the dwelling	The interior of my home can be seen from other apartments	Yes
R3	Privacy at home	I have a space in my home where I can be alone	No
R4	Privacy in the home	Noise from my neighbors comes into my apartment	Yes
R5	Privacy in the home	I can enter and leave my home without feeling watched	No
R6	Control of shared space	I feel that the hallway leading to my apartment is my own	No
R7	Control of shared space	We residents take care of the common areas of the condominium	No
R8	Control of shared space	Non-residents use the common areas without control	Yes
R9	Control of shared space	I can decorate the entrance to my apartment as I like	No
R10	Control of shared space	I recognize people who do not live in the condominium	No
R11	Relationship with neighbors	I greet my neighbors when I run into them in the condominium	No
R12	Relationship with neighbors	I can ask a neighbor for help if I have an emergency	No
R13	Relationship with neighbors	In my condominium there are frequent conflicts between neighbors	Yes
R14	Relationship with neighbors	Neighbors comply with the condominium management's agreements	No
R15	Relationship with neighbors	I take part in condominium residents' meetings	No

Note. Privacy, Territoriality and Coexistence in Condominiums Scale. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0013, survey LEV-0018, dataset DST-0020.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0020 with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive and internal-consistency analyses (runs RUN-00102 to RUN-00108). The supplementary analyses were conducted using the data file and the item dictionary exported by the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values for each item, as well as the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, and the calculations involve no manual intervention.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items; if any item correlates negatively with the rest of its dimension, the program does not report omega because the coefficient ceases to be interpretable. The internal structure was explored through exploratory factor analysis of the Pearson correlation matrix of the fifteen items, after checking the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), item-level adequacy (Lorenzo-Seva and Ferrando, 2021) and Bartlett's test of sphericity (Bartlett, 1950).

The number of factors was determined by parallel analysis (Horn, 1965) with 100 simulations and seed 2026; extraction was by minimum residual, and rotation was oblimin, which allows the factors to correlate. All loadings are reported, along with the communality and adequacy of each item. Finally, the program estimated the relationship between the mean scores of the dimensions using Spearman's coefficient and its 95% confidence interval, obtained through the

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Fisher transformation with the standard error of Bonett and Wright (2000).

Reference values for interpreting the indices, such as the 0.60 threshold for the KMO, are treated as guidelines rather than decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is proposed as future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit online informed consent and does not collect names, email addresses or any other identifying data. In a study on neighborhood coexistence, anonymity is particularly relevant, because opinions about neighbors or about the building management could affect relationships within the condominium if respondents were identified.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following were used in preparing this manuscript: the Factoriza UAS platform, for data management and descriptive and internal consistency analyses; a Python analysis program with fixed, validated procedures, for omega, exploratory factor analysis, and correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, preparing a draft, and assembling the document from the results. The authors reviewed, corrected, and approved the entire text, verified every reference, and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the flow of cases. Of the 33 individuals who opened the questionnaire, 23 completed it and were analyzed, with no exclusions for quality control. The difference between questionnaire openings and completions indicates an appreciable proportion of unfinished questionnaires, which should be examined during field administration. Every analyzed case answered all fifteen items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	33
Completed questionnaires	23
Cases excluded by quality control	0
Cases analyzed	23
Items	15

Note. Survey “Piloto condominios Mazatlán · Privacidad y convivencia” [Mazatlán Condominiums Pilot · Privacy and Coexistence] (LEV-0018); population: persons aged 18 years or older residing in condominiums in Mazatlán; territory: Mazatlán, Sinaloa, in condominiums selected by the project lead. Dataset DST-0020, fingerprint f28ceab13d9e8cf0. Source: Factoriza UAS. Preliminary cutoff: n = 23 out of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. For Privacy in the home, the lowest means were those of R1, the possibility of talking without being overheard by neighbors (M = 2.70, SD = 1.55), and R4, the intrusion of noise from neighbors in its recoded version (M = 2.74, SD = 1.42), with 39% and 30% of responses at the minimum value, respectively.

The highest mean in the dimension was for R2, the recoded item on visual exposure from other apartments (M = 3.35, SD = 0.78), followed by R3, having space to be alone (M = 3.30, SD = 1.46). Overall, acoustic privacy received the least favorable ratings in the dimension.

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In Control of shared space, the highest mean was for R7, residents' care of common areas (*M* = 3.74, *SD* = 1.25), with a distribution skewed toward high values (skewness = -0.98). The lowest was for R6, feeling that the hallway is one's own (*M* = 3.00, *SD* = 1.09).

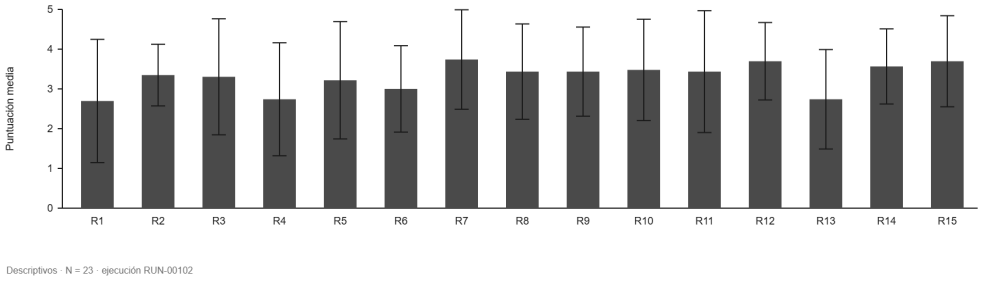
In Relationship with neighbors, the highest means were for R12, being able to ask a neighbor for help in an emergency, and R15, participation in neighborhood meetings, both with *M* = 3.70 (*SD* = 0.97 and 1.15). The lowest was for R13, frequent conflicts between neighbors in its recoded version (*M* = 2.74, *SD* = 1.25), indicating that the perception of conflict was not uncommon in the sample. The highest standard deviations, for R1 (1.55) and R11 (1.53), reflect widely dispersed responses.

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.70	1.55	0.16	-1.43	39%	17%
R2	3.35	0.78	-0.08	-0.29	13%	4%
R3	3.30	1.46	-0.39	-1.19	17%	26%
R4	2.74	1.42	-0.01	-1.48	30%	9%
R5	3.22	1.48	-0.41	-1.21	22%	22%
R6	3.00	1.09	0.46	-0.29	4%	13%
R7	3.74	1.25	-0.98	0.19	9%	30%
R8	3.43	1.20	-0.61	-0.34	9%	17%
R9	3.43	1.12	-0.56	0.31	9%	17%
R10	3.48	1.27	-0.45	-0.68	9%	26%
R11	3.43	1.53	-0.74	-1.06	22%	26%
R12	3.70	0.97	-0.29	-0.75	13%	22%
R13	2.74	1.25	0.09	-0.79	22%	9%
R14	3.57	0.95	-0.03	-0.76	13%	17%
R15	3.70	1.15	-0.53	-0.29	4%	30%

Note.N = 23. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column across the fifteen items is omitted because it combines three dimensions; the item-total correlation by dimension is presented in Table 4. Run RUN-00102 of Factoriza UAS. Preliminary cutoff: n = 23 out of a target of 100, with data collection still open.

Figure 1. Mean scores by item with one-standard-deviation error bars.



INTERNAL CONSISTENCY

Table 4 summarizes the item analysis by dimension computed by Factoriza, and Table 5 presents the coefficients from the complementary program. The alpha values matched in both calculations and were low in all three dimensions: α = .445 for Privacy in the home, α = .287 for Control of shared space, and α = -.132 for Relationship with neighbors.

Omega is not reported for any of them, because all three contained items that correlated negatively with the rest of their dimension: R2 in Privacy; R8 in Control; and R11, R13 and R15 in Relationship with neighbors.

The item-level analysis pinpoints the problems. In Privacy in the home, R2 showed a corrected item-total correlation of -.117 and R5 one of .041, and removing either item would raise alpha to .535 and .532, respectively; R1, R3 and R4, by contrast, showed correlations ranging from

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.384 to .431.

In Control of shared space, R8 showed a correlation of -.098, and its removal would raise alpha to .442, whereas R9 had the highest correlation (.396), and its removal would bring alpha to -.006. In Relationship with neighbors, the negative alpha indicates that the mean inter-item covariance was negative: R13 (-.290), R15 (-.206), and R11 (-.028) correlated negatively with the rest of the items, and only R12 (.270) and R14 (.192) correlated positively. In this dimension, the total score does not represent a common attribute and should not be interpreted as such.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Privacy in the home	R1	.431	.213
Privacy in the home	R2	-.117	.535
Privacy in the home	R3	.396	.256
Privacy in the home	R4	.384	.270
Privacy in the home	R5	.041	.532
Shared space control	R6	.076	.292
Control of shared space	R7	.203	.174
Control of shared space	R8	-.098	.442
Control of shared space	R9	.396	-.006
Control of shared space	R10	.158	.221
Relationship with neighbors	R11	-.028	-.157
Relationship with neighbors	R12	.270	-.543
Relationship with neighbors	R13	-.290	.239
Relationship with neighbors	R14	.192	-.414
Relationship with neighbors	R15	-.206	.107

Note.N = 23. Scale from 1 to 5; reverse-scored items R2, R4, R8, and R13 are shown recoded. Run RUN-00102 of Factoriza UAS. Preliminary cutoff: n = 23 out of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension/ Items	n	α	ω	Observation
Privacy in the home	5	23	.445	Reverse-worded items: R2; ω not interpretable
Control of shared space	5	23	.287	Reverse-worded items: R8; ω not interpretable
Relationship with neighbors	5	23	-.132	Reverse-keyed items: R11, R13, R15; ω not interpretable

Note.N = 23. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Privacy in the home = .445 (run RUN-00103); Control of shared space = .287 (RUN-00105); Relationship with neighbors = -.132 (RUN-00107). A negative alpha indicates that the mean covariance among the items of the dimension is negative. Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary cutoff: n = 23 out of a target of 100, with data collection ongoing.

INTERNAL STRUCTURE

The exploratory factor analysis could be estimated, but the data conditions were less than favorable. The overall measure of sampling adequacy was KMO = .401, below the indicative benchmark of 0.60, and several items showed low individual adequacy values flagged by the software (Table 7).

Bartlett's test was significant, $\chi^2(105) = 131.75$, $p = .040$, indicating that the matrix is not an identity matrix, but this is not sufficient to justify factoring. Parallel analysis indicated retaining five factors (Figure 2), which together explained 58.87% of the variance, with individual contributions ranging from 12.97% to 9.20% (Table 6). The interfactor correlations from the oblimin rotation were low, with a maximum of .293 between Factors 1 and 4.

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Figure 2. Scree plot with parallel analysis.

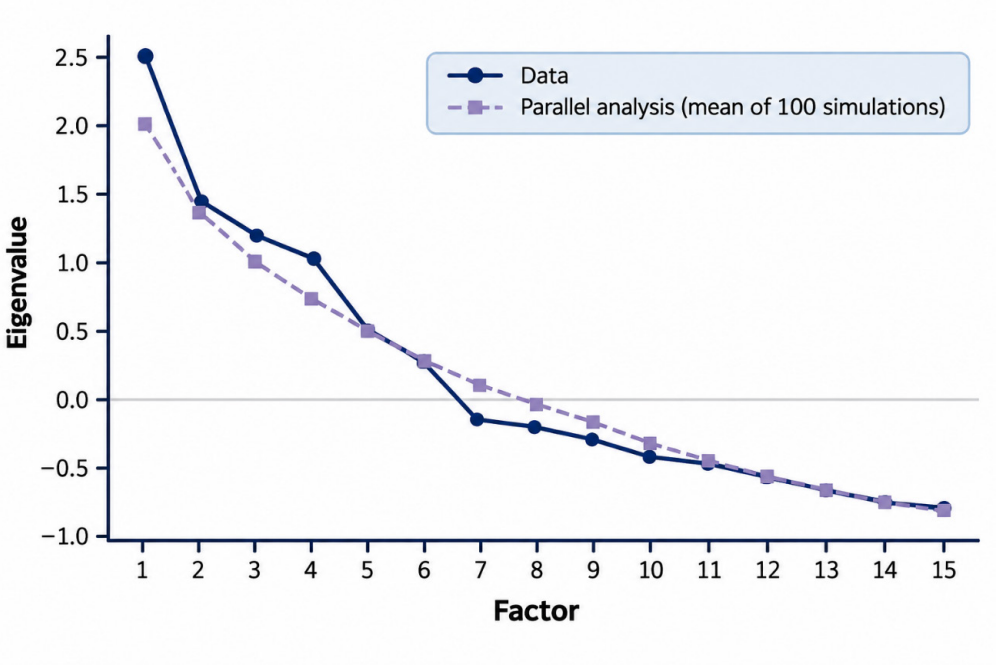


Table 6. Variance explained by the factors.

Factor	Sum of squared loadings	% of variance	Cumulative %
1	1.94	12.97	12.97
2	1.89	12.63	25.60
3	1.87	12.47	38.07
4	1.74	11.59	49.66
5	1.38	9.20	58.87

Note. Eigenvalues of the reduced data matrix compared with the mean of 100 simulated matrices of the same size (seed 2026). Source: prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0020_FZ_HAB_0013. Preliminary data cut: n = 23 of a target of 100, with data collection still ongoing.

The pattern matrix (Table 7) did not reproduce the three hypothesized dimensions. Factor 1 grouped items from two dimensions: R9, being able to decorate the entrance (.734); R1, talking without being overheard (.669); R5, coming and going without feeling watched (.455); and R11, greeting neighbors (.401), with a negative loading of R2 (-.658).

Factor 2 grouped the four reverse-worded items, R4 (.938), R8 (.550), R13 (.485), and R2 (.352), drawn from all three dimensions. Factor 3 combined R6, feeling that the hallway is one's own (.843), with R12 (.677) and R14 (.631), from the neighbor-relations dimension. Factor 4 was defined by R7, care of the common areas (.979), and R3, space to be alone (.573); Factor 5 was defined by R10, recognizing outsiders (.684), and R15, participation in meetings (.637).

The solution yielded a communality greater than 1 for R7 (1.007), that is, a Heywood case indicating an improper solution. The software also flagged eleven items requiring a decision by the authors because of low adequacy, cross-loadings or opposite signs. For these reasons, the loading matrix is presented to document item behavior, not as evidence of the dimensionality of the instrument.

Table 7. Factor loadings from the exploratory factor analysis.

Item	1	2	3	4	5	h^2	MSA
R1	.669	.299	.086	.168	-.042	.666	.454
R2	-.658	.352	.209	-.053	-.286	.729	.548
R3	.063	.196	.335	.573	-.103	.586	.371
R4	.031	.938	-.037	.102	.027	.914	.586
R5	.455	-.154	-.035	-.030	-.293	.294	.235
R6	-.011	-.002	.843	.111	.050	.735	.505

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Item	1	2	3	4	5	h^2	MSA
R7	.051	-.006	-.042	.979	.075	1.007	.307
R8	.123	.550	-.010	-.437	.104	.391	.433
R9	.734	.154	.185	.054	-.022	.654	.698
R10	.152	.074	-.099	.083	.684	.533	.365
R11	.401	-.387	.119	-.078	-.244	.369	.623
R12	.174	-.044	.677	-.016	-.258	.595	.532
R13	-.020	.485	-.116	-.216	-.276	.390	.229
R14	-.026	-.150	.631	-.250	.304	.520	.226
R15	-.107	.014	.210	.071	.637	.448	.415

Note. KMO = .401; Bartlett's test of sphericity: $\chi^2(105) = 131.75$, p = .040. Number of factors according to parallel analysis: 5. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0020_FZ_HAB_0013. Preliminary data cut: n = 23 out of a target of 100, with data collection still open. Given a KMO below the reference value and 1.5 cases per item, the solution is presented only as a preliminary exploration.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 8 presents the Spearman correlations between the mean scores of the three dimensions, based on 23 cases. The relationship between Privacy in the home and Control of shared space was positive and moderate, ρ = .514, 95% CI [.101, .775], *p* = .012, and it was the only one whose interval excluded zero.

The relationship between Control of shared space and Relationship with neighbors was positive and weak, ρ = .212, 95% CI [-.224, .577], *p* = .331. The relationship between Privacy in the home and Relationship with neighbors was practically zero, ρ = .104, 95% CI [-.323, .496], *p* = .636. Because the Relationship with neighbors score had a negative alpha, its correlations with the other dimensions lack a clear substantive interpretation.

Table 8. Correlations Between Dimensions.

Dimension pair	n	ρ	IC 95 %	p
Privacy in the Home and Control of Shared Space	23	.514	[.101, .775]	.012
Privacy in the home and Relationship with neighbors	23	.104	[-.323, .496]	.636
Control of Shared Space and Relationship with Neighbors	23	.212	[-.224, .577]	.331

Note. Pattern matrix. Minimum residual extraction and oblimin rotation (γ = 0) on the Pearson correlation matrix; 23 complete cases. h^2 = communality; MSA = measure of sampling adequacy per item. All loadings are shown. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0020_FZ_HAB_0013. Preliminary cut-off: n = 23 out of a target of 100, with data collection still open. The intended dimension and observations columns have been moved to this note to fit the table to the page width: R1 to R5 correspond to Privacy in the Home, R6 to R10 to Control of Shared Space, and R11 to R15 to Relationship with Neighbors (Table 1). The communality of R7 exceeding 1 indicates a Heywood case and, therefore, an improper solution; the matrix is presented to document item behavior and not as evidence of structure. Program observations by item: R1, low MSA; R2, cross-loading; opposite sign; R3, cross-loading; low MSA; R5, low MSA; R7, Heywood case; low MSA; R8, cross-loading; low MSA; R10, low MSA; R11, cross-loading; R13, low MSA; R14, cross-loading; low MSA; R15, low MSA.

DISCUSSION OF RESULTS

The purpose of this study was to describe the initial performance of a scale of privacy, territoriality, and neighborhood coexistence in condominiums in Mazatlán. The central finding is that none of the three dimensions behaved as a homogeneous scale in this cross-section: alphas were low or negative, omega was not interpretable in any dimension, and exploratory factor analysis, which also showed insufficient sampling adequacy and a Heywood case, suggested a five-factor structure that cuts across the theoretical dimensions.

With 23 cases, part of this pattern may be attributable to sampling error; the simulation literature on the alpha and omega coefficients has been developed with much larger samples (Malkewitz et al., 2023). However, the consistency of the pattern across the different analyses offers substantive clues worth examining before data collection is concluded.

The clearest clue is the grouping of the four reverse-worded items on a single factor. R2, R4, R8 and R13 belong to three different dimensions and yet loaded together on factor 2, whereas two

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of them (R2 and R8) and R13 correlated negatively with the rest of their dimension. This pattern is consistent with a wording effect, that is, with variance associated with the direction in which the items are worded rather than with their content.

Steinmann et al. (2022) showed that scales with items keyed in both directions require more careful reading and responding, and that some respondents respond inconsistently to the positive and negative items of the same dimension, which can produce wording-related effects.

García-Batista et al. (2021) documented that detecting and removing these inconsistent responses appreciably reduces wording effects in mixed scales. With such a small sample, this effect cannot be distinguished from other explanations, such as incorrect recoding.

The second clue is the heterogeneity of content noted in the theoretical framework. In Privacy in the Dwelling, R5 (entering and leaving without feeling observed) showed low covariance with the dimension and loaded together with R1 on a factor that also included the possibility of decorating the entrance, which suggests a component of control over the apartment's threshold that is distinct from interior privacy.

That acoustic privacy had the lowest means within the dimension is consistent with the literature placing neighbor noise among the most common annoyances in multifamily housing (Benz et al., 2021; Wang and Norbäck, 2021) and with its possible relationship to mental health (Gong et al., 2022).

In Control of shared space, individual appropriation (R6 and R9), collective care (R7) and access surveillance (R8 and R10) loaded on different factors, as would be expected if territoriality in semi-public spaces depends on the physical and organizational components that delimit those spaces (Nowzari et al., 2023; Rodríguez Sosa et al., 2022).

For Relationship with Neighbors, the negative alpha indicates that, in this cross-section, the dimension groups behaviors and perceptions that do not vary together. Participation in meetings (R15) and greeting neighbors (R11) correlated negatively with the remaining items, as did the perception of conflicts (R13) after recoding.

One possible substantive explanation is that participation in meetings and the perception of conflicts coexist, since meetings are often where conflicts are voiced; another is that neighbourhood coexistence combines distinct dimensions, such as sociability, familiarity and anonymity, which need not covary (Felder et al., 2023).

In turn, the grouping of R12 and R14 with the sense of ownership of the corridor (R6) on factor 3 suggests a component of trust in the immediate neighbourhood environment, consistent with studies that associate neighbourhood networks with cohesion and attachment (Nguyen et al., 2025).

The positive association between privacy and control of the shared space is the most robust finding of this wave, although its confidence interval is wide and both scores have low internal consistency. It is consistent with the idea that residential privacy is regulated within the apartment as well as at its thresholds and in the semi-public spaces surrounding it (Macedo et al., 2022; Nowzari et al., 2023).

In any case, the cross-sectional design precludes establishing the direction of this relationship. Finally, response quality should be reviewed before the final analysis, because in small samples careless response patterns can distort correlations (Ward and Meade, 2023).

CONCLUSIONS

The study met its objective to the extent permitted by a preliminary sample of 23 cases. In its pilot administration, the privacy, territoriality and coexistence scale of project FZ-HAB-0013 showed low internal consistency for Privacy in the dwelling (α = .445) and Control of shared space (α = .287), and negative internal consistency for Relationship with neighbors (α = -.132).

The exploratory factor analysis, with insufficient sampling adequacy (KMO = .401) and a Heywood case, suggested five factors that do not reproduce the theoretical dimensions; one of them consisted of the four reverse-worded items. The only relationship between dimensions whose interval excludes zero was the positive association between Privacy and Control of shared space. The results do not yet provide evidence of structural validity; their main use is to identify the items and design decisions that should be revised.

The limitations are substantial. The sample of 23 cases, against a target of 100 and with 1.5 cases per item, makes the statistics and the factor solution unstable; data collection was still ongoing, and some of the people who opened the questionnaire did not complete it.

The condominiums were selected by the project lead without a probabilistic procedure,

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and no information is available on their characteristics or on those of the residents, such as tenure, length of residence, or permanent versus temporary residence status. In a city with a high proportion of second homes, these factors may alter the experience of coexistence. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

These results point to several decisions for the authors. The first is to verify the recoding of the four reverse-worded items and, if it is correct, to consider whether they should be reworded in the positive direction or retained, with the wording effect modeled using a sufficiently large sample. The second is to review the Relationship with Neighbors dimension, particularly R11, R13 and R15, and to consider whether everyday sociability, conflict and participation in condominium management should be separated.

The third is to review R5 in Privacy and R8 in Control of Shared Space, and to assess whether privacy at the thresholds of the apartment constitutes a distinct facet. The fourth is to record each respondent's condominium and tenure characteristics. None of these decisions was made in the present analysis, which retains the original fifteen items.

For future work, we propose completing data collection up to the planned target, repeating the exploratory factor analysis with the final dataset, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample.

The measurement could be complemented by a physical characterization of the condominiums, such as the layout of corridors and common areas and the sound insulation between apartments, so that perception can be compared with building conditions. An instrument with documented validity evidence would make it possible to monitor the habitability of vertical housing in Mazatlán and to inform its design, its regulation, and the management of coexistence in condominiums.

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Chapter 6 / Capítulo 6

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Place identity and appraisal of climate-adapted traditional architecture in Mazatlán: Preliminary psychometric properties of a scale

Identidad de lugar y valoración de la arquitectura tradicional adaptada al clima en Mazatlán: propiedades psicométricas preliminares de una escala

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ABSTRACT

Traditional architecture in hot cities combines heritage value, identity bonds and climate-adaptive solutions. This instrumental study examined the preliminary psychometric properties of a place identity and traditional architecture appraisal scale, with ten items and two dimensions, Mazatlán identity and Appraisal of traditional architecture, in the pilot survey of project FZ-HAB-0014 on the Factoriza UAS platform, conducted in the Historic Centre and old neighbourhoods of Mazatlán. With a cross-sectional design, 9 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and the Spearman correlation between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was high for Mazatlán identity (α = .871; ω = .884) and for Appraisal of traditional architecture (α = .873; ω = .887), with the reverse-worded items as the least coherent. The factor analysis was not interpretable because the sample had fewer cases than items, and the dimensions were positively correlated (ρ = .723), with a very wide interval. Residents valued the coolness of high ceilings and wished new housing to retain traditional elements, although they leaned towards preferring new buildings. The findings are an initial favourable signal that the final data cut must confirm.

Keywords: place identity; built heritage; climate-adapted architecture; psychometric evidence

RESUMEN

La arquitectura tradicional de las ciudades cálidas reúne valor patrimonial, vínculos identitarios y soluciones de adaptación al clima. Este estudio instrumental examinó las propiedades psicométricas preliminares de una escala de identidad de lugar y valoración de la arquitectura tradicional, de diez reactivos y dos dimensiones, Identidad mazatleca y Valoración de la arquitectura tradicional, en el levantamiento piloto del proyecto FZ-HAB-0014 de Factoriza UAS, aplicado en el Centro Histórico y barrios antiguos de Mazatlán. Con diseño transversal, se analizaron 9 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y la correlación de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue alta en Identidad mazatleca (α = .871; ω = .884) y en Valoración de la arquitectura tradicional (α = .873; ω = .887), con los reactivos inversos como los menos coherentes. El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos, y las dimensiones se correlacionaron de manera positiva (ρ = .723), con un intervalo muy amplio. Los residentes valoraron la frescura de los techos altos y desearon que la vivienda nueva conserve elementos antiguos, aunque se inclinaron por las construcciones nuevas. Los resultados constituyen una primera señal favorable que el corte final deberá confirmar.

Palabras clave: identidad de lugar; patrimonio edificado; arquitectura adaptada al clima; evidencias psicométricas

INTRODUCTION

The traditional architecture of cities is at once material heritage and a component of the identity of those who inhabit them. In hot climates, much of this architecture incorporated solutions that respond to heat, such as high ceilings, thick walls, porticoes and cross-ventilation. Residents' appraisal of it therefore brings together aesthetic judgments, emotional bonds with place and perceptions of comfort.

Understanding how identification with the city relates to the appraisal of its traditional architecture is relevant to heritage conservation and to the design of new housing.

Mazatlán offers a distinctive case for this study. Its Historic Center includes a Historic Monuments Zone declared in 2001, comprising 479 buildings, and, according to the study by Castillo Romero (2023), its cultural function was largely replaced by a tourism function starting in the decade that began in 2010. This shift involved the adaptation of listed buildings for bars and restaurants, the construction of a condominium tower, and residents' protests over nighttime noise, although residential use still predominated.

The city is also undergoing a broader transformation associated with tourism: the boom in high-rise construction has generated social tensions along the coastal strip (Bojorquez Luque et al., 2023); the Playa Norte area has been examined from the perspective of creative destruction (Bojórquez Luque and Osuna Covarrubias, 2025); and studies have documented processes of touristification and tourism gentrification with sociocultural impacts on the local population (Mendieta Vega and Roldán Clarà, 2024).

In this context, residents' appraisal of old houses is not merely a matter of taste. It expresses their attachment to the city and their willingness to support the conservation of a heritage that competes with new ways of building.

At the same time, occupants of social housing in northwestern Mexico have described it as hot (Barraza-Bracamontes et al., 2022), which makes it relevant to ask whether residents recognize in traditional architecture comfort solutions that new housing could recover. However, no brief instruments were identified that jointly measure identification with the city and appreciation of its climate-adapted traditional architecture.

Project FZ-HAB-0014 of the Factoriza UAS platform set out to study place identity and the appraisal of climate-adapted traditional architecture in Mazatlán. To this end, the Place Identity and Appraisal of Traditional Architecture Scale was designed, comprising ten items organized into two dimensions: Mazatlán Identity and Appraisal of Traditional Architecture.

This article reports the results of the preliminary data cut of the pilot survey, administered in the Historic Center and old neighborhoods of the city.

The overall objective was to examine the preliminary psychometric properties of the scale in that data cut. The specific objectives were, first, to describe residents' self-reported identification with the city and their appraisal of traditional architecture; second, to estimate the internal consistency of each dimension using alpha and omega coefficients and to identify items showing discrepant behavior; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to describe the relationship between the scores on the two dimensions. The project package does not record any hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

PLACE IDENTITY AND PLACE ATTACHMENT

Place identity refers to the part of personal identity that is constructed through one's relationship with a place, and it is usually studied together with place attachment and place dependence. A systematic review of research published between 2010 and 2021 on place attachment and behavioral intentions concluded that there is no consensus on how place attachment should be measured and that its dimensions do not relate to behavioral intentions in the same way (Dang and Weiss, 2021).

In rural households in earthquake-prone areas of China, for example, place dependence was negatively associated with the intention to relocate, whereas place identity was indirectly related to evacuation intention through perceived response efficacy (Qing et al., 2022).

The relationship between identity and the built environment is central to this literature. The review by Kamani Fard and Paydar (2024) on place attachment in urban settings noted that social

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interaction and local features that express history and culture are associated with a stronger bond.

In Quanzhou, a World Heritage Site in China, a survey of 383 visitors to historic buildings found that multisensory perception, physical involvement, and cognitive processing were positively associated with place attachment and with the intention to support the destination, and that residents' identity climate strengthened some of these relationships (Cai et al., 2025).

In the ancient city of Pingyao, researchers have examined how the emotions and actions of residents of a heritage tourism destination evolve from conflict to co-creation (Xing, 2026).

The Mazatlán identity dimension of the instrument captures the centrality of being from Mazatlán in one's self-definition (R1), identification with the city's customs (R2), pride in living there (R3), the perception that Mazatlán is a place like any other (R4, reverse-scored) and missing the city when away from it (R5). It therefore combines components of identity, pride and affective attachment.

TRADITIONAL ARCHITECTURE AND CLIMATE ADAPTATION

Traditional architecture in hot regions has been studied as a repertoire of passive thermal control strategies. In a traditional stilt house in Indonesia, Arminda and Darmayanti (2026) measured surface temperatures and simulated solar exposure. They found that the configuration of the building envelope and the layering of materials markedly influenced thermal performance: a double timber wall with an air cavity maintained lower indoor temperatures, a timber ceiling reduced heat transfer from the roof, and enclosing the space beneath the house restricted ventilation.

The authors highlighted how traditional elements and their later modifications interact with the tropical climate, and presented their findings as evidence for conserving this type of housing.

In Mexico, the revival of bioclimatic strategies in historic buildings has been explored through simulation. In the Historic Center of Oaxaca, Aguilar Osante et al. (2026) proposed an intervention in a deteriorated building using bioclimatic strategies evaluated through energy simulation; these strategies brought indoor temperatures closer to comfort conditions and reduced cooling energy consumption.

In Irbid, Jordan, another hot setting, apartment residents perceived a more intense heat island in their neighborhood and rated tree shade and natural ventilation as less effective than did residents of single-family houses (Obeidat, 2026), which shows that housing type is associated with how occupants value passive strategies.

The instrument's Appreciation of Traditional Architecture dimension captures the regard for old houses as part of the city's identity (R6), the coolness of houses with high ceilings (R7), the appeal of porticoes (R8), the preference for new buildings over old ones (R9, reverse-scored), and the desire for new houses to retain elements of old ones (R10). It thus combines one symbolic appraisal, two appraisals of climate-adapted elements, and two attitudes toward new housing.

BUILT HERITAGE, TOURISM AND NEIGHBORHOOD LIFE

Residents' relationship with built heritage is affected by the tourist uses of historic centers. In the historic center of Zacatecas, Ramos-Jiménez and De La Barrera-Medina (2025) linked housing for tourist use to a reduction in the supply of traditional rental housing, rising rents, the displacement of residents, and the loss of traditional commerce.

In Mazatlán, Castillo Romero (2023) concluded that recent transformations in the architecture and urban layout of the Historic Center have responded more to touristification and economic interests than to heritage conservation, and recommended prioritizing conservation, regulating noise, and promoting housing. In this context, residents' identification with the city and their appreciation of traditional architecture are resources for conservation, and measuring them can guide policies for the historic center.

VALIDITY EVIDENCE IN THE INITIAL STAGE OF SCALE DEVELOPMENT

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared how the two coefficients perform

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under different data conditions (Malkewitz et al., 2023).

Internal structure is explored through exploratory factor analysis, which first requires checking that the data are suitable and that the sample size is sufficient (Ferrando et al., 2022; Goretzko et al., 2021).

Each dimension of the scale includes one reverse-worded item. Scales with items worded in both directions may exhibit wording effects, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022), and identifying these responses may reduce such effects (García-Batista et al., 2021). Given the cross-sectional design, the relationships between dimensions should be understood as associations rather than dependency relationships.

METHODOLOGY

DESIGN

We conducted an instrumental, quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope. The data come from survey LEV-0019, "Mazatlán Pilot · Identity and Traditional Architecture," of project FZ-HAB-0014 on the Factoriza UAS platform, and from the frozen dataset DST-0021, with a cut-off date of 9 October 2026. The survey is an independent sample and the only one in the project.

POPULATION, SAMPLE, AND DATA CUTOFF

The population was defined as individuals aged 18 years or older residing in Mazatlán, Sinaloa, and data collection was conducted in the Historic Center and in older neighborhoods selected by the project lead. Sampling was therefore nonprobabilistic. According to the Factoriza log, 32 individuals opened the questionnaire and 9 completed it; no cases were excluded on quality-control grounds, so 9 cases were analyzed (Table 2).

The analyzed data cut is preliminary: it comprises 9 cases out of a target of 100, and data collection was still open and in the field at the cut-off date. With 9 cases for 10 items, the ratio is 0.9 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Place Identity and Appreciation of Traditional Architecture Scale was administered. It consists of ten items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into two dimensions of five items each: Mazatlán Identity (R1 to R5) and Appreciation of Traditional Architecture (R6 to R10). Two items, R4 and R9, are reverse-worded and have been recoded in the data matrix, so that a higher score indicates greater identification with the city and greater appreciation of traditional architecture. Table 1 presents the code, dimension, wording, and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Mazatlán identity	Being Mazatlecan is an important part of who I am	No
R2	Mazatlán identity	I identify with the customs of Mazatlán	No
R3	Mazatlán identity	I am proud to live in Mazatlán	No
R4	Mazatlán identity	To me, Mazatlán is a place like any other	Yes
R5	Mazatlán identity	When I am away from Mazatlán, I miss the city	No
R6	Appreciation of traditional architecture	The old houses of Mazatlán are part of the city's identity	No
R7	Appreciation of traditional architecture	Old houses with high ceilings feel cool	No
R8	Appreciation of traditional architecture	The porches of old houses are pleasant places to spend time	No

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Code	Dimension	Item	Reverse
R9	Appreciation of traditional architecture	I prefer new buildings to the old houses of Mazatlán	Yes
R10	Appreciation of traditional architecture	I would like new houses to retain elements of old houses	No

Note. Place Identity and Appreciation of Traditional Architecture Scale. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the data matrix provided. Source: Factoriza UAS, project FZ-HAB-0014, survey LEV-0019, dataset DST-0021.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0021 with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00109 to RUN-00113). The complementary analyses were performed using the data file and the item dictionary exported from the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS computed the mean, standard deviation, skewness, kurtosis, and percentage of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), with the corrected item-total correlation and alpha if item deleted; and the Pearson correlations between the items of each dimension, with 95% confidence intervals obtained through the Fisher transformation.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), using NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020) and pandas 3.0.5. The program applies fixed, stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items. It also attempted an exploratory factor analysis of the ten items, with an assessment of sampling adequacy, a test of sphericity, parallel analysis to determine the number of factors, minimum residual extraction and oblimin rotation. Finally, it estimated the relationship between the mean scores of the two dimensions using Spearman's coefficient and its 95% confidence interval, computed through the Fisher transformation with the standard error of Bonett and Wright (2000).

Reference values for psychometric indices are treated as guidelines rather than as decision rules (Ferrando et al., 2022). No items were removed, and no confirmatory factor analysis was conducted; this is left for future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit online informed consent and does not collect names, email addresses or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following were used in preparing this manuscript: the Factoriza UAS platform, for data management and the descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, for omega, the attempted exploratory factor analysis and the correlation between dimensions; and the Claude Opus language model (Anthropic), to run that program, assist with literature searching, write a draft and assemble the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and assume full responsibility for the content of the article.

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RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 32 individuals who opened the questionnaire, 9 completed it and were analyzed, with no exclusions for quality control. All 9 analyzed cases answered the ten items.

Table 2. Sample composition.

Indicator	Value
Individuals who opened the questionnaire	32
Completed questionnaires	9
Cases excluded by quality control	0
Cases analyzed	9
Items	10

Note. Survey "Piloto Mazatlán · Identidad y arquitecturatradicional" (LEV-0019); population: persons aged 18 years or older residing in Mazatlán; area: Mazatlán, Sinaloa, in the Historic Center and older neighborhoods selected by the project lead. Dataset DST-0021, fingerprint 1d050ecbfc8a566c. Source: Factoriza UAS. Preliminary data cut: n = 9 of a target of 100, with the survey still open.

MAZATLÁN IDENTITY AND APPRECIATION OF TRADITIONAL ARCHITECTURE

Table 3 and Figure 1 present the descriptive statistics. For *M*azatlán identity, the centrality of being from Mazatlán to one's self-definition had the highest mean (R1: M = 3.89, *SD* = 1.17), with a marked negative skewness (-2.16) and a kurtosis of 5.94, indicating that responses were concentrated at the high end of the scale.

In its recoded version, the perception that Mazatlán is not a place like any other obtained *M* = 3.33 (R4: *SD* = 1.22). Identification with local customs, pride in living in the city, and longing when away shared a mean of 3.22 (R2: *SD* = 1.48; R3: *SD* = 1.30; R5: *SD* = 1.56), with considerable dispersion.

In Appreciation of traditional architecture, the desire for new houses to retain elements of old ones had the highest mean (R10: *M* = 3.89, *SD* = 0.93), followed by the view of old houses as part of the city's identity (R6: *M* = 3.67, *SD* = 1.58) and the coolness of high-ceilinged houses (R7: *M* = 3.67, *SD* = 1.32); the appeal of porches ranked somewhat lower (R8: *M* = 3.33, *SD* = 1.12).

Preference for new buildings, in its recoded version, had the lowest mean on the instrument (R9: *M* = 2.56, *SD* = 0.73), indicating a tendency to favor new buildings over old houses. Overall, this cross-section describes residents who recognize the symbolic and climatic value of traditional architecture and want new housing to incorporate its elements, but who, given the choice, lean toward new buildings.

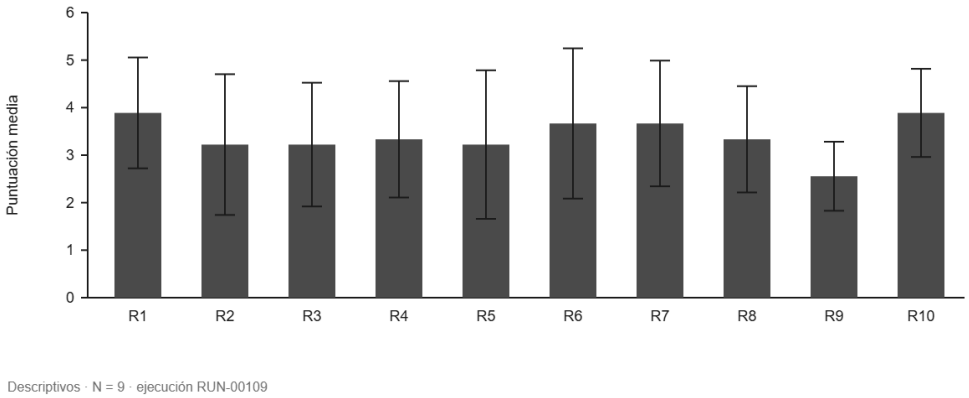
Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.89	1.17	-2.16	5.94	11%	22%
R2	3.22	1.48	-0.48	-0.71	22%	22%
R3	3.22	1.30	-0.52	-0.81	11%	11%
R4	3.33	1.22	-0.82	0.35	11%	11%
R5	3.22	1.56	-0.47	-1.34	22%	22%
R6	3.67	1.58	-1.25	0.17	22%	33%
R7	3.67	1.32	-0.88	0.73	11%	33%
R8	3.33	1.12	-0.84	1.94	11%	11%
R9	2.56	0.73	-1.50	1.47	11%	67%
R10	3.89	0.93	-0.94	1.35	11%	22%

Note.N = 9. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item–total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated from the total of each dimension. Factoriza UAS run RUN-00109. Preliminary cut-off: n = 9 out of a target of 100, with data collection still open.

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Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 presents the item analysis by dimension computed with Factoriza, and Table 5 shows the coefficients from the complementary program, whose alpha values match those obtained with Factoriza. The Mazatlán identity dimension showed high internal consistency (α = .871; ω = .884).

Pride in living in the city (R3: .852), identification with its customs (R2: .835) and nostalgia (R5: .821) were the most coherent items, whereas the recoded perception of Mazatlán as a distinct place showed a weaker relationship (R4: .357); removing this item would raise alpha to .915. The highest correlation in the dimension was between pride and nostalgia (R3 and R5: r = .894, 95% CI [.566, .978], p = .001), and none of the correlations involving R4 had an interval that excluded zero.

Appreciation of traditional architecture also showed high internal consistency (α = .873; ω = .887). The perception of old houses as part of the city's identity was the most consistent item (R6: .958), followed by the desire to preserve their elements in new housing (R10: .858) and the coolness of high ceilings (R7: .813); fondness for porticoes showed a somewhat weaker relationship (R8: .635).

The recoded preference for new buildings was the least consistent item (R9: .355), and its removal would raise alpha to .910. The highest correlation was between the heritage identity of the houses and the desire to preserve their elements (R6 and R10: r = .909, 95% CI [.617, .981], p < .001), followed by the correlation between that identity and the coolness of high ceilings (R6 and R7: r = .837, 95% CI [.388, .965], p = .005) and by that between high ceilings and porticoes (R7 and R8: r = .761, 95% CI [.195, .947], p = .017).

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Identity	R1	.666	.853
Identity	R2	.835	.808
Identity	R3	.852	.807
Identity	R4	.357	.915
Identity	R5	.821	.812
Architecture	R6	.958	.777
Architecture	R7	.813	.817
Architecture	R8	.635	.862
Architecture	R9	.355	.910
Architecture	R10	.858	.821

Note.N = 9. Scale from 1 to 5; reverse-scored items R4 and R9 are shown recoded. Run RUN-00109 of Factoriza UAS. Preliminary data cut: n = 9 out of a target of 100, with data collection still open.

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Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Remarks
Mazatlán identity	5	9	.871	.884	
Appreciation of traditional architecture	5	9	.873	.887	

Note.N = 9. Identity = Mazatlán identity; Architecture = Appreciation of traditional architecture. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each complete dimension, with 5 items each: Identity = .871 (run RUN-00110); Architecture = .873 (RUN-00112). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 9 out of a target of 100, with data collection still open.

Tables 6 and 7 present all the correlations between the items within each dimension. In Mazatlán Identity, the six correlations among R1, R2, R3 and R5 ranged from .632 to .894, and five of them had intervals that excluded zero; by contrast, none of the correlations involving R4 did. In Appreciation of Traditional Architecture, R9 was weakly related to high ceilings (r = .217) and negatively related to porticoes (r = -.103), although its correlation with the desire to preserve old elements was moderate and close to significance (R9 and R10: r = .659, 95% CI [-.009, .920], p = .053).

Table 6. Correlations between the Mazatlán Identity items.

Variable pair	r	IC 95%	p
R1 and R2	.739	[.148, .941]	.023
R1 and R3	.759	[.191, .946]	.018
R1 and R4	.029	[-.648, .680]	.941
R1 and R5	.632	[-.055, .913]	.068
R2 and R3	.749	[.169, .944]	.020
R2 and R4	.505	[-.239, .876]	.165
R2 and R5	.678	[.025, .925]	.045
R3 and R4	.261	[-.487, .789]	.497
R3 and R5	.894	[.566, .978]	.001
R4 and R5	.413	[-.346, .845]	.269

Note.α = Cronbach's alpha; ω = McDonald's omega total based on a one-factor minimum residual model, without reverse-scoring items. Complete cases per dimension. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0021_FZ_HAB_0014. Preliminary data cut: n = 9 out of a target of 100, with data collection still open.

Table 7. Correlations among the items of the Assessment of Traditional Architecture.

Variable pair	r	IC 95%	p
R6 and R7	.837	[.388, .965]	.005
R6 and R8	.707	[.081, .933]	.033
R6 and R9	.508	[-.236, .876]	.163
R6 and R10	.909	[.617, .981]	< .001
R7 and R8	.761	[.195, .947]	.017
R7 and R9	.217	[-.523, .770]	.575
R7 and R10	.679	[.027, .926]	.044
R8 and R9	-.103	[-.718, .603]	.793
R8 and R10	.522	[-.217, .881]	.149
R9 and R10	.659	[-.009, .920]	.053

Note.N = 9. Pearson correlation. Confidence intervals were obtained using Fisher's z transformation. Cross-sectional design: the reported relationships are associations. Run RUN-00111 of Factoriza UAS. Preliminary cutoff: n = 9 of a target of 100, with data collection still open.

INTERNAL STRUCTURE AND RELATIONSHIP BETWEEN DIMENSIONS

The planned exploratory factor analysis could not be estimated in an interpretable manner, and its results are not presented in tables. With 9 cases and 10 items, the correlation matrix is not invertible, so the measure of sampling adequacy and the test of sphericity could not be

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computed. Parallel analysis suggested one factor, which explained 61.88 % of the variance in the software's solution, but with fewer cases than items, that solution has no basis. These results are recorded in the reproducibility appendix, but they provide no evidence about the dimensionality of the instrument.

With 9 cases, the Spearman correlation between the mean scores for Mazatlán Identity and Appreciation of Traditional Architecture was positive and high, $\rho = .723$, 95% CI [.016, .948], $p = .028$. The interval, calculated using the standard error of Bonett and Wright (2000), excluded zero by a very narrow margin, so the magnitude of the relationship is highly uncertain. Because the analysis involves only one pair of dimensions, the result is reported in the text rather than in a table.

DISCUSSION OF RESULTS

This study examined the preliminary psychometric properties of the place identity and traditional architecture appraisal scale in Mazatlán. Both dimensions showed high internal consistency, with alpha and omega values ranging from .871 to .887.

With 9 cases, however, these coefficients are highly unstable: the simulation literature on alpha and omega has used much larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated. The results should be read as an initial favorable signal that the final data collection will need to confirm.

In both dimensions, the reverse-worded item was the least consistent, and in both, its removal would raise alpha above .90. This pattern is consistent with a wording effect, documented in scales with items keyed in both directions (García-Batista et al., 2021; Steinmann et al., 2022), but it also allows for a content-based explanation.

The statement that Mazatlán is a place like any other is a comparative claim and does not amount to a lack of identity, just as preferring new buildings does not amount to rejecting traditional architecture: it may reflect considerations of maintenance, cost or comfort that are not part of the symbolic and climatic appraisal captured by the other items. The moderate correlation between R9 and the desire for new houses to retain old elements suggests that residents do not see the two as opposed.

The descriptive profile of traditional architecture is consistent with the literature. The appreciation of the coolness provided by high ceilings and porches, and its association with the view of old houses as part of the city's identity, are in line with evidence that traditional housing elements in tropical climates moderate heat gains (Arminda and Darmayanti, 2026) and with proposals to recover bioclimatic strategies in historic buildings in Mexico (Aguilar Osante et al., 2026).

That residents want new housing to retain these elements is relevant to a region whose social housing has been described as hot (Barraza-Bracamontes et al., 2022). These parallels are descriptive: the study did not measure the temperature or type of the dwellings.

The positive relationship between identification with the city and appreciation of its traditional architecture is consistent with the association between place attachment and local characteristics that express history and culture (Kamani Fard and Paydar, 2024), and with the link between experiencing historic buildings and attachment at heritage sites (Cai et al., 2025).

With 9 cases and an interval that nearly touches zero, the magnitude of this relationship cannot yet be established. Nor can we rule out that it reflects a generally favorable appraisal of the city, which would appear in both dimensions, or the selection of residents from the Historic Center and older neighborhoods, whose bond with traditional architecture may be stronger than that of the rest of the population.

In the context of the touristification of the Historic Center (Castillo Romero, 2023; Mendieta Vega and Roldán Clarà, 2024), residents' identity and their appreciation of heritage are conservation resources that should be measured with robust instruments.

CONCLUSIONS

The study achieved its objective to the extent allowed by a preliminary sample of 9 cases. In the Mazatlán pilot survey, the scale of place identity and appreciation of traditional architecture showed high internal consistency for Mazatlán Identity ($\alpha = .871$; $\omega = .884$) and for Appreciation of Traditional Architecture ($\alpha = .873$; $\omega = .887$); the reverse-scored items were the least coherent in each dimension.

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The exploratory factor analysis could not be estimated interpretably because the sample had fewer cases than items. The two dimensions were positively correlated, with a very wide interval. Residents recognized the identity-related and climatic value of traditional architecture and wanted new housing to retain its elements, although they tended to prefer new buildings.

The limitations are substantial. The sample of 9 cases, against a target of 100 (0.9 cases per item), precludes estimation of the internal structure and makes all statistics unstable; data collection was still ongoing, and of the 32 people who opened the questionnaire, only 9 completed it.

The neighborhoods were selected by the project lead, and no information is available on the respondents, their length of residence, or the type of housing they live in. The study did not measure the thermal conditions of the dwellings; its findings refer only to perception. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

Decisions for the authors follow from these results. The first is to review the wording of the reverse-scored items, R4 and R9, and to decide whether they should be retained, reworded or treated as indicators of distinct facets, such as housing preference. The second is to document the origin of the items and the content review.

The third is to record length of residence, place of birth and type of dwelling, because identity and the valuation of heritage may vary with these factors. The fourth is to extend the survey to neighborhoods other than the Historic Center so that the sample is not concentrated among residents living close to traditional architecture. None of these decisions was made in the present analysis, which retains the ten original items.

For future research, we propose completing the survey up to the planned target, repeating the exploratory factor analysis once the number of cases allows it, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample. Combining the scale with thermal measurements in old and new houses would make it possible to compare perceived coolness with measured coolness. An instrument with documented validity evidence could support conservation policies for the Historic Center of Mazatlán and guide the design of new housing toward climate adaptation solutions that residents recognize and value.

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Chapter 7 / Capítulo 7

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Productive habitability: The home-workshop of brickmakers and fishers in southern Sinaloa. A preliminary review of a scale

Habitabilidad productiva: vivienda-taller de ladrilleros y pescadores del sur de Sinaloa. Revisión preliminar de una escala

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ABSTRACT

In the households of brickmakers and fishers, the dwelling also works as a workshop, and the overlap of domestic and productive space exposes the family to working conditions. This instrumental, cross-sectional and exploratory study carried out a preliminary review of a fifteen-item scale of productive habitability in the home-workshop, with three dimensions, compatibility of housing and work, safe working conditions and satisfaction with living and working at home, administered in the pilot survey of project FZ-HAB-0017 of the Factoriza UAS platform in brickmaking and fishing communities of southern Sinaloa, Mexico. A preliminary cut of 9 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha and Pearson inter-item correlations; omega, exploratory factor analysis and correlations between dimensions could not be estimated because the correlation matrix is singular. Satisfaction (α = .602) and safe conditions (α = .590) showed moderate internal consistency and compatibility a low one (α = .200); in each dimension, the reverse-worded item was the only one with a negative item-total correlation. Feeling safe while working obtained the highest mean (M = 4.44), and the risk to children and the wish to separate the workshop were frequently endorsed. Five of the nine cases gave the same answer to every item, which calls for reviewing the administration procedure and quality control before the final data cut.

Keywords: home-based work; brickmakers; small-scale fishers; productive habitability; response quality

RESUMEN

En los hogares de ladrilleros y pescadores, la vivienda funciona también como taller, y la superposición del espacio doméstico y productivo expone a la familia a las condiciones del trabajo. Este estudio instrumental, transversal y exploratorio realizó una revisión preliminar de la Escala de habitabilidad productiva en la vivienda-taller, con quince reactivos en tres dimensiones, Compatibilidad de vivienda y trabajo, Condiciones seguras para trabajar y Satisfacción con vivir y trabajar en casa, aplicada en el levantamiento piloto del proyecto FZ-HAB-0017 de Factoriza UAS en comunidades de ladrilleros y pescadores del sur de Sinaloa. Se analizó un corte preliminar de 9 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach y correlaciones de Pearson entre reactivos; el omega, el análisis factorial exploratorio y las correlaciones entre dimensiones no fueron estimables porque la matriz de correlaciones es singular. Satisfacción (α = .602) y Condiciones (α = .590) mostraron una consistencia moderada y Compatibilidad, una baja (α = .200); en cada dimensión, el reactivo inverso fue el único con correlación ítem-total negativa. La sensación de seguridad al trabajar obtuvo la media más alta (M = 4.44), y el riesgo para los niños y el deseo de separar el taller fueron señalados con frecuencia. Cinco de los nueve casos dieron la misma respuesta a todos los reactivos, lo que exige revisar el procedimiento de aplicación y el control de calidad antes del corte final.

Palabras clave: trabajo en la vivienda; ladrilleros; pescadores; habitabilidad productiva; calidad de las respuestas

INTRODUCTION

In many communities in northwestern Mexico, the home is also the workplace. In brickmakers' households, the kiln, the drying yard and the materials share the plot with the rest areas; in fishers' households, the home is used to store equipment, repair fishing gear and prepare the catch.

This overlap between domestic and productive space is a condition of habitability that housing studies address less often than the physical conditions of the dwelling.

The literature on working from home, which has developed mainly since the COVID-19 pandemic, has shown that the suitability of the space for work depends on the available floor area, the existence of a dedicated space, and indoor environmental quality (Cuerdo-Vilches et al., 2021). However, this literature has focused on office work rather than on the manual trades carried out in the home.

Artisanal brickmaking in Mexico is an informal activity that is usually organized around family labor, with kilns located close to homes (Saldaña-Villanueva et al., 2026).

There is abundant evidence on its health consequences. A systematic review and meta-analysis of 104 studies found that, compared with unexposed individuals, those working at brick kilns consistently had poorer lung function, more respiratory symptoms and more musculoskeletal complaints, although the studies were of low quality (Nicolaou et al., 2024).

In Mexico, exposure to arsenic, lead and polycyclic aromatic hydrocarbons has been documented among brick kiln workers in San Luis Potosí, Guanajuato and Querétaro (Pérez-Vázquez et al., 2025), as have ocular and neurotoxic symptoms among people who work or live in the brick-making area of El Refugio, in León, Guanajuato (Pedroza Carrillo et al., 2025).

Small-scale fishing poses its own risks. In a survey of 50 artisanal fishers in Bangladesh, 68% reported musculoskeletal discomfort in the previous five years (Zakaria et al., 2022). In a cross-sectional study of 650 people from 132 fishing families in the Indian Sundarbans, musculoskeletal disorders accounted for 20% of recorded morbidity (Roy et al., 2024).

In both occupations, the home is not only the place where people rest from hazardous work but may also form part of the workplace, with consequences for those who live there and do not take part in that work, particularly children.

The literature reviewed for this study did not reveal any brief Spanish-language instruments for assessing, from the perspective of their occupants, the habitability of dwellings that also function as workshops.

Project FZ-HAB-0017 of the Factoriza UAS platform designed the Productive Habitability in the Home-Workshop Scale, which comprises fifteen items organized into three dimensions (Compatibility of Housing and Work, Safe Working Conditions, and Satisfaction with Living and Working at Home). The project also began a pilot survey in brick-making and fishing communities in southern Sinaloa.

This article presents the results of the first preliminary data cut of that survey. The general objective is to conduct a preliminary review of how the scale performs. The specific objectives are to describe the responses to the items, estimate the internal consistency of each dimension, examine the relationships among the items within each dimension, review response quality, and identify the adjustments that the instrument and the administration procedure require before the final data cut.

DEVELOPMENT

THE HOME-WORKSHOP AS A WAY OF DWELLING

Habitability refers to the suitability of a dwelling's spaces for the activities that take place in it. When a dwelling also houses a productive activity, the demands of work are added to those of rest, cohabitation and care: space to carry it out without encroaching on family areas, places to store tools and materials, and conditions that allow work to be done without endangering those who do not take part in it.

Research on working from home has noted that the lack of a dedicated space and the small floor area of the dwelling limit the perceived adequacy of the workspace (Cuerdo-Vilches et al., 2021). In the home-workshop, these limitations coexist with work that produces dust, smoke, waste and hazardous objects, none of which stay in the area where the work is done.

The family-based organization of work is both an advantage and a risk. It allows productive

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activity to be combined with caring for children and other household members, and it avoids commuting; however, it also brings the whole family closer to working conditions. The review by Saldaña-Villanueva et al. (2026) of artisanal brick kilns in Mexico highlights the informality of the activity, the proximity of the kilns to homes, and family participation in the work as features that shape community exposure.

In a brick-making community in Baja California, a mixed-methods study involving all of the community's adult women documented social and structural barriers to accessing sexual and reproductive health services (Bejarano Zambrano et al., 2026). This finding illustrates that the vulnerability of these communities is not limited to environmental exposure.

SAFETY CONDITIONS AND EXPOSURE IN THE HOME-BASED PRODUCTION SETTING

Workspace safety conditions include ventilation, lighting, floor stability, and protection against accidents. In brick kilns, exposure to pollutants has been associated with clinical abnormalities in various organs.

In a study of 110 people across three precarious work settings in Mexico, brick kiln workers showed the highest frequency of clinical abnormalities, and length of employment in this type of work was negatively associated with pulmonary function parameters (Saldaña-Villanueva et al., 2023).

A systematic review with meta-analysis of thirteen studies in South Asia found that musculoskeletal disorders among brick kiln workers were concentrated in the lower back, shoulders, wrists and knees, and that posture, repetition and work duration were among the associated factors (Paira and Das, 2025).

Exposure extends to children in the household. In three communities in San Luis Potosí engaged in informal recycling, artisanal brickmaking and quarry stone carving, a study of 50 girls and boys found distinct urinary metal profiles depending on each community's activity, with higher arsenic concentrations in the brickmaking area, as well as exploratory associations between these metals and hematological parameters (Méndez-Rodríguez et al., 2025).

Studies on other forms of informal home-based production point in the same direction. In Brazilian households engaged in soldering costume jewelry, dust accumulated in the home contained potentially toxic elements whose levels correlated with concentrations in children's blood (Barrozo et al., 2022), and the women who performed this work showed changes in gene expression associated with arsenic exposure and with self-reported symptoms (Salles et al., 2025).

These findings give substance to two items on the project scale: the dust that the work leaves inside the home and the risk of accidents for children in the workspace.

SATISFACTION, LIVELIHOOD AND ROOTEDNESS

People's appraisal of their home-workshop does not depend solely on its material conditions. The home is the means by which the family earns its living, and losing it, or separating it from work, may mean losing that livelihood.

For this reason, satisfaction with the dwelling as a workplace, pride in it, and valuing it as a place for the family may coexist with the desire to separate the workshop from the dwelling, an aspiration that reflects awareness of the drawbacks of their overlap. A satisfaction dimension that combines these elements may not behave as a homogeneous set, and this possibility should be borne in mind when interpreting its coefficients.

RESPONSE QUALITY AND VALIDITY EVIDENCE IN THE EARLY STAGE OF A SCALE

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared how the two coefficients perform under different data conditions (Malkewitz et al., 2023).

Internal structure is explored with exploratory factor analysis, which requires checking data adequacy and a sufficient sample size (Ferrando et al., 2022; Goretzko et al., 2021). Neither coefficient is interpretable if the responses do not reflect the content of the items.

Scales that combine positively and negatively worded items make it possible to detect one type of problematic responding. Some respondents answer the positive and negative items of

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the same dimension inconsistently, for example, because they give the same answer to all items without attending to their wording. This inconsistency can produce factors associated with item wording direction and distort internal consistency estimates (Steinmann et al., 2022).

Factor mixture models make it possible to identify these individuals and to estimate the instrument's structure without their influence (García-Batista et al., 2021). The project's scale includes one reverse-worded item in each dimension, so this problem can be examined from the first wave of data collection.

METHODOLOGY

DESIGN

An instrumental, quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data come from survey LEV-0022, "Piloto sur de Sinaloa · Vivienda-taller" (Southern Sinaloa Pilot · Home Workshop), of project FZ-HAB-0017 on the Factoriza UAS platform, and from the frozen dataset DST-0022, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only one in the project.

POPULATION, SAMPLE, AND DATA CUTOFF

The population was defined as people aged 18 years or older from brickmaker and fisher households in southern Sinaloa who work at home. Data were collected in brickmaker and fisher communities selected by the project lead. According to the Factoriza log, 24 people opened the questionnaire and 9 completed it; no cases were excluded for quality control, so 9 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 9 cases out of a target of 100, and data collection was still open and in the field at the cut-off date. With 9 cases for 15 items, the ratio is 0.6 cases per item. The dataset does not indicate whether each person belongs to a brickmaking or a fishing household, so the two groups cannot be distinguished in the analysis.].

INSTRUMENT

The instrument administered was the Productive Habitability in the Dwelling-Workshop Scale, the name under which it appears in the Factoriza item dictionary. It consists of fifteen items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into three dimensions of five items each. Compatibility of housing and work (R1 to R5) assesses the availability of space to work without disturbing the family, the dust that work leaves inside the dwelling, the possibility of storing tools in a place separate from the bedrooms, the family's rest during work, and the possibility of attending to the family while working.

Safe working conditions (R6 to R10) assesses workplace ventilation, the risk of accidents for children, lighting, the sense of safety while working, and the firmness of the floor. Satisfaction with living and working at home (R11 to R15) assesses satisfaction with the dwelling as a workplace, its role in the household's livelihood, the desire to separate the workshop from the dwelling, pride in the home-workshop, and its value as a place for the family.

Three items are reverse-worded (R2, R7 and R13) and have been recoded in the data matrix, so that a higher score indicates greater compatibility, safer conditions and greater satisfaction. In the recoded version, a low mean on these items indicates that dust, risk to children and the desire to separate the workshop from the home were frequently reported. Table 1 presents the code, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Item	Reverse
R1	In my home there is space to work without disturbing my family	No
R2	The work I do at home leaves dust inside the dwelling	Yes
R3	I can store my tools in a place separate from the bedrooms	No
R4	My family can rest while I work from home	No

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Code	Item	Reverse
R5	Working from home allows me to take care of my family	No
R6	The place where I work in my home is well ventilated	No
R7	In my workspace there is a risk of accidents for children	Yes
R8	The space where I work has enough light to see clearly	No
R9	I feel safe working in my home	No
R10	The floor of my work area is firm	No
R11	I am satisfied with my home as a workplace	No
R12	My home allows me to earn a living	No
R13	I would like to separate my workshop from my home	Yes
R14	I feel proud of my home-workshop	No
R15	My home-workshop is a good place for my family	No

Note. R1 to R5 = Compatibility of housing and work; R6 to R10 = Safe working conditions; R11 to R15 = Satisfaction with living and working at home. The dimension column is omitted to preserve table readability. 5-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0017, survey LEV-0022, dataset DST-0022.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze the DST-0022 dataset with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00114 to RUN-00120). The supplementary analysis program was run using the data file and the item dictionary exported by the platform.

DATA HANDLING

All 9 cases analyzed responded to all fifteen items, so there were no missing values and no responses needed to be imputed. The reverse-scored items were analyzed in the recoded version provided by the platform, and none was reversed again. The values in the tables were copied exactly as produced by Factoriza UAS, without being recalculated or re-rounded; where tables from the package were combined into a single table or a column was omitted, the table note states this.

Inspection of the data matrix revealed response patterns that compromise the interpretation of the coefficients. Cases 3, 4, 7, and 9 have identical responses across all fifteen items: 4 on the positively worded items and 2 on the recoded reverse-worded items. Case 1 scores 5 on the positively worded items and 1 on the recoded reverse-worded items, and case 2 repeats the value 4 on most items.

On the original response scale, these patterns correspond to giving the same answer to all items, including the reverse-worded ones. The columns for R1, R6, and R14 are also identical, as are those for R4 and R15 and those for R8 and R12, although in some cases they belong to different dimensions. No case or item was removed in this analysis; the decision to apply an exclusion criterion for uniform responding is left to the authors.

DATA ANALYSIS

Factoriza UAS computed the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted; and Pearson correlations between the items of each dimension, with 95% confidence intervals obtained through Fisher's z transformation.

In addition, the project's supplementary analysis program, analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy (Harris et al., 2020), SciPy (Virtanen et al., 2020), and pandas. This program estimates McDonald's omega total

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(McDonald, 1999/2013) and examines internal structure through exploratory factor analysis. The factor analysis includes the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), Bartlett's (1950) test of sphericity, and parallel analysis to determine the number of factors (Horn, 1965). The program also computes Spearman correlations between dimension scores.

The program stopped while computing the sampling adequacy index, before producing any results, because the correlation matrix of the fifteen items is singular: with 9 cases for 15 items it cannot be inverted, and the identical columns described in the previous section add exact linear dependencies among the items.

Consequently, no omega coefficient, exploratory factor analysis or correlations between dimensions are available. The program was not modified, and the execution log is provided in the reproducibility appendix. Given the size of the cohort, the Factoriza coefficients are reported to document how the instrument functions, not as estimates of its properties. The reference values of the psychometric indices are treated as guidelines, not as decision rules (Ferrando et al., 2022). No items were removed, and no confirmatory factor analysis was performed.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records express informed consent online and does not collect names, email addresses, or any other identifying data. Because the scale asks about risk to children in the workplace, the information gathered may inform protective actions in the participating communities.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive, internal consistency, and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, whose execution stopped because the correlation matrix was singular; and the Claude Opus language model (Anthropic), for running that program, for assisted literature searching, for drafting, and for assembling the document from the results. The authors reviewed, corrected, and approved the entire text, verified every reference, and take full responsibility for the content of the article.

RESULTS
SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 24 people who opened the questionnaire, 9 completed it and were analyzed, with no exclusions for quality control. The 9 analyzed cases answered all fifteen items. The proportion of people who abandoned the questionnaire before completing it was high, and the Factoriza log does not indicate at which item they dropped out.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	24
Completed questionnaires	9
Cases excluded by quality control	0
Cases analyzed	9
Items	15

Note. Survey "Southern Sinaloa Pilot · Home Workshop" (LEV-0022); population: persons aged 18 years or older from brickmaker and fisher households in southern Sinaloa who work in their homes; territory: southern Sinaloa, in brickmaker and fisher communities selected by the project lead. Dataset DST-0022, fingerprint e5c76ac62c9575a5. Source: Factoriza UAS. Preliminary cut-off: n = 9 of a target of 100, with the survey still open.

COMPATIBILITY, SAFETY CONDITIONS, AND SATISFACTION

Table 3 and Figure 1 present the descriptive statistics. Means for the twelve direct items

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ranged from 3.89 to 4.44 (standard deviations between 0.33 and 0.93), whereas the recoded means of the three reverse-worded items ranged from 1.78 to 2.67. In Home–Work Compatibility, the possibility of storing tools in a place separate from the bedrooms (R3: *M* = 4.00, *SD* = 0.87) and the family's rest while work is being done (R4: *M* = 4.00, *SD* = 0.50) had the highest means, followed by space to work without disturbing the family (R1: *M* = 3.89, *SD* = 0.78) and the possibility of attending to the family (R5: *M* = 3.89, *SD* = 0.93). Dust left inside the dwelling by the work (a reverse-worded item, recoded) had the lowest mean in the dimension and the greatest dispersion in the instrument (R2: *M* = 2.67, *SD* = 1.32).

In Safe Conditions for Working, the feeling of safety when working in the home had the highest mean in the instrument (R9: *M* = 4.44, *SD* = 0.53), followed by light for seeing clearly (R8: *M* = 4.11, *SD* = 0.33), floor firmness (R10: *M* = 4.00, *SD* = 0.87) and ventilation (R6: *M* = 3.89, *SD* = 0.78). The risk of accidents for children, in the recoded version of the reverse-scored item, had a mean of 1.89 (R7: *SD* = 0.60); that is, most respondents agreed that their workspace entails this risk. Respondents felt safe working in their homes and, at the same time, acknowledged the risk that this same space poses to children.

In the Satisfaction with Living and Working at Home dimension, the possibility of earning a living at home had the highest mean (R12: *M* = 4.11, *SD* = 0.33), followed by satisfaction with the home as a workplace (R11: *M* = 4.00, *SD* = 0.87), its rating as a good place for the family (R15: *M* = 4.00, *SD* = 0.50), and pride in the home-workshop (R14: *M* = 3.89, *SD* = 0.78). The desire to separate the workshop from the home, in the recoded version of the reverse-scored item, had the lowest mean on the instrument (R13: *M* = 1.78, *SD* = 0.44).

Overall, the responses describe a favorable appraisal of the home-workshop as a livelihood and as a place for the family, alongside an acknowledgment of the dust, the risk to children, and the desire to separate the workshop. This pattern should be read in light of the review of response quality presented later, because the three reverse-worded items drew agreement from the same respondents who agreed with all of the direct items.

The distributions were highly concentrated. Light (R8) and livelihood (R12) had the lowest standard deviations in the instrument, 0.33, with eight of the nine responses at the same value. The skewness and kurtosis of these items, 3.00 and 9.00, reflect a single response departing from the rest. With nine cases, these shape indices are highly sensitive to an isolated response and are reported for descriptive purposes only.

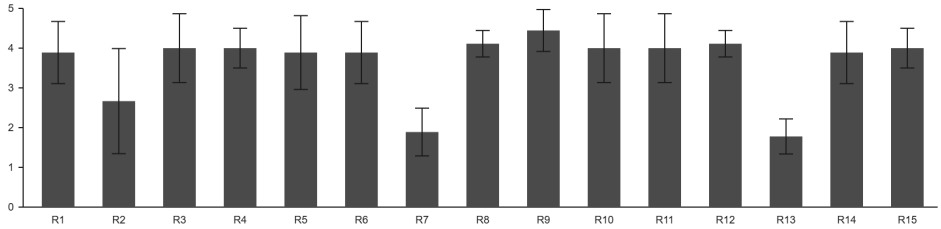
Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.89	0.78	-1.80	5.65	11%	11%
R2	2.67	1.32	0.79	-0.66	11%	11%
R3	4.00	0.87	-1.48	4.00	11%	22%
R4	4.00	0.50	0.00	4.00	11%	11%
R5	3.89	0.93	-0.94	1.35	11%	22%
R6	3.89	0.78	-1.80	5.65	11%	11%
R7	1.89	0.60	-0.02	1.13	22%	11%
R8	4.11	0.33	3.00	9.00	89%	11%
R9	4.44	0.53	0.27	-2.57	56%	44%
R10	4.00	0.87	-1.48	4.00	11%	22%
R11	4.00	0.87	-1.48	4.00	11%	22%
R12	4.11	0.33	3.00	9.00	89%	11%
R13	1.78	0.44	-1.62	0.73	22%	78%
R14	3.89	0.78	-1.80	5.65	11%	11%
R15	4.00	0.50	0.00	4.00	11%	11%

Note.N = 9. R1 to R5 = Compatibility of housing and work; R6 to R10 = Safe working conditions; R11 to R15 = Satisfaction with living and working at home. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. Reverse-scored items R2, R7, and R13 are shown recoded. The item-total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not computed on the total of each dimension. Factoriza UAS run RUN-00114. Preliminary cut-off: n = 9 of a target of 100, with data collection still open.

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Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 presents the item analysis by dimension calculated with Factoriza. Satisfaction with living and working at home had the highest alpha (α = .602), supported by the rating of the dwelling as a good place for the family (R15: .844) and satisfaction with the dwelling as a workplace (R11: .721), followed by livelihood (R12: .505). Pride showed a weak relationship (R14: .187), and the desire to separate the workshop was negatively related to the remaining items (R13: -.146), so removing it would raise alpha to .721.

Safe working conditions yielded an alpha of .590. Floor firmness (R10: .825) and ventilation (R6: .773) were the most consistent items, followed by the sense of safety (R9: .483) and lighting (R8: .359). The risk of accidents for children, by contrast, was negatively related to the remaining items (R7: -.348), and its removal would raise alpha to .818. Housing–work compatibility had the lowest alpha (α = .200).

Caring for the family (R5: .674), space for working (R1: .629), and a place for tools (R3: .520) were positively related to the remaining items; family rest was unrelated (R4: .000); and dust was negatively related (R2: -.499), so removing it would raise alpha to .841. In all three dimensions, the reverse-scored item was the only one with a negative item-total correlation and the one that most reduced internal consistency.

Table 4. Item analysis by dimension.

Item	Corrected item-total r	α if item deleted
R1	.629	-.400
R2	-.499	.841
R3	.520	-.333
R4	.000	.225
R5	.674	-.634
R6	.773	.208
R7	-.348	.818
R8	.359	.559
R9	.483	.479
R10	.825	.123
R11	.721	.256
R12	.505	.531
R13	-.146	.721
R14	.187	.667
R15	.844	.321

Note.N = 9. Scale from 1 to 5; reverse-scored items R2, R7, and R13 are shown recoded. Factoriza UAS run RUN-00114. Preliminary cutoff: n = 9 out of a target of 100, with data collection still open.

CORRELATIONS BETWEEN ITEMS

Table 5 shows all correlations among the items within each dimension. In Compatibility, space to work was related to the place for tools (R1 and R3: r = .923, 95% CI [.670, .984], p < .001) and to the possibility of caring for the family (R1 and R5: r = .842, 95% CI [.405, .966], p = .004). The

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recoded dust item (R2) had negative coefficients with the other four items, ranging from -.567 (R2 and R4) to -.327 (R2 and R3), all with intervals that included zero. The place for tools was not related to family rest (R3 and R4: *r* = .000).

In Conditions, ventilation was related to floor firmness (R6 and R10: *r* = .923, 95% CI [.670, .984], *p* < .001), and no other correlation had an interval that excluded zero; the highest was between the sense of safety and floor firmness (R9 and R10: *r* = .548, 95% CI [-.183, .889], *p* = .127). The recoded item on risk to children (R7) had negative coefficients with the other four items, ranging from -.555 (R7 and R8) to -.219 (R7 and R9), all with intervals that included zero.

In the Satisfaction dimension, satisfaction with the dwelling as a workplace was related to its rating as a good place for the family (R11 and R15: *r* = .866, 95% CI [.475, .971], *p* = .003), and livelihood was also related to that rating (R12 and R15: *r* = .750, 95% CI [.171, .944], *p* = .020). The item on the desire to separate the workshop (R13), recoded so that a high value indicates a lower desire to separate it, had negative coefficients with livelihood (R12 and R13: *r* = -.661, 95% CI [-.921, .005], *p* = .052) and with pride (R13 and R14: *r* = -.443), a positive one with satisfaction (R11 and R13: *r* = .327), and a null one with the rating of the dwelling as a place for the family (R13 and R15: *r* = .000); the intervals for these coefficients included zero.

Table 5. Correlations between items within each dimension.

Dimension	Variable pair	r	IC 95%	p
Compatibility	R1 and R2	-.524	[-.881, .215]	.148
Compatibility	R1 and R3	.923	[.670, .984]	< .001
Compatibility	R1 and R4	.320	[-.437, .812]	.402
Compatibility	R1 and R5	.842	[.405, .966]	.004
Compatibility	R2 and R3	-.327	[-.814, .430]	.390
Compatibility	R2 and R4	-.567	[-.894, .156]	.111
Compatibility	R2 and R5	-.339	[-.819, .419]	.372
Compatibility	R3 and R4	.000	[-.664, .664]	1.000
Compatibility	R3 and R5	.622	[-.071, .910]	.074
Compatibility	R4 and R5	.539	[-.195, .886]	.134
Conditions	R6 and R7	-.296	[-.802, .458]	.440
Conditions	R6 and R8	.533	[-.203, .884]	.140
Conditions	R6 and R9	.438	[-.319, .854]	.238
Conditions	R6 and R10	.923	[.670, .984]	< .001
Conditions	R7 and R8	-.555	[-.891, .173]	.121
Conditions	R7 and R9	-.219	[-.771, .521]	.571
Conditions	R7 and R10	-.240	[-.780, .504]	.534
Conditions	R8 and R9	.395	[-.365, .839]	.292
Conditions	R8 and R10	.433	[-.324, .852]	.244
Conditions	R9 and R10	.548	[-.183, .889]	.127
Satisfaction	R11 and R12	.433	[-.324, .852]	.244
Satisfaction	R11 and R13	.327	[-.430, .814]	.390
Satisfaction	R11 and R14	.185	[-.546, .756]	.634
Satisfaction	R11 and R15	.866	[.475, .971]	.003
Satisfaction	R12 and R13	-.661	[-.921, .005]	.052
Satisfaction	R12 and R14	.533	[-.203, .884]	.140
Satisfaction	R12 and R15	.750	[.171, .944]	.020
Satisfaction	R13 and R14	-.443	[-.856, .313]	.232
Satisfaction	R13 and R15	.000	[-.664, .664]	1.000
Satisfaction	R14 and R15	.320	[-.437, .812]	.402

Note.N = 9. R1 to R5 = Compatibility of housing and work; R6 to R10 = Safe working conditions; R11 to R15 = Satisfaction with living and working at home. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Compatibility = .200 (run RUN-00115); Conditions = .590 (RUN-00117); Satisfaction = .602 (RUN-00119). Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary cut-off: n = 9 out of a target of 100, with data collection still open.

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The correlations of .923 should be interpreted in light of the caveat in the note to Table 5. Because the columns for R1 and R6 are identical, the correlations of R1 with R3 and of R6 with R10 derive from the same responses on the first item of each pair, so their agreement is not an independent finding. Moreover, with nine cases, the confidence intervals are very wide: most of the correlations in the table have intervals ranging from moderately negative to high positive values.

INTERNAL STRUCTURE AND RELATIONSHIP BETWEEN DIMENSIONS

The exploratory factor analysis, McDonald's omega and the correlations between the scores on the three dimensions could not be estimated. With 9 cases for 15 items, and with three groups of items that had identical responses, the correlation matrix was singular, and the supplementary analysis program stopped when computing the measure of sampling adequacy. Consequently, the study provides no evidence on the dimensionality of the instrument or on the relationship between compatibility, safety and satisfaction.

RESPONSE QUALITY

The review of the data matrix, described in the data processing section, makes it possible to interpret the pattern common to all three dimensions. Five of the nine cases gave the same response to all items on the original scale, and a sixth did so for most of them. When a person answers "Agree" to all items, their recoded response is low on the reverse-worded items and high on the directly worded ones.

With five or six of the nine cases in that situation, the reverse-worded items correlate negatively with the rest of their dimension because of the response style, not necessarily because of their content. The low means of R2, R7 and R13 in their recoded version largely reflect the same generalized agreement. This pattern is consistent with the uniform responding or acquiescence described in the literature on mixed-worded scales (García-Batista et al., 2021; Steinmann et al., 2022).

DISCUSSION OF RESULTS

This study aimed to conduct a preliminary review of how a productive habitability scale performs in the workshop-dwellings of brickmakers and fishers in southern Sinaloa. With 9 cases, the coefficients cannot be interpreted as estimates of the instrument's properties: the simulation literature on alpha and omega has been developed with much larger samples (Malkewitz et al., 2023), and factor analysis requires a sample size that this data cut does not reach (Ferrando et al., 2022; Goretzko et al., 2021). The data cut does, however, allow us to identify three problems that should be resolved before data collection continues and to formulate some content hypotheses for the final cut.

The first and most important problem is the quality of the responses. Most respondents answered uniformly, without distinguishing the reverse-worded items, and the platform's quality control did not exclude them. The literature shows that individuals who respond inconsistently to mixed-worded items can produce factors associated with item wording direction and alter the internal consistency of the dimensions (Steinmann et al., 2022), and that identifying them allows the instrument's structure to be estimated more precisely (García-Batista et al., 2021).

In this subsample, the three reverse-worded items were the only ones with negative item-total correlations and the ones that most reduced the alpha of their dimension. This is consistent with what would be expected if the manner of responding, rather than the content, organizes the responses. The mode of administration may be relevant: if the questionnaire was read aloud to the respondents, uniform responding may reflect fatigue, politeness toward the interviewer, or difficulty processing negative sentences aloud. The procedural record would allow these possibilities to be examined.

The second problem is the identical columns. The fact that ventilation, workspace, and pride in the home-workshop received exactly the same responses in all nine cases may be partly explained by the overall uniformity of responses, since five cases gave the same answer to every item. It also means, however, that an error in questionnaire configuration or data entry must be ruled out. Until this point is verified, the highest correlations in the wave, which involve these

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items, cannot be interpreted as substantive relationships.

The singularity of the correlation matrix, which prevented the factor analysis from being conducted, has the same root cause.

The third problem concerns design. The scale was administered in households engaged in two very different trades, brickmaking and fishing, but the dataset does not record which trade each person belongs to. Conditions in homes where bricks are fired, with kilns, combustion and clay dust, are not equivalent to those in homes where fishing equipment is stored and repaired, and the literature documents different risk profiles for each trade (Nicolaou et al., 2024; Roy et al., 2024; Zakaria et al., 2022).

Without a record of the occupation, it is not possible to examine whether the items function in the same way in both groups.

With these caveats, the results suggest content hypotheses that the final wave can examine. Dust inside the dwelling was the item with the greatest dispersion in the instrument and the one that deviated most from the compatibility dimension. The literature on informal home-based production has documented that accumulated household dust is a route through which children are exposed to toxic elements (Barrozo et al., 2022), and in Mexican brick-making communities, metal exposures have been measured in both adults and children (Méndez-Rodríguez et al., 2025; Pérez-Vázquez et al., 2025).

Dust is therefore more an environmental condition of the dwelling than an indicator of compatibility, and on the scale it could be placed alongside the safety conditions.

Recognition of risk to children, if confirmed once the problem of response quality has been resolved, is the most relevant content finding of this round. The coexistence of a strong sense of safety at work with recognition of risk to children suggests that respondents distinguish between their own safety and that of people who live alongside the work without taking part in it. This distinction is consistent with the evidence on child exposure in precarious work communities (Méndez-Rodríguez et al., 2025) and with the proximity of kilns to homes and family involvement in brickmaking (Saldaña-Villanueva et al., 2026).

If the final data cut confirms that risk to children does not cluster with ventilation, lighting, flooring and personal safety, it could be treated as a distinct dimension focused on protecting children and other household members.

In the satisfaction dimension, appraisals of the dwelling as a workplace, as a means of livelihood and as a place for the family varied together. The recoded item on the desire to separate the workshop had negative coefficients with livelihood and with pride, indicating that agreement with separating the workshop tended to accompany higher appraisals of livelihood and pride, although the intervals for these coefficients included zero.

This pattern, which should be interpreted with caution, is consistent with the ambivalence described in the development section: those who earn their livelihood at home may feel proud of their home and, at the same time, wish to separate the workshop from the family spaces. The literature on brickmaking communities describes an activity carried out under conditions of informality and poverty, with family labor and kilns close to homes (Saldaña-Villanueva et al., 2026); the social vulnerability of these communities, moreover, is not limited to environmental exposure (Bejarano Zambrano et al., 2026).

The desire to separate the workshop could therefore be interpreted as an aspiration linked to available resources rather than as dissatisfaction, and its place in the satisfaction dimension warrants review.

IMPLICATIONS FOR REVISING THE INSTRUMENT AND THE PROCEDURE

The results suggest several adjustments. For the procedure, it would be advisable to add to the platform's quality control a criterion for identifying straightlining (uniform responding), to record the mode of administration, and, if the questionnaire is read aloud, to train those administering it to present the response options neutrally.

In the instrument, reverse-worded items could be rewritten as direct items when their content allows, or balanced with a sufficient number of items worded in each direction within every dimension, so that the variance associated with wording can be modeled in the final version. The items on dust and on risk to children could be grouped with other items on smoke, waste and tool storage to form a dimension of household exposure to work.

The wording of some items also deserves attention. Three items are worded in the masculine form ("me siento seguro" [I feel safe], "estoy satisfecho" [I am satisfied] and "me siento

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orgulloso" [I feel proud]); these should be replaced with gender-neutral wording, all the more so in communities where women take part in family work. It would also be advisable to record the household's trade, the activity each person carries out in the dwelling, the presence of girls and boys, and the location of the workspace relative to the bedrooms. These proposals do not derive from the coefficients of the data cut, which lack the precision needed to justify changes to specific items, but from a joint reading of the scale's content, the literature reviewed and the patterns that the data cut reveals.

CONCLUSIONS

The study met its objective to the extent allowed by a preliminary sample of 9 cases: it does not provide estimates of the psychometric properties of the scale, but it identifies the adjustments required by the instrument and the administration procedure. Satisfaction with living and working at home (α = .602) and Safe working conditions (α = .590) showed moderate internal consistency, and Compatibility of housing and work showed low consistency (α = .200); in all three dimensions, the reverse-scored item was the only one with a negative item-total correlation.

Respondents rated the home-workshop favorably as a means of livelihood and as a place for the family, felt safe working in it, and acknowledged the dust, the risk to children, and the desire to separate the workshop, although this last pattern cannot yet be disentangled from the uniform way most of them responded.

The main finding of this data cut is methodological: five of the nine cases gave the same response to all items, and three pairs or groups of items received identical responses. These patterns account for the singularity of the correlation matrix, which prevented estimation of omega, the exploratory factor analysis, and the inter-dimension correlations. They also require a review of the administration procedure and quality control before data collection continues. The dataset has been frozen with a cryptographic hash, and the program execution log is compiled in a reproducibility appendix, so the review can be carried out on the same data.

The limitations are substantial. The sample of 9 cases, against a target of 100 and with data collection still ongoing, is insufficient to estimate internal consistency precisely and does not allow factor analysis. The respondents belong to communities selected by the project leader, so the results do not generalize to the households of brickmakers and fishers in southern Sinaloa, and the dataset does not distinguish between the two occupations. The quality of the responses has not been verified. The cross-sectional design means that the direction of the relationships cannot be established, and no confirmatory factor analysis was performed.

These results point to several decisions for the authors. The first is to verify the recoding criterion, the cases with uniform responses and the identical columns in Factoriza, and to decide whether to apply an exclusion criterion for uniform responses. The second is to review where dust, the risk to children and the desire to separate the workshop are placed within the dimensions of the scale.

The third is to add the household's trade and the presence of girls and boys to the questionnaire, and to replace the masculine-gendered wording. None of these decisions was made in the present analysis, which retains the fifteen items and the nine cases.

For future work, we propose completing data collection up to the planned target, with a sufficient number of households from each trade; repeating the internal consistency analysis and running the exploratory factor analysis on the final dataset, with and without the uniform-response cases; confirming the structure in an independent sample through confirmatory factor analysis; and complementing the ratings with observations of conditions in the home-workshop. A scale with sufficient validity evidence would make it possible to document, from the perspective of its inhabitants, the conditions of the dwelling that functions as a workshop, and to guide actions to protect children in the brick-making and fishing communities of the region.

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Chapter 8 / Capítulo 8

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Educational habitability scale for the classroom: Preliminary psychometric properties among primary school teachers in southern Sinaloa

Escala de habitabilidad educativa del aula: propiedades psicométricas preliminares en docentes de primaria del sur de Sinaloa

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ABSTRACT

The physical conditions of the classroom are part of the conditions for teaching and learning, yet in primary schools of northwestern Mexico they are rarely measured from the teachers' perspective with instruments supported by validity evidence. Using the preliminary data cut from the pilot survey of project FZ-HAB-0018 on the Factoriza UAS platform, this study described the preliminary psychometric properties of a twelve-item educational habitability scale for the classroom, with two dimensions, Environmental comfort of the classroom and Conditions for learning in the classroom, answered by primary school teachers in southern Sinaloa, Mexico. With a cross-sectional design, 11 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and the Spearman correlation between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was moderate for Environmental comfort ($\alpha = .601$; $\omega = .652$) and for Conditions for learning ($\alpha = .671$), where the item on teaching materials did not covary with the rest. The factor analysis was not interpretable because the sample had fewer cases than items. The dimensions were positively associated ($\rho = .768$, 95% CI [.223, .947]). Outdoor noise received the lowest rating. The findings do not yet provide structural validity evidence and point to revisions of the instrument.

Keywords: classroom habitability; indoor environmental quality; primary school teachers; psychometric evidence

RESUMEN

Las condiciones físicas del aula forman parte de las condiciones de enseñanza y aprendizaje, pero en las escuelas primarias del noroeste de México rara vez se miden desde la percepción docente con instrumentos con evidencias de validez. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0018 de Factoriza UAS, las propiedades psicométricas preliminares de una escala de habitabilidad educativa del aula de doce reactivos, con dos dimensiones: Confort ambiental del aula y Condiciones para aprender en el aula, respondida por docentes de primaria del sur de Sinaloa. Con diseño transversal, se analizaron 11 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y la correlación de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue moderada en Confort ambiental ($\alpha = .601$; $\omega = .652$) y en Condiciones para aprender ($\alpha = .671$), donde el reactivo sobre los materiales didácticos no covarió con el resto. El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos. Las dimensiones se asociaron de forma positiva ($\rho = .768$, IC 95 % [.223, .947]). El ruido exterior fue el aspecto peor valorado. Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento.

Palabras clave: habitabilidad del aula; calidad ambiental interior; docentes de primaria; evidencias psicométricas

INTRODUCTION

The classroom is the space where girls, boys and teachers spend most of the school day, and its physical conditions are part of the setting in which teaching and learning take place. Temperature, ventilation, acoustics, lighting, furniture and available space are not secondary aspects of infrastructure: recent research links them to the academic performance, health and well-being of students and teachers.

A scientometric analysis of research on the school built environment and child health identified thermal comfort, indoor air quality, perception and performance as among the core themes of the field (Zhang and Meng, 2025). A recent systematic review found that higher temperatures are generally associated with lower academic outcomes, with greater vulnerability in lower-income communities (Umerani et al., 2026).

In warm-climate regions such as southern Sinaloa, heat and classroom ventilation are an everyday concern. Studies of naturally ventilated classrooms in warm climates have documented seasonal thermal discomfort, noise from the street and the schoolyard, and variable ratings of air freshness (Afifi et al., 2025).

In northwestern Mexico, research on comfort in educational spaces has focused on university classrooms in Baja California, where studies have documented thermal discomfort when indoor temperatures fall outside the comfort range, as well as insufficient daylight levels (de la Cruz Chaidez et al., 2022; Rincón-Martínez, 2023). The habitability of primary school classrooms, by contrast, has received less empirical attention in the region.

Teachers are privileged informants on classroom habitability because they spend the entire school day there and observe how physical conditions relate to their students' attention and behavior. Their perception, however, is not equivalent to an objective measurement: a recent review of indoor air quality in schools found that educators' subjective perceptions do not agree with objective measurements (Cooke et al., 2026). For this reason, a teacher-perception instrument with validity evidence is useful for diagnosis and monitoring, provided that what it does and does not measure is acknowledged.

Project FZ-HAB-0018 on the Factoriza UAS platform set out to develop and test a classroom educational habitability scale for primary school teachers, with two dimensions: Classroom Environmental Comfort and Classroom Learning Conditions. On the platform, the project is listed as a validation of the scale; however, this article reports the results of the first pilot survey from a very small preliminary data cut, which does not yet support claims of validation, only an initial review of the instrument's psychometric properties.

The general objective was to describe the preliminary psychometric properties of a classroom educational habitability scale, based on the preliminary data cut from its pilot survey of primary school teachers in southern Sinaloa.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to explore the relationship between the scores on the two dimensions. The project did not state any hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

CLASSROOM HABITABILITY AS A CONDITION FOR TEACHING AND LEARNING

The notion of habitability, as applied to educational spaces, refers to the extent to which the classroom provides physical conditions suited to the activities carried out in it. The literature on the indoor environmental quality of school buildings breaks it down into thermal comfort, air quality, visual comfort and acoustic comfort, to which furniture and spatial layout are added.

In three university buildings in a hot-summer, cold-winter region of China, Weng et al. (2023) compared indoor environmental quality and the satisfaction of teachers and students. They recommended improving natural ventilation, giving users control over windows and temperature, and increasing illuminance on the work plane to enhance learning efficiency.

The relationship between classroom conditions and learning has been documented mainly for temperature and air quality. The systematic review by Umerani et al. (2026) compiled observational studies in primary and secondary education and concluded that higher temperatures are generally associated with poorer academic outcomes; it therefore recommended investing in

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climate-resilient school infrastructure that includes cooling, ventilation and insulation.

Cooke et al. (2026), for their part, concluded that indoor air pollutants are negatively associated with students' cognitive and academic performance, and proposed a whole-school approach that considers both student learning and the experience of teaching staff.

ENVIRONMENTAL COMFORT: TEMPERATURE, VENTILATION, VISIBILITY, AND ACOUSTICS

Acoustic comfort holds a special place in the teaching experience. The scoping review by Mealings et al. (2024) found vocal health to be the most studied aspect, and most of its findings show that higher noise levels or larger numbers of students are negatively associated with teachers' health and well-being.

In a study of primary and secondary school teachers in Finland, Patjas et al. (2021) identified background noise as the most disruptive factor for voice in the classroom and associated voice problems with greater stress and lower work ability.

Bottalico et al. (2023) showed that, in primary school classrooms, better acoustic conditions are required for children to achieve good speech intelligibility, especially when the teacher's voice is impaired. In the Chinese-language literature, Xie and Huang (2024) proposed incorporating acoustic indicators, such as reverberation time control, into the spatial design of classrooms.

The Classroom Environmental Comfort dimension of the instrument under study captures these facets from the teacher's perspective: heat during the school day (R1, reverse-scored), the inflow of fresh air (R2), the visibility of the blackboard from any location (R3), how clearly students hear the teacher without the teacher having to raise their voice (R4), interruption of lessons by outside noise (R5, reverse-scored), and the comfort of the furniture (R6). The dimension therefore brings together thermal, visual, acoustic, and ergonomic conditions. The literature treats these as distinct components of environmental quality that may vary independently depending on the orientation, construction, and equipment of each classroom.

TEACHERS' PERCEPTIONS AS A SOURCE OF INFORMATION ON THE CLASSROOM

Measuring classroom habitability through teachers' perceptions has advantages and limitations that should be made explicit. The advantages include the possibility of gathering information from many classrooms at low cost, without measuring equipment, and of capturing the experience of those who spend the entire school day in the space and observe its consequences in class.

Research on teacher voice also shows that the perception of acoustic conditions and air quality is associated with teachers' own symptoms, stress and work capacity (Patjas et al., 2021); thus, perception is not merely an imperfect proxy for measurement but a relevant indicator of occupational well-being in its own right (Mealings et al., 2024).

Two limitations stand out: the documented lack of agreement between perception and objective measurement of air quality in schools (Cooke et al., 2026), and occupants' adaptation to thermal conditions.

In naturally ventilated educational buildings in Baja California, Rincón-Martínez (2023) found that occupants showed greater adaptation to temperatures above neutral through actions aimed at restoring comfort. This implies that the assessment of heat depends on expectations and on the adjustment options available. For this reason, a teacher-perception instrument should be interpreted as a measure of experienced habitability and complemented, where possible, with physical measurements in the classroom.

CONDITIONS FOR LEARNING: SPACE, CLEANLINESS, LIGHTING, AND MATERIALS

Beyond environmental comfort, classroom habitability also involves conditions of order, space, and equipment. With respect to furniture, Loredan et al. (2024) found a high degree of mismatch between the dimensions of school furniture and the anthropometric measurements of primary school and university students, along with musculoskeletal pain from primary school onward. Fidelis and Ogunlade (2022) documented large mismatches in Nigerian schools and the need for furniture design standards.

As for lighting, de la Cruz Chaidez et al. (2022) found natural light levels below the recommended minimum in the classrooms studied in Tijuana. In naturally ventilated primary

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school classrooms in a hot, arid climate, Afifi et al. (2025) found that seat location, ventilation and lighting were generally rated favorably, with variation between schools and classrooms.

The Conditions for Learning in the Classroom dimension includes cleanliness during the school day (R7), space for students to move around (R8), sufficient lighting to read without strain (R9), the perception that classroom conditions distract students (R10, reverse-scored), the availability of teaching materials (R11), and the appraisal of the classroom as a pleasant place to learn (R12). Unlike the first dimension, it combines material conditions with an overall appraisal and a perceived consequence for students' attention. Given the cross-sectional design, the relationship between the two dimensions should be understood as an association, not as a relationship of dependence.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data come from survey LEV-0023, "Southern Sinaloa Pilot · Classroom Habitability (Teachers)," of project FZ-HAB-0018 on the Factoriza UAS platform, and from the frozen dataset DST-0023, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only survey in the project. The project is registered on Factoriza with a mixed-methods route; the results package contains only the survey component, which is the component analyzed here.

POPULATION, SAMPLE, AND DATA CUTOFF

The survey population was defined as primary school teachers in southern Sinaloa working in schools that authorized their participation. According to the Factoriza log, 32 people opened the questionnaire and 11 completed it; no cases were excluded for quality control, so 11 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 11 cases out of a target of 100, and data collection was still open, in the field, as of the cut-off date. With 11 cases for 12 items, the ratio is 0.9 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and the sample is the first condition that the methodological literature asks researchers to check in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Classroom Habitability Scale for Primary School Teachers was administered. It comprises twelve items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into two six-item dimensions: Classroom Environmental Comfort (R1 to R6) and Classroom Learning Conditions (R7 to R12). Three items are reverse-worded (R1, "The classroom where I teach is hot during the school day"; R5, "Outside noise interrupts my lessons"; and R10, "The conditions in my classroom distract the students") and are already recoded in the data matrix. After recoding, a higher score indicates better perceived conditions. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Classroom environmental comfort	The classroom where I teach is hot during the school day	Yes
R2	Classroom environmental comfort	Fresh air enters my classroom during lessons	No
R3	Classroom environmental comfort	Students can see the blackboard from anywhere in the classroom	No
R4	Classroom environmental comfort	In my classroom, students hear me clearly without my having to raise my voice	No
R5	Classroom environmental comfort	Outside noise interrupts my classes	Yes
R6	Classroom environmental comfort	The furniture in my classroom is comfortable for the students	No
R7	Conditions for learning in the classroom	My classroom is kept clean throughout the school day	No

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Code	Dimension	Item	Reverse
R8	Conditions for learning in the classroom	In my classroom there is space for students to move around	No
R9	Conditions for learning in the classroom	The lighting in my classroom allows me to read without effort	No
R10	Classroom learning conditions	The conditions in my classroom distract the students	Yes
R11	Classroom learning conditions	The teaching materials in my classroom are within the students' reach	No
R12	Classroom learning conditions	My classroom is a pleasant place to learn	No

Note. Classroom habitability scale for primary school teachers. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the data matrix provided. Source: Factoriza UAS, project FZ-HAB-0018, survey LEV-0023, dataset DST-0023.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze the DST-0023 dataset with a cryptographic hash, generated the data matrix with the reverse-scored items recoded, and produced the descriptive and internal-consistency analyses (runs RUN-00121 to RUN-00125). The supplementary analyses were performed using the data file and the item dictionary exported by the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values of each item. It also calculated the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items; when any item correlates or loads negatively relative to the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable. It also attempted an exploratory factor analysis of the twelve items, preceded by the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), item-level sampling adequacy (Lorenzo-Seva and Ferrando, 2021), and Bartlett's test of sphericity (Bartlett, 1950). The number of factors was determined by parallel analysis (Horn, 1965), with minimum residual extraction and oblimin rotation.

Finally, it estimated the relationship between the mean scores of the dimensions using Spearman's coefficient and its 95% confidence interval, computed via the Fisher transformation with the Bonett and Wright (2000) standard error.

Reference values for interpreting the indices, such as 0.60 for the KMO, are treated as guidelines rather than decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is left for future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous, and took place in schools that authorized the administration of the instrument. Factoriza UAS records express informed consent online and does not collect names, email addresses or other identifying data. In a study in which teachers assess the conditions of their workplace, anonymity protects respondents from school management and educational authorities.

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STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following tools were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive and internal consistency analyses; a Python analysis program with fixed, validated procedures, for omega, exploratory factor analysis and correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, writing a first draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 32 individuals who opened the questionnaire, 11 completed it and were analyzed, with no exclusions for quality control. Most of those who started the questionnaire did not finish it, which should be reviewed in the field administration procedures, for example with regard to the time of day at which participants are invited to respond. All analyzed cases answered all twelve items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	32
Completed questionnaires	11
Cases excluded by quality control	0
Cases analyzed	11
Items	12

Note. Survey “Southern Sinaloa Pilot · Classroom Habitability (Teachers)” (LEV-0023); population: primary school teachers in southern Sinaloa, with school authorization; territory: southern Sinaloa, in primary schools that authorized their participation. Dataset DST-0023, fingerprint 8ba1330fb6f702fc. Source: Factoriza UAS. Preliminary cut-off: n = 11 out of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. For Environmental Comfort, the highest mean was for R4, the clarity with which students hear the teacher without the teacher having to raise their voice (*M* = 3.73, *SD* = 0.79). The lowest was for R5, the interruption of classes by outside noise in its recoded version (*M* = 2.09, *SD* = 1.04). This was also the lowest mean of the entire set, with 36% of responses at the minimum value; that is, a substantial proportion of teachers believe that outside noise interrupts their classes.

Heat during the school day, in its recoded version (R1), and the intake of fresh air (R2) both had *M* = 2.91 (*SD* = 1.22 and 1.30, respectively), and visibility of the blackboard (R3) had *M* = 2.82 (*SD* = 1.17).

In Conditions for learning, the highest mean was for R12, the classroom as a pleasant place to learn (*M* = 3.36, *SD* = 1.12), followed by R8, space for students to move around (*M* = 3.27, *SD* = 0.90), and the lowest was for R7, classroom cleanliness during the school day (*M* = 2.82, *SD* = 1.08). Lighting (R9) and students’ distraction due to classroom conditions, in its recoded version (R10), both had *M* = 3.00, and the reach of teaching materials (R11) had *M* = 2.91 (*SD* = 1.14). Overall, most means fell around the midpoint of the scale, with less favorable ratings for noise, cleanliness, visibility, heat, and ventilation.

Table 3. Descriptive statistics for the items.

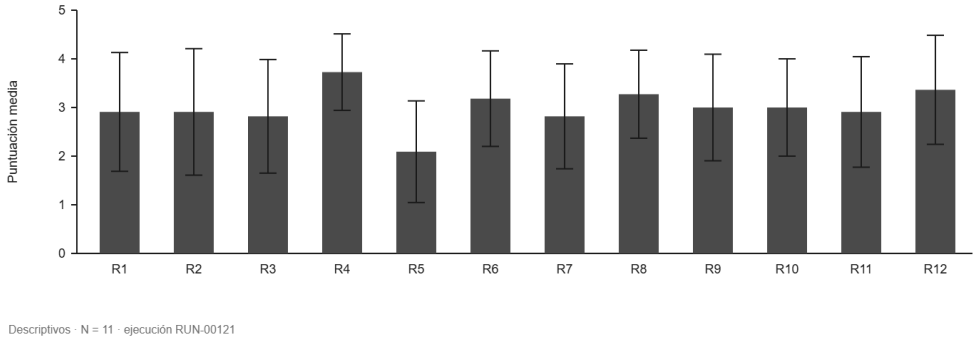
Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.91	1.22	0.21	-0.92	9%	9%
R2	2.91	1.30	-0.13	-0.88	18%	9%
R3	2.82	1.17	-0.04	-1.91	9%	45%
R4	3.73	0.79	-0.94	1.65	9%	9%

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Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R5	2.09	1.04	0.43	-0.93	36%	9%
R6	3.18	0.98	0.35	-0.59	27%	9%
R7	2.82	1.08	-0.15	-1.39	9%	36%
R8	3.27	0.90	-0.65	-1.55	27%	55%
R9	3.00	1.10	-0.56	-1.11	9%	45%
R10	3.00	1.00	0.73	-0.13	36%	9%
R11	2.91	1.14	0.21	-0.07	9%	9%
R12	3.36	1.12	-0.89	0.81	9%	9%

Note.N = 11. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item–total correlation column across the twelve items is omitted because it combines two dimensions; the item–total correlation by dimension is presented in Table 4. Run RUN-00121 of Factoriza UAS. Preliminary data cut: n = 11 of a target of 100, with data collection still open.

Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 reports the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary program. The alpha values were identical in both calculations. Classroom environmental comfort yielded α = .601 and ω = .652. Classroom learning conditions yielded α = .671; omega is not reported because R11, the scope of the teaching materials, correlated negatively with the rest of the dimension.

The item-level analysis pinpoints the problems.

In Environmental comfort, R6, comfort of the furniture, had the highest corrected item-total correlation (.706), and its deletion would reduce alpha to .407, whereas the remaining items showed low correlations, ranging from .242 to .361. The internal consistency of the dimension therefore rests largely on a single item. In Conditions for learning, R8, space to move around, was the most coherent item (.594), followed by R10 (.551) and R9 (.542), while R11 showed a correlation of -.059, and its deletion would raise alpha to .780.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Classroom environmental comfort	R1	.267	.588
Classroom environmental comfort	R2	.361	.546
Classroom environmental comfort	R3	.247	.594
Classroom environmental comfort	R4	.242	.590
Classroom environmental comfort	R5	.267	.582
Classroom environmental comfort	R6	.706	.407
Conditions for learning in the classroom	R7	.485	.598
Conditions for learning in the classroom	R8	.594	.572
Conditions for learning in the classroom	R9	.542	.576
Conditions for learning in the classroom	R10	.551	.578

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Dimension	Item	Corrected item-total r	α if item deleted
Conditions for learning in the classroom	R11	-.059	.780
Conditions for learning in the classroom	R12	.435	.617

Note.N = 11. Scale from 1 to 5; reverse-scored items R1, R5, and R10 are shown recoded. Run RUN-00121 of Factoriza UAS. Preliminary data cut: n = 11 out of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Observation
Classroom environmental comfort	6	11	.601	.652	
Classroom learning conditions	6	11	.671		Reverse-keyed items: R11; ω not interpretable

Note.N = 11. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension, with 6 items each: Classroom Environmental Comfort = .601 (run RUN-00122); Conditions for Learning in the Classroom = .671 (RUN-00124). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 11 out of a target of 100, with data collection still open.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated interpretably, and its results are not presented in tables. With 11 cases and 12 items, the correlation matrix is not invertible, so the indices that depend on its inverse cannot be interpreted: the overall measure of sampling adequacy yielded a numerical value of .180, well below the indicative reference value of 0.60, and Bartlett's test, $\chi^2(66) = 428.28$, is artificially inflated when the determinant of the matrix is practically zero.

Parallel analysis suggested three factors, but with fewer cases than items, that solution has no support. These results are reported in the reproducibility appendix, but they provide no evidence about the dimensionality of the instrument and should not be cited as such.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlation between the mean scores of the two dimensions, based on 11 cases. The relationship between Environmental Comfort and Conditions for Learning was positive and strong, $\rho = .768$, 95% CI [.223, .947], $p = .006$. The interval excludes zero but is very wide, as expected for a sample of this size, and its lower bound is compatible with a barely moderate association.

Table 6. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Classroom Environmental Comfort and Classroom Learning Conditions	11	.768	[.223, .947]	.006

Note.α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum residual model, without reverse-scoring items. Complete cases per dimension. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0023_FZ_HAB_0018. Preliminary cutoff: n = 11 out of a target of 100, with data collection still open.

DISCUSSION OF RESULTS

The aim of this study was to describe the preliminary psychometric properties of a classroom educational habitability scale in a pilot study with primary school teachers from southern Sinaloa. The main finding is that both dimensions showed moderate internal consistency and that their behavior depends on only a few items: in Environmental Comfort, on the comfort of the furniture; in Conditions for Learning, on space, lighting, and the absence of distractions, whereas the accessibility of teaching materials did not covary with the other items.

With only 11 cases, all coefficients are provisional: the simulation literature on alpha and omega coefficients has been based on much larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated.

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The low coherence of the environmental comfort items, except for furniture, is consistent with a view of classroom environmental quality as a set of distinct components (thermal, acoustic, visual and ergonomic) that may vary independently depending on the orientation, construction and equipment of each classroom (Weng et al., 2023; Zhang and Meng, 2025).

A classroom can be hot while also having good acoustics and good visibility of the blackboard. If this pattern is confirmed in the final sample, it will be worth considering whether the dimension should be treated as a formative index of conditions rather than as a reflective scale in which all items are expected to covary.

The descriptive statistics point to substantive problems that are consistent with the literature. Outdoor noise was the lowest-rated aspect, in line with studies identifying background noise as the most disruptive factor for teachers' voices (Patjas et al., 2021), with evidence linking it to teachers' health and well-being (Mealings et al., 2024), and with the annoyance caused by street and playground noise documented in naturally ventilated classrooms in warm climates (Afifi et al., 2025).

The intermediate ratings for heat and ventilation are relevant in a warm region, given the association between high temperatures and lower academic performance (Umerani et al., 2026); the cleanliness and visibility of the blackboard emerge as conditions that warrant attention in school management.

The behavior of R11, the accessibility of teaching materials, warrants separate consideration. Unlike the other items in its dimension, which describe conditions of the physical space, R11 refers to the arrangement of materials, a decision that depends largely on the teacher's pedagogical organization and on the resources available to the school.

That it did not covary with space, lighting or cleanliness suggests that it measures content distinct from classroom habitability understood as a physical condition, and that it could be reworded or moved to a learning-resources dimension. The decision rests with the authors and should be made at the final data cutoff, because with 11 cases a single atypical response can change the sign of a correlation.

Two findings call for additional caution. The strong association between the two dimensions may indicate that teachers appraise classroom habitability as a whole, but it may also reflect a common response style in a very small sample; moreover, as Cooke et al. (2026) have shown for air quality, teachers' perceptions are no substitute for objective measurement of conditions.

Furthermore, response quality should be checked before the final analysis because, in small samples, careless or extreme response patterns can markedly distort correlations (Ward and Meade, 2023).

CONCLUSIONS

The study met its objective within the scope permitted by a preliminary sample of 11 cases. In its pilot administration, the classroom educational habitability scale from project FZ-HAB-0018 showed moderate internal consistency for Classroom Environmental Comfort (α = .601; ω = .652) and for Classroom Learning Conditions (α = .671), with one item, R11, that did not covary with its dimension. The exploratory factor analysis could not be estimated in an interpretable way because the sample has fewer cases than items.

The two dimensions were positively associated. The results do not yet provide evidence of structural validity, nor do they allow the instrument to be presented as a scale with sufficient validity evidence; their main use is to identify the items that should be revised.

The limitations are substantial. The sample of 11 cases, against a target of 100 (0.9 cases per item), precludes estimating the internal structure and makes all statistics unstable; data collection was still ongoing, and most of those who started the questionnaire did not complete it. No information is available on the participating schools, the selection procedure, or the characteristics of the teachers and their groups, and the student-support component of the mixed pathway is not part of the analyzed package. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

These results point to several decisions for the authors. The first is to revise R11, the scope of teaching materials, which may relate more to pedagogical organization than to the habitability of the space. The second is to assess whether Environmental comfort should be retained as a reflective scale or treated as an index of conditions, given that its thermal, acoustic, visual, and ergonomic components did not covary in this cross-section.

The third is to record the school, shift, grade and number of students, so that variation

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between classrooms can be analyzed. None of these decisions was made in the present analysis, which retains the original twelve items.

From a school management perspective, the descriptive statistics of this pilot, although provisional, point to specific conditions that can be addressed through low-cost interventions rather than major construction: controlling outside noise by relocating playground activities and selectively closing openings, cleaning during the school day, arranging furniture to improve visibility of the blackboard, and cross-ventilation during hot periods.

Furniture comfort, the item on which the internal consistency of the comfort dimension was concentrated, also suggests that it would be advisable to review whether the furniture fits students' body measurements, as the literature on school ergonomics recommends (Fidelis and Ogunlade, 2022; Loredan et al., 2024).

As directions for future research, we propose completing data collection up to the planned target, repeating the exploratory factor analysis once the number of cases allows it, and then evaluating the resulting structure with confirmatory factor analysis in an independent sample.

Teachers' perceptions could be compared with measurements of temperature, noise level and lighting in a subsample of classrooms, and with indicators of student attention, as envisaged in the original project design. An instrument with documented validity evidence would make it possible to diagnose the habitability of primary school classrooms in the region and to guide investment in school infrastructure adapted to the hot climate.

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Chapter 9 / Capítulo 9

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Habitability and gender. Women's psychoenvironmental experience of housing in southern Sinaloa: Preliminary psychometric properties of a scale

Habitabilidad y género. Experiencia psicoambiental de la mujer en la vivienda del sur de Sinaloa: propiedades psicométricas preliminares de una escala

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ABSTRACT

Women and men do not experience housing in the same way, and a gender perspective remains scarce in habitability research. This instrumental, cross-sectional and exploratory study examined the preliminary psychometric properties of the Women's Housing Experience Scale, a fifteen-item instrument with three dimensions: own space, safety and well-being in the dwelling. The preliminary cut of the pilot survey of project FZ-HAB-0019 of the Factoriza UAS platform was analyzed, with 14 women aged 18 or older living in southern Sinaloa, Mexico, out of a target of 100. Descriptive statistics, Cronbach's alpha, McDonald's omega, inter-item correlations and Spearman correlations between dimensions were computed; exploratory factor analysis was not interpretable because the sample was smaller than the number of items. Item means ranged from 3.50 to 4.57. Internal consistency was acceptable for own space (α = .777; ω = .785), moderate for safety (α = .690; ω = .804) and low according to alpha for well-being (α = .593; ω = .720). The three reverse-worded items and the item on feeling calm at home were the least coherent with their dimensions. The dimensions were positively correlated (ρ between .585 and .790). The results are provisional and guide the revision of the instrument before the final data cut.

Keywords: gender; housing habitability; women's safety; psychometric evidence

RESUMEN

La vivienda no se experimenta igual por mujeres y hombres, y la perspectiva de género sigue siendo escasa en los estudios de habitabilidad. Este estudio instrumental, transversal y exploratorio examinó las propiedades psicométricas preliminares de la Escala de experiencia de las mujeres en la vivienda, de quince reactivos en tres dimensiones: Espacio propio, Seguridad y Bienestar en la vivienda. Se analizó el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0019 de Factoriza UAS, con 14 mujeres de 18 años o más residentes en el sur de Sinaloa, de una meta de 100. Se calcularon estadísticos descriptivos, alfa de Cronbach, omega de McDonald, correlaciones entre reactivos y correlaciones de Spearman entre dimensiones; el análisis factorial exploratorio no fue interpretable porque la muestra fue menor que el número de reactivos. Las medias se situaron entre 3.50 y 4.57. La consistencia interna fue aceptable en Espacio propio (α = .777; ω = .785), moderada en Seguridad (α = .690; ω = .804) y baja según el alfa en Bienestar (α = .593; ω = .720). Los tres reactivos inversos y el reactivo sobre la tranquilidad en la vivienda fueron los menos coherentes con su dimensión. Las dimensiones se correlacionaron positivamente entre sí (ρ entre .585 y .790). Los resultados son provisionales y orientan la revisión del instrumento antes del corte final.

Palabras clave: género; habitabilidad de la vivienda; seguridad de las mujeres; evidencias psicométricas

INTRODUCTION

Housing is not experienced in the same way by all the people who live in it. Gender relations are produced and reproduced within the domestic sphere, such that the distribution of space, time and tasks in the household, as well as the sense of safety in the home and its immediate surroundings, may differ between women and men.

A critical review of the literature on housing and health found that, overall, the consequences of housing conditions were worse for women and for non-binary or trans people, but that very few studies incorporate a gender perspective; the authors therefore considered it urgent to establish an interdisciplinary agenda on this relationship (Vásquez-Vera et al., 2022).

In Mexico, housing policy in the first decades of this century favored the mass production of social housing, characterized by small dwellings, developments located far from urban centers, and insufficient services (Hernández Ilizaliturri et al., 2025).

In a habitability study of housing developments in Mérida, Torres Pérez (2023) argued that standardized minimum housing was designed around a male user. The study documented how women, in their role as homemakers, reorganize indoor and outdoor space to meet family needs and generate income, and how they are more concerned than men about noise, visibility and privacy. In the hot climates of the northwest, thermal comfort becomes an additional requirement: in Culiacán, residents of a social housing development described their homes as very hot (Barraza-Bracamontes et al., 2022).

Safety is a central dimension of that experience. According to the 2021 National Survey on the Dynamics of Household Relationships, 70.1% of women aged 15 years and older had experienced at least one incident of violence over their lifetime, and 11.4% had experienced violence in the family setting in the previous 12 months (Instituto Nacional de Estadística y Geografía [INEGI], 2022).

Outside the home, women's perceived insecurity in public space is associated with personal, social, environmental and temporal factors, such as the difference between day and night (te Braak and van Tienoven, 2025). For women, therefore, the home can be both a refuge and a place of surveillance or risk; the route from the street to the front door is also part of their residential experience.

Despite the relevance of the topic, instruments that specifically measure women's psycho-environmental experience in their homes are scarce; the search conducted for this study did not identify any previous instruments developed for this purpose in southern Sinaloa. A brief scale capturing the personal space, safety and well-being that women experience in their homes would allow a gender perspective to be incorporated into housing habitability studies in the region, provided that the scale shows evidence of validity and acceptable internal consistency.

Project FZ-HAB-0019 of the Factoriza UAS platform set out to study women's psycho-environmental experience of housing in southern Sinaloa. To this end, the Women's Housing Experience Scale was designed, comprising fifteen items organized into three dimensions: Own Space in the Home, Safety within the Home, and Well-being in the Home.

This article presents the results of the first preliminary data cut of the pilot survey. The general objective is to examine the preliminary psychometric properties of the scale. The specific objectives are to describe participants' responses to the items; to estimate the internal consistency of each dimension using alpha and omega coefficients; to explore the internal structure of the scale; and to estimate the relationship between the scores on the three dimensions.

DEVELOPMENT

GENDER, HOUSING, AND THE EXPERIENCE OF HOME

The literature distinguishes between housing as a material object and home as an experience. Keynejad et al. (2026) proposed a framework that spans a continuum from housing, as its most concrete manifestation, through the symbolic representations of home, to the psychological experience of belonging to a place.

Within this framework, housing insecurity erodes community, relationships and safety, and is accompanied by an ontological insecurity associated with greater vulnerability to interpersonal violence. The authors further propose that these dynamics are bidirectional and that mental health and housing conditions are mutually reinforcing. They therefore advocated gender-sensitive interventions that expand access to safe and stable housing.

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The review by Vásquez-Vera et al. (2022) helps situate this proposal within the empirical evidence. Of the 90 articles analyzed in full text, most examined the affordability and physical conditions of housing, and only a subset adopted a feminist or gender-sensitive perspective; the remaining studies merely compared outcomes by sex or did not include a gender perspective.

This scarcity justifies the development of instruments that, rather than comparing women and men, describe how women experience their own housing.

ONE'S OWN SPACE WITHIN THE HOME

Having a space of one's own, being able to make decisions about how the household is organized, and having the opportunity to rest alone are aspects of the domestic experience that depend as much on the size of the dwelling as on the distribution of power within the household.

In Hong Kong, a study of 413 female caregivers living in subdivided units found that a total floor area of less than 13.0 m^2 was associated with a higher likelihood of anxiety and depression and with lower health-related quality of life. The study also found that crowding was related to well-being through the physical, relational and personal aspects of the home experience, including exhaustion from domestic work, family conflict and feelings of repression (Chan et al., 2024).

In Beijing, among 1,613 residents, residential crowding was associated with a higher risk of depression through stress specific to the living space; women were among the subgroups with a relatively stronger association (Wang and Liu, 2023).

In Mexican social housing, Torres Pérez (2023) observed that women adapted to small dwellings and that, in some cases, the bathroom was the only private space for the couple.

These observations support the inclusion of items in the project scale on having a space that feels like one's own, the ability to decide how the home is arranged, the existence of a place to rest alone, and the possibility of carrying out personal activities, as well as a reverse-scored item that asks whether one's own needs take second place.

SAFETY IN AND AROUND THE HOME

The systematic review by te Braak and van Tienoven (2025), which included 50 studies published between 2002 and 2024, proposed a framework in which women's perceived safety in urban public space results from the interaction of personal, social, environmental, and temporal factors.

In addition to gender, factors related to this perception included age, socioeconomic status, social cohesion, urban design, and environmental maintenance, as well as the time of day. In a rural setting in Colima, women identified ten types of insecurity, including gender-based violence, lack of street lighting, and lack of surveillance, and reported that the absence of light forced them to return home earlier (Valladares Anguiano et al., 2018).

This study, which predates the five-year period prioritized in the search, is included because it is one of the few empirical precedents from the Mexican Pacific region.

Within the dwelling, safety also depends on household relationships. In the housing complexes of Mérida, about half of the women reported feeling safe in their homes; among those who did not, some attributed their insecurity to the external environment and others to their partner (Torres Pérez, 2023).

National data on family violence (INEGI, 2022) indicate that the home is not a protected space for all women. Therefore, the safety dimension of the scale combines items on safety inside the home and when arriving home at night, the reassurance provided by door locks, and trust in the street, with one reverse-scored item on the feeling of being watched inside the home.

WELL-BEING IN THE HOME

The home can function as a restorative environment, that is, as a place where the psychological resources depleted by everyday life are recovered. In Israel, a study of Arab and Jewish women that applied the Perceived Restorativeness Scale across four environments, including the home, found between-group differences in the restoration experienced at home and in the residential environment; social discomfort was the intervening variable most strongly associated with restoration (Saadi et al., 2021).

For women who take on most of the domestic work, however, the home is also a workplace;

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exhaustion from household chores has been documented as one of the pathways through which housing conditions are related to their well-being (Chan et al., 2024).

Residential satisfaction and well-being in the home are also related to the community environment. In Yangpu District, Shanghai, a study based on 923 valid questionnaires across 36 communities found that the built environment of community facilities was associated with the perception that the neighborhood considers women's needs and with residential satisfaction, particularly for recreational facilities. The same study found that the direct relationship between this perception and satisfaction was weak and that subjective perception mediated the relationship between the built environment and satisfaction (Fang et al., 2025).

In the suburbs of the same city, proximity to outdoor facilities and lower noise pollution were associated with better self-reported mental health in both women and men, whereas other associations, such as that involving the distance between workplace and residence, were observed only in men (Shen et al., 2021).

More broadly, the review by Saleem and Alchalabi (2025) grouped the factors associated with residential satisfaction into interacting categories, ranging from functional and technical to psychological and public policy factors.

VALIDITY EVIDENCE IN THE INITIAL STAGE OF SCALE DEVELOPMENT

The internal consistency of a dimension is usually estimated using Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared the performance of both coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is explored through exploratory factor analysis, which first requires verifying the adequacy of the data and a sufficient sample size; current recommendations for this analysis call for treating cutoff values as guidelines rather than rules (Ferrando et al., 2022; Goretzko et al., 2021).

Scales with items keyed in both directions may show wording effects, because some respondents answer the positively and negatively worded items of the same dimension inconsistently (Steinmann et al., 2022). Identifying these responses can reduce such effects (García-Batista et al., 2021). The project's scale includes one reverse-keyed item in each dimension, so this aspect should be examined from the first administration.

METHODOLOGY

DESIGN

An instrumental, quantitative, non-experimental, cross-sectional study was carried out with a descriptive and exploratory scope. The data correspond to the survey LEV-0024, "Southern Pilot of Sinaloa - Women and Housing", of the FZ-HAB-0019 project of the Factoriza UAS platform, and to the frozen dataset DST-0024, with a cut-off date of October 9, 2026. The survey constitutes an independent sample and is the only one of the project.

POPULATION, SAMPLE, AND DATA CUTOFF

The population was defined as women aged 18 years or older residing in southern Sinaloa. Data collection took place in localities selected by the project lead. According to the Factoriza log, 40 individuals opened the questionnaire and 14 completed it; no cases were excluded on quality-control grounds, so 14 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 14 cases out of a target of 100, and data collection was still open and in the field at the cut-off date. With 14 cases for 15 items, the ratio is 0.9 cases per item, so the correlation matrix among the fifteen items is not invertible. The adequacy of the data and of the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

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INSTRUMENT

The Women's Housing Experience Scale was administered. It comprises fifteen items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into three dimensions of five items each: Own Space in the Home (R1 to R5), Safety within the Home (R6 to R10), and Well-being in the Home (R11 to R15). Three items (R4, R9, and R13) are reverse-worded and have already been recoded in the data matrix, so that a higher score indicates a more favorable experience across all three dimensions. Table 1 presents the code, dimension, wording, and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse-scored
R1	Personal space	In my home, I have a space that I feel is my own	No
R2	Personal space	I can decide how the spaces in my home are arranged	No
R3	Personal space	In my home, I have a place to rest alone	No
R4	Personal space	In my home, my needs take a back seat	Yes
R5	Personal space	I can carry out my personal activities within my home	No
R6	Safety	I feel safe inside my home	No
R7	Safety	I feel safe when I arrive home at night	No
R8	Safety	My home has locks that give me peace of mind	No
R9	Safety	I feel watched in my home	Yes
R10	Safety	The street where I live makes me feel safe when I leave my home	No
R11	Well-being	I feel calm in my home	No
R12	Well-being	My home is a place where I recharge my energy	No
R13	Well-being	When I am at home, I feel tired	Yes
R14	Well-being	I feel happy with the home I live in	No
R15	Well-being	My home makes me feel at peace	No

Note. Women's Housing Experience Scale. Own Space = Own space in the home; Safety = Safety within the home; Well-being = Well-being in the home. Responses were given on a 5-point scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0019, survey LEV-0024, dataset DST-0024.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0024 with a cryptographic hash, generated the data matrix with the reverse-scored items recoded, and produced the descriptive, internal consistency, and within-dimension correlation analyses (runs RUN-00126 to RUN-00132). The complementary analyses were performed using the data file and the item dictionary exported from the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis and the percentages of responses at the extreme values for each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), with the corrected item-total correlation and the alpha if item deleted; and the Pearson correlations among the items of each dimension, with 95% confidence intervals obtained by Fisher's transformation.

In a second stage, the program analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items. It also attempted an exploratory factor analysis of the fifteen items, including sampling adequacy, a test of sphericity, the number of factors

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determined by parallel analysis with 100 simulations, minimum residual extraction, and oblimin rotation. Finally, it estimated the relationship between the mean scores of the three dimensions using Spearman's coefficient and its 95% confidence interval, obtained through the Fisher transformation with the standard error of Bonett and Wright (2000).

The reference values for the psychometric indices are treated as guidelines rather than as decision rules (Ferrando et al., 2022). No items were removed. Confirmatory factor analysis was not conducted and is proposed as future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records express informed consent online and does not collect names, email addresses or any other identifying data. Because the scale explores safety within the home and the feeling of being watched, the protocol should provide participants with guidance on support services if administration of the scale evokes situations of violence.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and the correlation between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 40 individuals who opened the questionnaire, 14 completed it and were analyzed, with no exclusions for quality control. The 14 analyzed cases answered all fifteen items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	40
Completed questionnaires	14
Cases excluded by quality control	0
Cases analyzed	14
Items	15

Note. Survey "Southern Sinaloa Pilot · Women and Housing" (LEV-0024); population: women aged 18 years or older residing in southern Sinaloa; territory: southern Sinaloa, in localities selected by the project lead. Dataset DST-0024, fingerprint 1cac45b14364e4c1. Source: Factoriza UAS. Preliminary cut-off: n = 14 of a target of 100, with data collection ongoing.

PERSONAL SPACE, SAFETY, AND WELL-BEING IN THE HOME

Table 3 and Figure 1 present the descriptive statistics. The means of the fifteen items ranged from 3.50 to 4.57, above the midpoint of the scale, and most items showed negative skewness, indicating that responses were concentrated at the high values. In the Own space in the home dimension, being able to carry out personal activities at home had the highest mean (R5: M = 4.36, SD = 0.84), followed by the availability of a place to rest alone (R3: M = 4.29, SD = 1.07), whose skewness (-2.43) and kurtosis (7.25) were, together with those of R11, the most pronounced in the instrument.

Having a space that feels like one's own (R1: M = 4.07, SD = 1.21) and the recoded version of

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the reverse-scored item on one's own needs (R4: *M* = 4.07, *SD* = 0.73) had the same mean; the ability to decide how spaces are arranged had the lowest mean in the dimension (R2: *M* = 3.79, *SD* = 0.89).

In Safety inside the home, feeling safe inside the home had the highest mean and the lowest dispersion in the dimension (R6: *M* = 4.50, *SD* = 0.52), followed by the peace of mind provided by door locks (R8: *M* = 4.43, *SD* = 0.65) and by confidence on the street when leaving the home (R10: *M* = 4.14, *SD* = 0.95).

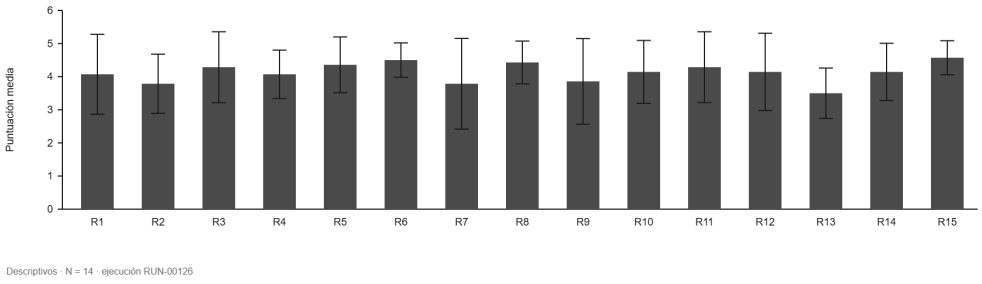
The feeling of not being watched, in the recoded version of the reverse-scored item (R9: *M* = 3.86, *SD* = 1.29), and feeling safe when arriving home at night (R7: *M* = 3.79, *SD* = 1.37) had the lowest means and the greatest dispersion in the dimension. In Well-being at home, feeling at peace at home had the highest mean of the entire instrument (R15: *M* = 4.57, *SD* = 0.51), followed by feeling calm (R11: *M* = 4.29, *SD* = 1.07); recovering energy at home and feeling content with the home shared a mean of 4.14 (R12: *SD* = 1.17; R14: *SD* = 0.86), whereas the recoded reverse-scored item on tiredness had the lowest mean of the entire instrument (R13: *M* = 3.50, *SD* = 0.76).

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	4.07	1.21	-1.69	2.62	7%	43%
R2	3.79	0.89	-1.04	1.00	14%	14%
R3	4.29	1.07	-2.43	7.25	7%	50%
R4	4.07	0.73	-0.11	-0.86	21%	29%
R5	4.36	0.84	-1.73	3.99	7%	50%
R6	4.50	0.52	0.00	-2.36	50%	50%
R7	3.79	1.37	-1.23	0.76	14%	36%
R8	4.43	0.65	-0.69	-0.25	7%	50%
R9	3.86	1.29	-0.94	0.12	7%	43%
R10	4.14	0.95	-0.95	0.34	7%	43%
R11	4.29	1.07	-2.43	7.25	7%	50%
R12	4.14	1.17	-1.67	3.06	7%	50%
R13	3.50	0.76	0.00	0.16	7%	7%
R14	4.14	0.86	-0.31	-1.64	29%	43%
R15	4.57	0.51	-0.32	-2.24	43%	57%

Note.N = 14. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated with respect to the total of each dimension. Factoriza UAS run RUN-00126. Preliminary data cut: n = 14 out of a target of 100, with data collection ongoing.

Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 summarizes the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary software, whose alpha values match those obtained with Factoriza. Personal space in the home had the highest alpha of the three dimensions (α = .777; ω = .785). Having a space of one's own (R1: .684), a place to rest alone (R3:

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.662) and engaging in personal activities (R5: .625) were the most consistent items, whereas the reverse-scored item on one's own needs showed the weakest relationship (R4: .312); removing this item would raise alpha to .800.

Safety within the home had an alpha of .690 and an omega of .804. The reassurance provided by locks was the most coherent item (R8: .808), followed by trust in the street (R10: .588), whereas the reverse-scored item on the feeling of being watched showed the weakest relationship (R9: .247); removing this item would raise alpha to .755. Well-being in the home had the lowest internal consistency according to alpha (α = .593), which differed appreciably from omega (ω = .720).

Feeling at peace (R15: .713) and recovering energy (R12: .669) were the most consistent items; tiredness, in its recoded version, showed a weak relationship (R13: .286), and feeling calm in the home was practically unrelated to the rest of the dimension (R11: .016), so removing this item would raise alpha to .733.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Own space	R1	.684	.688
Own space	R2	.504	.751
Own space	R3	.662	.695
Own space	R4	.312	.800
Own space	R5	.625	.716
Safety	R6	.503	.656
Safety	R7	.462	.652
Safety	R8	.808	.554
Safety	R9	.247	.755
Safety	R10	.588	.581
Well-being	R11	.016	.733
Well-being	R12	.669	.293
Well-being	R13	.286	.569
Well-being	R14	.379	.522
Well-being	R15	.713	.447

Note.N = 14. Scale of 1 to 5; reverse-scored items R4, R9, and R13 are shown recoded. Factoriza UAS run RUN-00126. Preliminary data cut: n = 14 out of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω
Own space	5	14	.777	.785
Safety	5	14	.690	.804
Well-being	5	14	.593	.720

Note.N = 14. Own space = Own space in the home; Safety = Safety within the home; Well-being = Well-being in the home. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension, with 5 items each: Own space = .777 (run RUN-00127); Safety = .690 (RUN-00129); Well-being = .593 (RUN-00131). Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary cutoff: n = 14 of a target of 100, with data collection still open.

Table 6 presents all the correlations among the items within each dimension. In Own Space, the highest correlation was between having one's own space and having a place to rest alone (R1 and R3: r = .877, 95% CI [.649, .961], p < .001), followed by the correlation between the ability to decide on the arrangement of the space and carrying out personal activities (R2 and R5: r = .724, 95% CI [.314, .906], p = .003); none of the correlations involving R4 had an interval that excluded zero.

In Safety, the highest correlations were between the locks and trust in the street (R8 and R10: r = .770, 95% CI [.405, .923], p = .001), between the locks and safety inside the home (R6 and R8: r = .688, 95% CI [.248, .893], p = .007), and between the locks and safety when arriving at night (R7 and R8: r = .547, 95% CI [.023, .835], p = .043); none of the R9 correlations had an interval that excluded zero.

In Well-being, feeling at peace was associated with regaining energy (R12 and R15: r = .752, 95% CI [.368, .917], p = .002) and with feeling content with the dwelling (R14 and R15: r = .668, 95%

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CI [.213, .885], p = .009). The correlation between regaining energy and recoded tiredness was moderate, with an interval that included zero (R12 and R13: r = .521, 95% CI [-.014, .824], p = .056). The four correlations of R11 with the other items in the dimension ranged from -.095 to .100.

Table 6. Correlations between items within each dimension.

Dimension	Variable pair	r	IC 95%	p
Own space	R1 and R2	.301	[-.273, .717]	.296
Own space	R1 and R3	.877	[.649, .961]	< .001
Own space	R1 and R4	.256	[-.318, .692]	.378
Own space	R1 and R5	.427	[-.134, .781]	.128
Own space	R2 and R3	.230	[-.342, .678]	.428
Own space	R2 and R4	.379	[-.189, .758]	.181
Own space	R2 and R5	.724	[.314, .906]	.003
Own space	R3 and R4	.169	[-.397, .642]	.564
Own space	R3 and R5	.476	[-.073, .804]	.085
Own space	R4 and R5	.206	[-.365, .664]	.481
Safety	R6 and R7	.379	[-.190, .757]	.181
Safety	R6 and R8	.688	[.248, .893]	.007
Safety	R6 and R9	.115	[-.443, .608]	.696
Safety	R6 and R10	.469	[-.083, .800]	.091
Safety	R7 and R8	.547	[.023, .835]	.043
Safety	R7 and R9	.155	[-.409, .634]	.596
Safety	R7 and R10	.440	[-.118, .787]	.116
Safety	R8 and R9	.355	[-.216, .745]	.213
Safety	R8 and R10	.770	[.405, .923]	.001
Safety	R9 and R10	.206	[-.364, .664]	.480
Well-being	R11 and R12	.088	[-.464, .591]	.765
Well-being	R11 and R13	-.095	[-.595, .459]	.747
Well-being	R11 and R14	-.048	[-.564, .496]	.872
Well-being	R11 and R15	.100	[-.455, .599]	.734
Well-being	R12 and R13	.521	[-.014, .824]	.056
Well-being	R12 and R14	.436	[-.124, .785]	.119
Well-being	R12 and R15	.752	[.368, .917]	.002
Well-being	R13 and R14	.117	[-.441, .610]	.690
Well-being	R13 and R15	.197	[-.372, .659]	.499
Well-being	R14 and R15	.668	[.213, .885]	.009

Note.α = Cronbach's alpha; ω = McDonald's omega total based on a one-factor minimum residual model, without reverse-scoring items. Complete cases by dimension. Own space = Own space in the home; Safety = Safety within the home; Well-being = Well-being in the home. The observations column, empty for all three dimensions, is omitted. Source: Prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0024_FZ_HAB_0019. Preliminary data cut: n = 14 out of a target of 100, with data collection ongoing.

INTERNAL STRUCTURE AND RELATIONSHIP BETWEEN THE DIMENSIONS

The planned exploratory factor analysis could not be estimated in an interpretable manner, and its results are not presented in tables. With 14 cases and 15 items, the correlation matrix is not invertible, so the measure of sampling adequacy and the test of sphericity could not be computed. Parallel analysis suggested two factors, which in the software's solution explained 57.51% of the variance; however, that solution showed a Heywood case, with a communality greater than 1 for R3, and it is not tenable with fewer cases than items. These results are reported in the reproducibility appendix, but they provide no evidence on the dimensionality of the instrument.

Table 7 presents the Spearman correlations between the mean scores of the three dimensions. All three were positive, and their intervals excluded zero. The strongest relationship was between Safety and Well-being, ρ = .790, 95% CI [.375, .941], p < .001, followed by Own Space

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and Safety, ρ = .722, 95% CI [.243, .918], *p* = .004; the relationship between Own Space and Well-being was moderate, ρ = .585, 95% CI [.031, .864], *p* = .028, with a lower bound very close to zero. The width of the intervals, calculated with the standard error proposed by Bonett and Wright (2000), indicates that the magnitude of these relationships is highly uncertain with 14 cases.

Table 7. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Personal space and Safety	14	.722	[.243, .918]	.004
Own space and Well-being	14	.585	[.031, .864]	.028
Safety and Well-being	14	.790	[.375, .941]	< .001

Note.N = 14. Own space = Own space in the dwelling; Safety = Safety within the dwelling; Well-being = Well-being in the dwelling. Pearson correlation. Confidence intervals were obtained using Fisher's z transformation. Cross-sectional design: the reported relationships are associations. Runs RUN-00128, RUN-00130, and RUN-00132 of Factoriza UAS (Tables 5, 7, and 9 of the package, compiled without modifying values). Preliminary cutoff: n = 14 out of a target of 100, with data collection ongoing.

DISCUSSION OF RESULTS

The purpose of this study was to examine the preliminary psychometric properties of the Scale of Women's Experience in Housing in southern Sinaloa. Own Space in the Home showed acceptable internal consistency with both coefficients; Safety Within the Home had a moderate alpha and a higher omega; and Well-being in the Home had the lowest alpha, which differed appreciably from its omega.

With 14 cases, these coefficients are highly unstable: the simulation literature on alpha and omega has been developed with much larger samples (Malkewitz et al., 2023); in addition, the internal structure could not be estimated. The results should be read as an initial review of the instrument, to be confirmed by the final data cut.

The difference between alpha and omega in Safety and in Well-being is consistent with the presence of items whose relationship with their dimension is very uneven. Alpha assumes that all items contribute equally to the construct, whereas omega weights each item according to its loading (McDonald, 1999/2013); thus, when one or two items are weakly related to the rest, alpha is lower than omega (Malkewitz et al., 2023).

In the Well-being dimension, R11 is the most striking case. Feeling calm in one's home is, in principle, a core component of well-being at home, and yet it was practically unrelated to the other items in the dimension. With 14 cases, a single atypical response can appreciably alter a correlation, so before any decision is made about this item, the cohort's response pattern and how well the item wording was understood should be reviewed.

In all three dimensions, the reverse-worded item was among the least consistent: R4 and R9 had the weakest relationship with their dimension, and R13 the second weakest. This pattern is compatible with a wording-related artifact, documented in scales with items keyed in both directions (García-Batista et al., 2021; Steinmann et al., 2022), but it also allows for a content-based explanation. Having one's own needs pushed into the background, feeling watched inside one's own home, and feeling tired while at home are not simply the negative pole of personal space, safety, and well-being; rather, they are experiences that the literature associates with the burden of domestic and care work (Chan et al., 2024; Torres Pérez, 2023) and with power relations within the household (INEGI, 2022; Keynejad et al., 2026).

It is therefore possible that the three reverse-scored items capture a facet of domestic burden and control that warrants examination as a dimension in its own right.

The safety items with the lowest means and the greatest dispersion were feeling safe when arriving home at night and the sense of not being watched. The former links the experience of the home to the immediate surroundings and to the time of day, factors that the literature has associated with women's perceptions of safety (te Braak and van Tienoven, 2025; Valladares Anguiano et al., 2018).

The fact that the reassurance provided by locks was related both to safety inside the home and to confidence on the street suggests that, for the participants, the physical protection of the home and the safety of the surrounding environment are part of a single appraisal.

The high correlations among the three dimensions, particularly that between safety and well-being, indicate that participants who feel safer in their homes also tend to experience greater well-being there, in line with frameworks linking residential safety to the experience of home and

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women's mental health (Keynejad et al., 2026).

At the same time, correlations of this magnitude raise the question of whether the three dimensions are empirically distinct or whether they partly reflect an overall favorable appraisal of the dwelling. This question can only be answered through the factor analysis of the final cohort.

Finally, the high means and negative skewness of most items describe a data collection wave in which participants rated their space, safety, and well-being in the home favorably.

This concentration at the high end of the scale reduces the variability available for estimating the relationships between items, and may reflect both the participants' actual experience and the characteristics of those who completed the questionnaire (at this data cutoff, 14 of the 40 people who opened it).

The studies that found associations between housing and women's well-being were conducted under conditions of overcrowding or informality (Chan et al., 2024; Wang and Liu, 2023), and a gender perspective remains scarce in housing and health research (Vásquez-Vera et al., 2022). Expanding the sample to women in diverse residential conditions will be necessary for the scale to capture the full range of the experience it aims to measure.

CONCLUSIONS

The study met its objective within the scope allowed by a preliminary data cut of 14 cases. In the pilot survey conducted in southern Sinaloa, the Women's Housing Experience Scale showed acceptable internal consistency for Own Space in the Home (α = .777; ω = .785), moderate consistency for Safety within the Home (α = .690; ω = .804), and low consistency according to alpha for Well-being in the Home (α = .593; ω = .720).

The participants rated their housing favorably across all three dimensions, with the highest means for feeling at peace and safe inside the home and the lowest means for tiredness, the ability to decide how spaces are arranged, and safety when arriving home at night. The three dimensions were positively related to one another.

The limitations are substantial. The sample of 14 cases, against a target of 100 and with data collection still ongoing, is insufficient to estimate the internal structure and produces unstable coefficients and wide confidence intervals. The participants completed the questionnaire in localities selected by the project lead, so the results cannot be generalized to women in southern Sinaloa.

The study did not measure the characteristics of the participants or their dwellings; therefore, the responses cannot be related to tenure, dwelling size, household composition, or caregiving burden. Because the design was cross-sectional, the direction of the relationships between the dimensions cannot be established. No confirmatory factor analysis was performed.

These results lead to several decisions for the authors. The first is to revise R11, whose relationship with its dimension was virtually null, by examining the response pattern in this data collection wave and respondents' comprehension of the item wording.

The second is to decide whether the reverse-worded items R4, R9, and R13 should be rewritten as positively worded items or grouped, together with additional items, into a dimension of domestic burden and control. The third is to document the origin of the items, the operational definition of the dimensions, and the criterion for selecting the localities. None of these decisions was made in the present analysis, which retains all fifteen items.

For future research, we propose completing data collection up to the planned target and including women in diverse residential conditions, such as social housing and peripheral settlements; repeating the exploratory factor analysis with the final dataset; confirming the structure in an independent sample through confirmatory factor analysis; and collecting data on the characteristics of the participants and their dwellings to relate psycho-environmental experience to the physical conditions of the home.

A scale with sufficient validity evidence would make it possible to incorporate a gender perspective into habitability studies in northwestern Mexico and to guide the design of housing that takes into account the needs of the women who live in it.

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Chapter 10 / Capítulo 10

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Habitability and gender: Comfort and control of domestic space in housing in southern Sinaloa. A preliminary review of a scale

Habitabilidad y género: comodidad y control del espacio doméstico en la vivienda del sur de Sinaloa. Revisión preliminar de una escala

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ABSTRACT

Gender relations are produced and reproduced in the home, yet few habitability studies adopt a gender perspective. This instrumental, cross-sectional and exploratory study carried out a preliminary review of a ten-item scale with two dimensions, comfort in the dwelling and control of domestic space, administered in the pilot survey of project FZ-HAB-0020 of the Factoriza UAS platform to people aged 18 or older living in southern Sinaloa, Mexico. A preliminary cut sof 7 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha and Pearson inter-item correlations; omega, exploratory factor analysis and the correlation between dimensions could not be estimated because the correlation matrix is singular. Item means ranged from 3.00 to 4.43. Control of domestic space showed high internal consistency (α = .836), whereas comfort in the dwelling showed low consistency (α = .325), supported by two items with identical responses in every case, which calls for checking data capture. The dataset does not record respondents' sex or gender, so the gender comparison the project intends requires adding those variables. The results do not estimate the properties of the scale, but they guide its revision before the final data cut.

Keywords: gender; housing habitability; domestic space; psychometric evidence

RESUMEN

Las relaciones de género se producen y reproducen en la vivienda, pero pocos estudios de habitabilidad incorporan esa perspectiva. Este estudio instrumental, transversal y exploratorio realizó una revisión preliminar de una escala de diez reactivos con dos dimensiones, Comodidad en la vivienda y Control del espacio doméstico, aplicada en el levantamiento piloto del proyecto FZ-HAB-0020 de Factoriza UAS a personas de 18 años o más residentes en el sur de Sinaloa. Se analizó un corte preliminar de 7 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach y correlaciones de Pearson entre reactivos; el omega, el análisis factorial exploratorio y la correlación entre dimensiones no fueron estimables porque la matriz de correlaciones es singular. Las medias se situaron entre 3.00 y 4.43. Control del espacio doméstico mostró una consistencia interna alta (α = .836), mientras que Comodidad en la vivienda mostró una consistencia baja (α = .325), sostenida por dos reactivos con respuestas idénticas en todos los casos, lo que exige verificar la captura. El conjunto de datos no registra el sexo ni el género de las personas encuestadas, de modo que la comparación por género que plantea el proyecto requiere incorporar esas variables. Los resultados no estiman las propiedades de la escala, pero orientan su revisión antes del corte final.

Palabras clave: género; habitabilidad de la vivienda; espacio doméstico; evidencias psicométricas

INTRODUCTION

The habitability of a dwelling depends not only on its physical attributes but also on how its occupants are able to use it, appropriate it and feel comfortable in it.

This experience is not the same for all members of the household. Gender relations are produced and reproduced within the domestic sphere. A critical review of the literature on housing and health found that, overall, the consequences of housing conditions were worse for women and for non-binary or trans people, although very few studies incorporate a gender perspective (Vásquez-Vera et al., 2022).

Two aspects of domestic experience are particularly sensitive to gender relations. The first is comfort, understood as the possibility of finding rest, sufficient space for daily activities, and safety in the home. The second is control over domestic space: participating in decisions about how spaces are used, having a place for one's own belongings, using common areas when needed, and having privacy. Both aspects depend on the size and layout of the dwelling, but also on who makes decisions about it; they are therefore natural candidates for observing differences among the people who live in it.

In Mexico, housing policy in the first decades of this century prioritized the mass production of social housing, with small dwellings, housing developments located far from urban centers, and insufficient services (Hernández Ilizaliturri et al., 2025).

In the housing developments of Mérida, Torres Pérez (2023) argued that standardized minimal housing was designed around a male user and documented that women showed greater concern than men about noise, visibility, and privacy. In the hot climates of the northwest, thermal comfort becomes an additional requirement: in Culiacán, residents of a social housing subdivision described their homes as very hot (Barraza-Bracamontes et al., 2022).

Project FZ-HAB-0020 of the Factoriza UAS platform set out to study housing habitability from a gender perspective in southern Sinaloa. To this end, a ten-item scale organized into two dimensions, Comfort in the Dwelling and Control of Domestic Space, was designed, and a pilot survey of individuals aged 18 years or older was launched.

This article presents the results of the first preliminary data cut of that survey. The general objective is to conduct a preliminary review of how the scale performs. The specific objectives are to describe the responses to the items, estimate the internal consistency of each dimension, examine the correlations among the items within each dimension, and identify the adjustments the instrument and the survey require before the final data cut. Because the data cut does not record the sex or gender of the respondents, the between-group comparison that gives the project its purpose falls outside the scope of this work and is proposed as a requirement for the final survey.

DEVELOPMENT

GENDER AND THE EXPERIENCE OF HOUSING

The literature distinguishes between housing as a material object and home as an experience. Keynejad et al. (2026) proposed a framework spanning a continuum from housing, as its most concrete manifestation, through the symbolic representations of home, to the psychological experience of belonging to a place; they placed ontological security at the center of the relationship between housing, place, and women's mental health. From this perspective, housing can offer protection and belonging, but it can also be a space of control and insecurity, depending on the relationships established within it.

The review by Vásquez-Vera et al. (2022) allows this proposal to be situated within the empirical evidence. Of the 90 articles analyzed in full, most examined housing affordability and physical conditions, and only some adopted a feminist or gender-sensitive perspective; the remaining studies merely compared outcomes by sex or did not include a gender perspective.

The authors considered it urgent to establish an interdisciplinary and intersectoral agenda on the relationship between gender, housing and health. An instrument measuring comfort and control over domestic space, administered to people of different sexes and genders, could contribute to this agenda if it shows sufficient evidence of validity.

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COMFORT AND SPACE IN THE HOME

Housing comfort encompasses rest, the space available for daily activities, and safety. Insufficient space has been consistently associated with well-being.

In Hong Kong, a study of 413 female caregivers living in subdivided units found that a total floor area of less than 13.0 m^2 was associated with a higher likelihood of anxiety and depression and with lower health-related quality of life; it also found that overcrowding was related to well-being through the physical, relational, and personal aspects of the experience of home (Chan et al., 2024).

In Beijing, among 1,613 residents, residential crowding was associated with a higher risk of depression through stress specific to the living space; women were among the subgroups with a relatively stronger association (Wang and Liu, 2023).

Housing can also function as a restorative environment. In Israel, a study of Arab and Jewish women that applied the Perceived Restorativeness Scale in four environments, including the home, found between-group differences in the restoration experienced at home and in the residential environment; social discomfort was the intervening variable most strongly associated with restoration (Saadi et al., 2021).

This finding indicates that the possibility of resting at home depends not only on the physical conditions of the dwelling but also on the social relationships that take place within and around it. More broadly, the review by Saleem and Alchalabi (2025) grouped the factors associated with residential satisfaction into interacting categories, ranging from functional and technical to psychological and public policy categories.

SAFETY AND POWER RELATIONS IN THE HOUSEHOLD

The scale used in the project includes safety within the dwelling as part of comfort, and the possibility that other people decide where to be as part of control over space. Both items point to power relations within the household. According to the 2021 National Survey on the Dynamics of Household Relationships, 70.1% of women aged 15 years and older had experienced at least one situation of violence over their lifetime, and 11.4% had experienced violence in the family setting in the previous 12 months (Instituto Nacional de Estadística y Geografía [INEGI], 2022).

In the housing developments of Mérida, about half of the women reported feeling safe in their homes; among those who did not, some attributed their sense of insecurity to the external environment and others to their partner (Torres Pérez, 2023).

Outside the home, women's perceived safety in urban public space has been described as the result of an interaction among personal, social, environmental and temporal factors, including age, socioeconomic status, social cohesion, urban design and the difference between day and night (te Braak and van Tienoven, 2025).

Gender differences are not limited to safety either: in the suburbs of Shanghai, some associations between the residential environment and self-reported mental health, such as the one involving the distance between workplace and home, were observed only in men, whereas proximity to outdoor facilities and lower noise pollution were associated with better mental health in both groups (Shen et al., 2021).

These results support designing an instrument on housing habitability and gender that allows women's and men's responses to be compared, rather than one that merely describes the experience of a single group.

CONTROL OF DOMESTIC SPACE AND PRIVACY

Control over domestic space refers to the ability to decide how the dwelling is used and to have places of one's own within it. In Mexican social housing, Torres Pérez (2023) observed that women, in their role as homemakers, reorganized interior and exterior spaces to meet the family's needs and to earn income, that they adapted to the small house, and that, in some cases, the bathroom was the only private space for the couple. In Hong Kong, feelings of repression and low self-efficacy were among the negative home experiences documented in very small dwellings (Chan et al., 2024).

Control over space is also evident in the community environment. In Yangpu District, Shanghai, a study based on 923 valid questionnaires across 36 communities found that the built environment of community facilities was associated both with residents' perception that

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the neighborhood takes women's needs into account and with residential satisfaction, and that subjective perception mediated the relationship between the built environment and satisfaction (Fang et al., 2025).

The project's scale focuses on the interior of the dwelling, but these findings are a reminder that the experience of domestic space extends into the shared spaces of the neighborhood.

VALIDITY EVIDENCE IN THE INITIAL STAGE OF SCALE DEVELOPMENT

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared the performance of both coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis, which first requires verifying the adequacy of the data and a sufficient sample size; current recommendations for this analysis call for treating cutoff values as guidelines rather than rules (Ferrando et al., 2022; Goretzko et al., 2021).

Scales with items keyed in both directions may show wording effects, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022); identifying these responses can reduce such effects (García-Batista et al., 2021). The project's scale includes one reverse-keyed item in each dimension.

At the initial stage of an instrument's development, a data cut with few cases does not allow its properties to be estimated precisely, but it does make it possible to detect construction problems that should be corrected before data collection is completed: items that are not related to their dimension, items that behave identically, and missing variables needed to answer the research question. That is the use made of the available data cut in this article.

METHODOLOGY

DESIGN

An instrumental, quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data correspond to survey LEV-0025, "Piloto sur de Sinaloa · Habitabilidad y género," from project FZ-HAB-0020 on the Factoriza UAS platform, and to the frozen dataset DST-0025, with a data cutoff date of 9 October 2026. The survey is an independent sample and is the only one in the project.

POPULATION, SAMPLE AND DATA CUTOFF

The population was defined as individuals aged 18 years or older residing in southern Sinaloa; data were collected in localities selected by the project lead. According to the Factoriza log, 15 individuals opened the questionnaire and 7 completed it; no cases were excluded on quality-control grounds, so 7 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 7 cases out of a target of 100, and data collection was still open and in the field as of the cut-off date. With 7 cases for 10 items, the ratio is 0.7 cases per item; consequently, the inter-item correlation matrix is not invertible. The dataset does not include sex or gender variables.

INSTRUMENT

A ten-item scale was administered, with a five-point response format ranging from Strongly disagree (1) to Strongly agree (5). The items were organized into two dimensions of five items each: Housing comfort (R1 to R5) and Control of domestic space (R6 to R10). Two items, R4 and R9, are reverse-worded and have already been recoded in the data matrix, so that a higher score indicates greater comfort and greater control of space. Table 1 presents the code, dimension, wording, and direction of each item.

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Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Comfort	I feel comfortable in my home	No
R2	Comfort	My home has space for my daily activities	No
R3	Comfort	In my home, I find moments of rest	No
R4	Comfort	My home is uncomfortable for me	Yes
R5	Comfort	I feel safe inside my home	No
R6	Control	I participate in decisions about the use of the spaces in my home	No
R7	Control	In my home I have a place for my belongings	No
R8	Control	I can use the room when I need it	No
R9	Control	In my home, other people decide for me where to be	Yes
R10	Control	I have privacy within my home	No

Note. Comfort = Housing comfort; Control = Control of domestic space. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the data matrix provided. Source: Factoriza UAS, project FZ-HAB-0020, survey LEV-0025, dataset DST-0025.

PROCEDURE

Responses were collected using the survey questionnaire administered through Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza locked dataset DST-0025 with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive, internal consistency, and within-dimension correlation analyses (runs RUN-00133 to RUN-00137).

DATA ANALYSIS

Factoriza UAS computed the mean, standard deviation, skewness, kurtosis and percentages of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), with the corrected item-total correlation and alpha if item deleted; and the Pearson correlations among the items of each dimension, with 95% confidence intervals obtained through Fisher's z transformation.

In addition, the project's supplementary analysis program (analisis_psicometrico.py, version 1.0) was run in Python 3.13.16 (Python Software Foundation, 2026) using NumPy (Harris et al., 2020), SciPy (Virtanen et al., 2020) and pandas to estimate McDonald's omega (McDonald, 1999/2013), conduct the exploratory factor analysis and estimate the correlation between dimensions.

The program stopped when computing the measure of sampling adequacy because, with 7 cases for 10 items, the correlation matrix is singular, so those results were not obtained. The execution log is provided in the reproducibility appendix.

Given the size of the cohort, the Factoriza coefficients are reported to document how the instrument performed and not as estimates of its properties. The reference values for the psychometric indices are treated as guidance and not as decision rules (Ferrando et al., 2022). No items were removed, and no confirmatory factor analysis was performed.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit informed consent online and does not collect names, email addresses or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following were used: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, whose execution was halted because of the singularity of the correlation matrix; and the Claude Opus (Anthropic)

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language model, for running that program, assisted literature searching, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the flow of cases. Of the 15 individuals who opened the questionnaire, 7 completed it and were analyzed, with no exclusions on quality-control grounds. All 7 analyzed cases answered the ten items.

Table 2. Sample composition.

Indicator	Value
Individuals who opened the questionnaire	15
Completed questionnaires	7
Cases excluded by quality control	0
Cases analyzed	7
Items	10

Note. Survey "Southern Sinaloa Pilot · Habitability and Gender" (LEV-0025); population: persons aged 18 years or older residing in southern Sinaloa; territory: southern Sinaloa, in localities selected by the project lead. Dataset DST-0025, fingerprint 76b3f828557e1bb5. Source: Factoriza UAS. Preliminary cut-off: n = 7 of a target of 100, with the survey still open.

COMFORT AND CONTROL OF THE DOMESTIC SPACE

Table 3 and Figure 1 present the descriptive statistics. The means of the ten items ranged from 3.00 to 4.43. In the Comfort in the Home dimension, finding moments of rest had the highest mean (R3: *M* = 4.29, *SD* = 0.76), followed by comfort and safety within the home, which had identical descriptive statistics (R1 and R5: *M* = 4.00, *SD* = 0.58).

The availability of space for daily activities (R2: *M* = 3.57, *SD* = 1.27) and the recoded version of the reverse-scored item on discomfort in the home (R4: *M* = 3.57, *SD* = 1.51) had the lowest means in the dimension, with the greatest dispersion.

In the Control of domestic space dimension, privacy had the highest mean on the instrument and the lowest dispersion (R10: *M* = 4.43, *SD* = 0.53), followed by the possibility of using the living room when needed (R8: *M* = 4.29, *SD* = 1.11) and the availability of a place for one's own belongings (R7: *M* = 3.86, *SD* = 1.07).

Participation in decisions about the use of spaces had a mean of 3.43 (R6: *SD* = 1.27), and the reverse-scored item on whether other people decide where one stays, after recoding, had the lowest mean on the instrument and the greatest dispersion (R9: *M* = 3.00, *SD* = 1.53). Overall, respondents reported having privacy and access to common areas, but more limited participation in decisions about space and widely dispersed responses regarding autonomy to decide where to be.

Table 3. Descriptive statistics of the items.

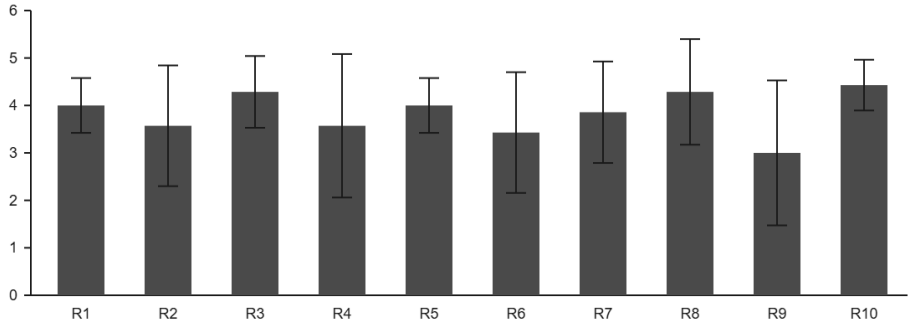
Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	4.00	0.58	0.00	3.00	14%	14%
R2	3.57	1.27	-1.58	3.17	14%	14%
R3	4.29	0.76	-0.60	-0.35	14%	43%
R4	3.57	1.51	-1.00	-0.20	14%	29%
R5	4.00	0.58	0.00	3.00	14%	14%
R6	3.43	1.27	0.22	-1.71	29%	29%
R7	3.86	1.07	-0.77	0.26	14%	29%
R8	4.29	1.11	-1.78	3.23	14%	57%
R9	3.00	1.53	0.39	-1.11	14%	29%

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Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R10	4.43	0.53	0.37	-2.80	57%	43%

Note.N = 7. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated from the total of each dimension. Factoriza UAS run RUN-00133. Preliminary cutoff: n = 7 out of a target of 100, with data collection still open.

Figure 1. Mean scores per item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 presents the item analysis by dimension computed with Factoriza. The two dimensions showed opposite patterns. Control of domestic space had an alpha of .836. Participation in decisions about the use of spaces was the most consistent item (R6: .882), followed by having a place for belongings (R7: .790) and use of the living room (R8: .733); the reverse-scored item showed a moderate relationship (R9: .575), and privacy was the weakest (R10: .312), so removing it would raise the alpha to .872.

Comfort in the home had an alpha of .325. Only comfort and safety within the home reached a corrected item-total correlation of .502 (R1 and R5); rest showed a weak relationship (R3: .256), the reverse-scored item on discomfort was practically unrelated to the other items (R4: .085), and the availability of space for daily activities was negatively related (R2: -.078), such that its removal would raise the alpha to .525. Removing R1 or R5, by contrast, would reduce it to .120.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Comfort	R1	.502	.120
Comfort	R2	-.078	.525
Comfort	R3	.256	.220
Comfort	R4	.085	.414
Comfort	R5	.502	.120
Control	R6	.882	.725
Control	R7	.790	.763
Control	R8	.733	.777
Control	R9	.575	.844
Control	R10	.312	.872

Note.N = 7. Scale from 1 to 5; reverse-scored items R4 and R9 are shown recoded. Run RUN-00133 of Factoriza UAS. Preliminary cutoff: n = 7 of a target of 100, with data collection still open.

Table 5 presents all correlations among the items of each dimension. In the Comfort dimension, the correlation between comfort and safety inside the home was 1.000 (R1 and R5); that is, both items received identical responses in all 7 cases. The remaining correlations in the dimension ranged from -.285 (R2 and R4) to .417 (R3 and R4), and none of their intervals excluded zero; rest was not related to comfort or to safety (R1 and R3, R3 and R5: r = .000).

In the Control dimension, the correlations were mostly positive and of moderate or high magnitude. The correlation between participation in decisions and a place for belongings was

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the only one whose interval excluded zero (R6 and R7: *r* = .788, 95% CI [.085, .967], *p* = .035). This was followed by the correlation between a place for belongings and use of the room (R7 and R8: *r* = .741, 95% CI [-.028, .959], *p* = .057) and that between participation in decisions and use of the room (R6 and R8: *r* = .723, 95% CI [-.066, .956], *p* = .066). Privacy was related mainly to use of the room (R8 and R10: *r* = .600) and was not related to the reverse-scored item (R9 and R10: *r* = .000).

Table 5. Correlations between the items of each dimension.

Dimension	Variable pair	r	IC 95%	p
Comfort	R1 and R2	.227	[-.635, .837]	.625
Comfort	R1 and R3	.000	[-.753, .753]	1.000
Comfort	R1 and R4	.191	[-.657, .825]	.682
Comfort	R1 and R5	1.000	[1.000, 1.000]	< .001
Comfort	R2 and R3	-.025	[-.764, .742]	.958
Comfort	R2 and R4	-.285	[-.855, .596]	.536
Comfort	R2 and R5	.227	[-.635, .837]	.625
Comfort	R3 and R4	.417	[-.490, .890]	.352
Comfort	R3 and R5	.000	[-.753, .753]	1.000
Comfort	R4 and R5	.191	[-.657, .825]	.682
Control	R6 and R7	.788	[.085, .967]	.035
Control	R6 and R8	.723	[-.066, .956]	.066
Control	R6 and R9	.686	[-.139, .949]	.089
Control	R6 and R10	.420	[-.487, .891]	.348
Control	R7 and R8	.741	[-.028, .959]	.057
Control	R7 and R9	.612	[-.261, .934]	.144
Control	R7 and R10	.125	[-.693, .803]	.789
Control	R8 and R9	.392	[-.512, .884]	.384
Control	R8 and R10	.600	[-.279, .932]	.154
Control	R9 and R10	.000	[-.753, .753]	1.000

Note.N = 7. Comfort = Comfort in the home; Control = Control of domestic space. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Comfort = .325 (run RUN-00134); Control = .836 (RUN-00136). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 7 out of a target of 100, with data collection still open.

INTERNAL STRUCTURE AND RELATIONSHIP BETWEEN THE DIMENSIONS

Exploratory factor analysis, McDonald's omega and the correlation between the two dimension scores could not be estimated. With 7 cases for 10 items, and with two items showing identical responses, the correlation matrix was singular, and the supplementary analysis program stopped while calculating the measure of sampling adequacy. Consequently, the study provides no evidence on the dimensionality of the instrument or on the relationship between comfort and control of the domestic space.

DISCUSSION OF RESULTS

The purpose of this study was to conduct a preliminary review of the performance of a scale assessing comfort and control of domestic space in southern Sinaloa. With 7 cases, the coefficients cannot be interpreted as estimates of the instrument's properties: the simulation literature on alpha and omega has been developed with much larger samples (Malkewitz et al., 2023), and factor analysis requires a sample size that this data cut does not reach (Ferrando et al., 2022; Goretzko et al., 2021).

The data cut does, however, make it possible to identify three problems that should be resolved before data collection continues.

The first is the complete overlap between the responses to R1 and R5. Comfort and safety

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within the home are distinct constructs, and although two items may coincide by chance in a sample of 7 people, the exact match across all cases means that an error in the questionnaire setup or in data entry must be ruled out. This finding has direct consequences for the Comfort dimension: R1 and R5 are the only items that sustain its internal consistency, and without one of them alpha would drop to .120. Until this point is verified, the internal consistency of the dimension cannot be assessed.

The second is the lack of coherence in the Comfort dimension, even without considering that problem. The availability of space for daily activities was negatively related to the other items, and the reverse-worded item on discomfort was virtually unrelated to this item. The literature on crowding indicates that available space is a central component of the home experience (Chan et al., 2024; Wang and Liu, 2023). Its lack of association with comfort in this cross-section therefore points not so much to its irrelevance as to the possibility that the dimension combines heterogeneous content, such as rest, space, and safety, that may not form a single construct.

Furthermore, the behavior of R4 is consistent with an artifact associated with reverse wording (García-Batista et al., 2021; Steinmann et al., 2022).

The Control of the domestic space dimension, by contrast, functioned more coherently, with high item-total correlations for participation in decisions, having a place for one's belongings, and use of the living room. This finding is consistent with the notion that the capacity to make decisions about the space and to have places of one's own is part of a single experience of appropriation of the home (Keynejad et al., 2026; Torres Pérez, 2023).

Privacy was the least coherent item in the dimension and had the highest mean and the lowest dispersion in the instrument; with responses so concentrated, its ability to relate to the other items is limited in this cross-section. The reverse-scored item on whether other people decide where one should be showed the greatest dispersion in the instrument, suggesting that it captures real differences among respondents that warrant examination with a larger sample.

The placement of safety within the home in the Comfort dimension also warrants review. The literature on residential safety links it to household relationships and to the immediate surroundings (INEGI, 2022; te Braak and van Tienoven, 2025; Torres Pérez, 2023), rather than to rest or available space. If the final data collection wave confirms that safety does not cluster with the rest of the Comfort content, it could be considered a dimension in its own right, bringing together safety within the home, on arriving there, and in the surrounding area.

Similarly, the item on whether other people decide where one should be relates to control over space but also to power relations within the household; its interpretation would be more precise if the questionnaire recorded who makes decisions about the dwelling.

The third problem is one of design and affects the aim of the project. The scale was administered to people aged 18 years or older, but the dataset does not include the respondents' sex or gender, so it is not possible to examine whether comfort and control over domestic space differ between women and men.

The review by Vásquez-Vera et al. (2022) warned that many studies on housing and health lack a gender perspective or are limited to comparisons by sex; if the project is to contribute to that agenda, the final survey will need to record at least the sex and gender of respondents and, where possible, their role in the household and in caregiving tasks.

CONCLUSIONS

The study met its objective to the extent permitted by a preliminary data cut of 7 cases: it does not provide estimates of the psychometric properties of the scale, but it identifies the adjustments the scale requires.

The Control of domestic space dimension showed high internal consistency ($\alpha = .836$), with participation in decisions, a place for belongings, and use of the living room as the most coherent items. In contrast, the Comfort in the home dimension showed low internal consistency ($\alpha = .325$), supported only by two items that received identical responses across all cases. Respondents reported privacy and moments of rest in their homes, while their responses on participation in decisions about the space and autonomy in deciding where to be were lower and more dispersed.

The limitations are substantial. With 7 cases against a target of 100, and with data collection still ongoing, the sample is insufficient to estimate internal consistency precisely and does not permit factor analysis, omega, or the correlation between dimensions, none of which could be calculated. Respondents completed the questionnaire in localities selected by the project lead, so the results cannot be generalized to the population of southern Sinaloa. The dataset does

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not include the sex or gender of the respondents, which precludes the comparison that gives the project its purpose. Because the design is cross-sectional, the direction of the relationships cannot be established. No confirmatory factor analysis was performed.

Several decisions for the authors follow from these results. The first is to verify the complete agreement between the responses to R1 and R5 in Factoriza and, if it stems from an error, to correct it before proceeding. The second is to review the Comfort dimension, particularly R2 and R4, and decide whether their contents should remain together or be separated. The third is to add the sex and gender of the respondents, and their role in the household, to the questionnaire. The fourth is to document the origin of the items and the criterion used to select the localities. None of these decisions was made in the present analysis, which retains all ten items.

For future work, we propose completing data collection to the planned target using a design that ensures the participation of women and men in sufficient proportions to allow comparison between them; repeating the internal consistency analysis and performing the exploratory factor analysis on the final dataset; confirming the structure in an independent sample through confirmatory factor analysis; and examining whether comfort and control of domestic space differ by gender once the validity evidence for the instrument has been established. A scale with such evidence would allow a gender perspective to be incorporated into habitability studies in northwestern Mexico.

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Chapter 11 / Capítulo 11

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Vacant housing and perceived abandonment in social housing subdivisions of northwestern Mexico

Vivienda deshabitada y percepción del abandono en fraccionamientos de interés social del noroeste de México

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ABSTRACT

Vacant housing is one of the most visible expressions of habitability problems in Mexican social housing subdivisions. Using the preliminary data cut from the pilot survey of project FZ-HAB-0029 on the Factoriza UAS platform, this study described the initial behaviour of a ten-item scale with two dimensions, Perceived abandonment in the subdivision and Rootedness in the subdivision, among residents of social housing subdivisions in Mazatlán. With a cross-sectional design, 7 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and the Spearman correlation between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was practically null for Perceived abandonment (α = .062), owing to the negative correlation of a reverse-worded item, and low for Rootedness (α = .357), with omega not interpretable in either dimension. The factor analysis was not interpretable because the sample had fewer cases than items, and the correlation between dimensions included zero (ρ = .218). Residents perceived deterioration of vacant dwellings, intended to stay in their subdivision and rarely took part in neighbourhood activities. The findings do not yet provide validity evidence and point to revisions of the instrument.

Keywords: vacant housing; perceived abandonment; place attachment; social housing

RESUMEN

La vivienda deshabitada es una de las expresiones más visibles de los problemas de habitabilidad de los fraccionamientos de interés social en México. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0029 de Factoriza UAS, el comportamiento inicial de una escala de diez reactivos con dos dimensiones, Abandono percibido en el fraccionamiento y Arraigo en el fraccionamiento, en residentes de fraccionamientos de interés social de Mazatlán. Con diseño transversal, se analizaron 7 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y la correlación de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue prácticamente nula en Abandono percibido (α = .062), por la correlación negativa de un reactivo inverso, y baja en Arraigo (α = .357), con el omega no interpretable en ambas dimensiones. El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos, y la correlación entre dimensiones incluyó el cero (ρ = .218). Los residentes percibieron deterioro de las viviendas deshabitadas, conservaron la intención de permanecer en su fraccionamiento y apenas participaron en actividades vecinales. Los resultados no aportan todavía evidencias de validez y orientan la revisión del instrumento.

Palabras clave: vivienda deshabitada; abandono percibido; apego al lugar; vivienda de interés social

INTRODUCTION

During the first two decades of this century, Mexico produced social housing on an unprecedented scale, in housing complexes built by private developers with financing from public housing agencies.

The policy reduced the housing backlog, but it did so unevenly and at costs that are now visible: small dwellings, housing developments far from urban centers, insufficient services and a high number of abandoned homes. The federal government itself acknowledged the scale of this abandonment in 2020, and several studies link it to an expansive policy that failed to address the needs of its residents (Hernández Ilizaliturri et al., 2025). Vacant housing is therefore one of the most visible expressions of the habitability problems in social housing subdivisions.

Vacant homes are not only a problem for the people who abandoned them. They also transform the experience of those who stay behind. In southeastern Ciudad Juárez, the presence of uninhabited and squatted homes is accompanied by insecurity, a lack of public spaces and social isolation (Holguín Ávila and Maycotte Pansza, 2024). In neighborhoods in the state of Hidalgo, abandoned housing has been associated with security and environmental problems and with a deteriorated urban landscape (Chávez-San Juan et al., 2024).

Outside Mexico, residents of neighborhoods with vacant properties describe a cycle in which the abandonment of the built environment is linked to violence, loss of social cohesion, and the deterioration of health and well-being (Roude et al., 2024).

Given this environment, whether residents stay depends on their bond with the place. Research on residential mobility has shown that perceived neighborhood disorder is associated with a greater intention to move, whereas community attachment and satisfaction are associated with a lower one (Gu et al., 2025).

The relationship between perceived abandonment and the place attachment of those who remain is therefore a central question for the habitability of social housing developments. However, no instruments were identified that jointly measure both aspects in housing developments in northwestern Mexico.

Project FZ-HAB-0029 of the Factoriza UAS platform set out to study unoccupied housing and the perception of abandonment in social housing developments in northwestern Mexico. This article reports the results of the first pilot survey of the Perceived Abandonment and Rootedness in Housing Developments Scale (ten items organized into two dimensions), conducted in Mazatlán and based on a very small preliminary data cut. For this reason, the article's scope is the initial review of the instrument, not the estimation of population parameters or the measurement of housing vacancy.

The general objective was to describe the initial behavior of a scale of perceived abandonment and rootedness in the preliminary data cut from its pilot survey of residents of social housing subdivisions in Mazatlán.

The specific objectives were, first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to explore the relationship between the scores on the two dimensions. The project package records no hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

UNINHABITED HOUSING IN SOCIAL HOUSING DEVELOPMENTS

Housing abandonment in social housing developments has been explained by a combination of locational, design and household economic factors.

The peripheral location of the housing developments is accompanied by limited access to employment, transport and services. The evaluation of social housing policy has emphasized that the expansion of supply was not matched by sufficient attention to the needs of residents (Hernández Ilizaliturri et al., 2025).

At the dwelling level, architectural design, functionality, comfort, construction quality and aesthetics are related to the decision to stay or leave, so a dwelling that does not meet the main needs of its occupants may end up abandoned (Chávez-San Juan et al., 2024).

Difficulties in social organization compound the problem. In Ciudad Juárez, Rodríguez Sosa et al. (2022) identified difficulty in organizing the maintenance of multifamily units as a risk to

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the acceptance of social housing. Holguín Ávila and Maycotte Pansza (2024) documented that, in housing developments with unoccupied dwellings, the invasion of empty houses is accompanied by a perception of loneliness and insecurity among those who remain.

Abandonment, therefore, is not merely a feature of the housing stock but a condition that is perceived and experienced on the street.

The Perceived Abandonment in the Housing Development dimension of the instrument captures this experience through five indicators: the presence of unoccupied dwellings on the respondent's own street (R1), their deterioration (R2), the use of vacant houses for activities that worry residents (R3), the proportion of occupied houses in the housing development (R4, reverse-scored), and the closure of businesses in recent years (R5). After R4 was recoded, a higher score indicates greater perceived abandonment.

ABANDONMENT, DISORDER, AND SAFETY

The literature on vacant properties has documented their relationship with neighborhood safety and health. In a cluster-randomized trial in Philadelphia, full remediation of abandoned houses (installing working doors and windows and clearing trash and overgrown vegetation) was associated with relative reductions in weapons violations and gun assaults, although nearby residents' perceptions of safety and the time they spent outdoors did not change (South et al., 2023).

In Baltimore, the demolition of vacant housing was associated with a small decrease in emergency department visits, but not with significant changes in crime (Kvik et al., 2022).

These findings show that the relationship between vacant housing and safety is complex: interventions targeting the physical environment may be associated with changes in some indicators of violence without immediately altering residents' perceptions.

In New Orleans, residents linked neglected properties to their health, their sense of safety, social cohesion, and civic participation, and recommended improving neighborhood conditions to reduce violence and enhance quality of life (Roude et al., 2024). Item R3, on the use of empty houses for unsettling activities, touches on this dimension of the experience of abandonment.

ROOTEDNESS AND PERMANENCE IN THE HOUSING DEVELOPMENT

Rootedness refers to the bond people maintain with the place where they live and their willingness to remain there. The literature on place attachment distinguishes several dimensions, such as place identity, place dependence, affect, and social bonds. A systematic review noted that there is no consensus on how to measure place attachment and that its dimensions do not behave in the same way with respect to behavioral intentions (Dang and Weiss, 2021).

In rural households in seismic zones of China, place dependence was negatively associated with relocation intention, whereas place identity was indirectly related to evacuation intention through perceived response efficacy (Qing et al., 2022).

In urban settings, a study based on 1,568 questionnaires administered in 74 communities in Guangzhou grouped perceptions of the community environment into three aspects (perceived disorder, community attachment and satisfaction). It found that perceived disorder was positively associated with the intention to move, whereas attachment and satisfaction were negatively associated with it (Gu et al., 2025).

In subsidized housing developments in the same city, Tang et al. (2024) associated greater residential satisfaction with larger dwellings, well-equipped neighborhoods, close neighborhood ties, and community activities.

The instrument's Rootedness in the Housing Development dimension brings together five aspects of this bond: feeling part of the housing development (R6), knowing the neighbors on one's street (R7), intending to continue living in the housing development (R8), having considered leaving one's home (R9, reverse-scored), and participating in activities with neighbors (R10).

After R9 is recoded, a higher score indicates greater place attachment. As in the literature reviewed, the dimension combines affective, social and intention-to-stay components, which do not necessarily move together.

From this perspective, the expected relationship between perceived abandonment and place attachment is negative, but not necessarily simple. A resident may perceive considerable abandonment around them while also maintaining a strong bond with their home and with

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the neighbors who remain. Given the cross-sectional design, any relationship between the two dimensions must be understood as an association rather than one of dependence.

METHODOLOGY
DESIGN

We conducted a quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope. The data come from survey LEV-0034, "Mazatlán Pilot · Perceived Abandonment and Rootedness," from project FZ-HAB-0029 on the Factoriza UAS platform, and from the frozen dataset DST-0032, with a data cut-off date of 9 October 2026. The survey constitutes an independent sample and is the only one in the project.

POPULATION, SAMPLE, AND DATA CUTOFF

The survey population was defined as individuals aged 18 years or older residing in social housing developments in northwestern Mexico, with a pilot study in Mazatlán.

According to the survey log, the participating housing developments are classified as social housing and have unoccupied dwellings documented in an official source. Selection was non-probabilistic. The Factoriza log shows that 14 people opened the questionnaire and 7 completed it; no cases were excluded on quality-control grounds, so 7 cases were analyzed (Table 2).

The analyzed data cut is preliminary: it comprises 7 cases out of a target of 100, and data collection was still open, in the field, at the cut-off date. With 7 cases for 10 items, the ratio is 0.7 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and of the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Perceived Abandonment and Place Attachment in Housing Developments Scale was administered. It comprises ten items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5), organized into two five-item dimensions: Perceived Abandonment in the Housing Development (R1 to R5) and Place Attachment to the Housing Development (R6 to R10). Two items are reverse-worded, R4 ("In my housing development, most of the houses are occupied") and R9 ("I have thought about leaving my home in this housing development"), and are already recoded in the data matrix.

After recoding, a higher score indicates greater perceived abandonment and greater rootedness. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Perceived abandonment in the housing development	There are unoccupied homes on my street	No
R2	Perceived abandonment in the housing development	The unoccupied houses in my neighborhood are deteriorated	No
R3	Perceived abandonment in the housing development	The empty houses in my housing development are used for activities that worry me	No
R4	Perceived abandonment in the housing development	In my housing development, most of the houses are occupied	Yes
R5	Perceived abandonment in the housing development	Businesses in my residential development have closed in recent years	No
R6	Rootedness in the residential development	I feel part of my residential development	No
R7	Rootedness in the residential subdivision	I know the neighbors on my street	No
R8	Rootedness in the housing development	I plan to continue living in this housing development	No
R9	Attachment to the housing development	I have thought about leaving my home in this housing development	Yes
R10	Rootedness in the housing development	I take part in activities with my neighbors	No

Note. Scale of perceived abandonment and rootedness in housing developments. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0029, survey LEV-0034, dataset DST-0032.

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PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0032 with a cryptographic hash, generated the matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency and within-dimension correlation analyses (runs RUN-00186 to RUN-00190). The complementary analyses were run on the data file and the item dictionary exported by the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted; and the correlations among the items of each dimension, which the package notes identify as Spearman correlations, with 95% confidence intervals computed using the Fisher transformation.

In a second stage, the program analisis_psicometrico.py (version 1.0) was run in Python 3.13.16 (Python Software Foundation, 2026) with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, explicitly stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items; when any item correlates or loads negatively with the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable. It also attempted an exploratory factor analysis of the ten items, preceded by an assessment of overall and item-level sampling adequacy (Lorenzo-Seva and Ferrando, 2021) and a test of sphericity, using parallel analysis to determine the number of factors, minimum residual extraction and oblimin rotation.

Finally, it estimated the relationship between the mean dimension scores using Spearman's coefficient and its 95% confidence interval, computed via the Fisher transformation with the standard error from Bonett and Wright (2000).

The reference values for interpreting the psychometric indices are treated as guidelines rather than as decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is proposed as future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit informed consent online and does not collect names, email addresses or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and the correlation between dimensions; and the Claude Opus language model (Anthropic), to run that program, assist with literature searches, prepare a draft and assemble the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference, and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 14 individuals who opened the questionnaire, 7 completed it and were analyzed, with no quality-control exclusions. All analyzed cases answered

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all ten items. The proportion of incomplete questionnaires should be reviewed during field administration.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	14
Completed questionnaires	7
Cases excluded by quality control	0
Cases analyzed	7
Items	10

Note. Survey "Piloto Mazatlán · Abandono percibido y arraigo" [Mazatlán Pilot · Perceived Abandonment and Rootedness] (LEV-0034); population: persons aged 18 years or older residing in social-interest (low-income) housing subdivisions in northwestern Mexico, with a pilot in Mazatlán; territory: Mazatlán, Sinaloa, in social-interest housing subdivisions with uninhabited housing documented in an official source. Dataset DST-0032, fingerprint af001bcad37888fc. Source: Factoriza UAS. Preliminary cut-off: n = 7 out of a target of 100, with the survey still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. For Perceived Abandonment in the Housing Development, the highest mean was for the deterioration of unoccupied dwellings (R2: *M* = 3.57, *SD* = 0.79), followed by the presence of unoccupied dwellings on the respondent's own street (R1: *M* = 3.29, *SD* = 1.60), which showed the greatest dispersion in the instrument, and by the closure of businesses in recent years (R5: *M* = 3.29, *SD* = 1.38).

The use of empty houses for activities that worry residents had an intermediate mean (R3: *M* = 2.86, *SD* = 1.07). The reverse-scored item R4, in its recoded version, had the lowest mean in the dimension (*M* = 2.00, *SD* = 1.41), with 43% of responses at the minimum value, which corresponds to strongly agreeing that most of the houses in the housing development are occupied.

In the Attachment to the housing development dimension, means were high for knowing the neighbors on one's street (R7: *M* = 4.14, *SD* = 0.90), intending to continue living in the housing development (R8: *M* = 4.14, *SD* = 0.38), and feeling part of the housing development (R6: *M* = 4.00, *SD* = 0.58). R9, in its recoded version, also had a high mean (*M* = 3.86, *SD* = 1.07), indicating, on average, little willingness to leave one's home.

In contrast, participation in activities with neighbors had the lowest mean on the instrument (R10: *M* = 1.86, *SD* = 1.07), with 43% of responses at the minimum value. Taken together, this cross-section depicts residents who perceive signs of abandonment in their surroundings without believing, on average, that most of the houses are vacant. They maintain a bond with their housing development and intend to remain there, but they hardly take part in neighborhood activities.

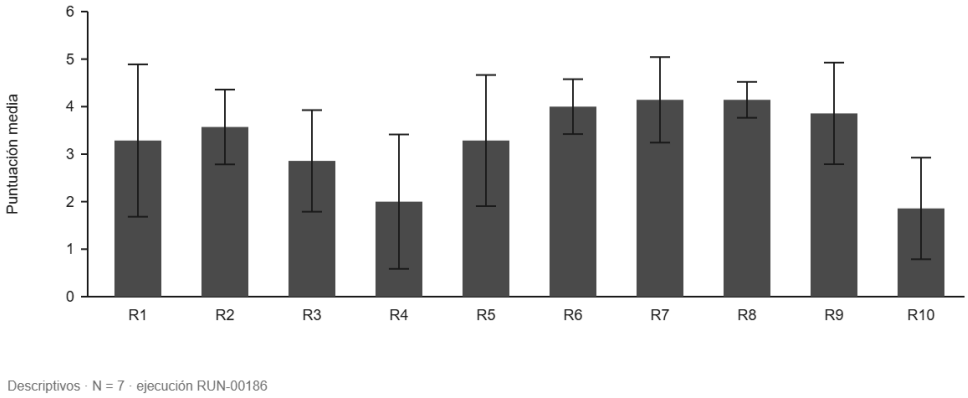
Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.29	1.60	-0.98	-0.86	29%	14%
R2	3.57	0.79	1.11	0.27	57%	14%
R3	2.86	1.07	-0.77	0.26	14%	29%
R4	2.00	1.41	1.98	4.40	43%	14%
R5	3.29	1.38	-0.71	-0.33	14%	14%
R6	4.00	0.58	0.00	3.00	14%	14%
R7	4.14	0.90	-0.35	-1.82	29%	43%
R8	4.14	0.38	2.65	7.00	86%	14%
R9	3.86	1.07	-0.77	0.26	14%	29%
R10	1.86	1.07	1.52	2.71	43%	14%

Note.N = 7. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column across the ten items is omitted because it combines two dimensions; the item-total correlation by dimension is presented in Table 4. Run RUN-00186 of Factoriza UAS. Preliminary cutoff: n = 7 out of a target of 100, with data collection still open.

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Figure 1. Mean scores per item with one-standard-deviation bars.



INTERNAL CONSISTENCY

Table 4 compiles the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary software. The dimension Perceived abandonment in the housing development yielded α = .062 in both calculations, a value indicating that the items, taken together, do not share variance.

Omega is not reported because R4 correlated negatively with the rest of the dimension (-.739); its removal would raise alpha to .766. Among the remaining items, R2, the deterioration of unoccupied dwellings, was the most consistent (.763), followed by R5 (.524), R1 (.281), and R3 (.261). None of the inter-item correlations in this dimension had a confidence interval that excluded zero; the highest was between R2 and R5 (.682, 95% CI [-.146, .948], *p* = .091).

Rootedness in the housing development yielded α = .357 in both calculations; omega is not reported because R10, participation in activities with neighbors, correlated negatively with the rest of the dimension (-.137), and its removal would raise alpha to .610. R7 (.605), R8 (.464), and R6 (.452) were the most consistent items, whereas R9 had a practically null correlation (.011). The only correlation whose interval excluded zero was the one between feeling part of the housing development and intending to continue living in it (R6 and R8: .764, 95% CI [.025, .963], *p* = .046). Participation in neighborhood activities correlated negatively with R9 (-.606, 95% CI [-.933, .270], *p* = .149) and with R8 (-.441), with neither interval excluding zero.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Perceived abandonment	R1	.281	-.449
Perceived abandonment	R2	.763	-.589
Perceived abandonment	R3	.261	-.207
Perceived abandonment	R4	-.739	.766
Perceived abandonment	R5	.524	-.829
Rootedness	R6	.452	.156
Rootedness	R7	.605	-.154
Rootedness	R8	.464	.230
Rootedness	R9	.011	.483
Rootedness	R10	-.137	.610

Note.N = 7. Scale from 1 to 5; reverse-scored items R4 and R9 are shown recoded. Run RUN-00186 of Factoriza UAS. Preliminary data cut: n = 7 out of a target of 100, with data collection still open.

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Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Remarks
Perceived abandonment in the housing development	5	7	.062		Reverse-worded items: R4; □ not interpretable
Rootedness in the housing development	5	7	.357		Reverse-keyed items: R10; □ not interpretable

Note.N = 7. Perceived abandonment = Perceived abandonment in the residential subdivision; Rootedness = Rootedness in the residential subdivision. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for the full dimension, with 5 items each: Perceived abandonment in the residential subdivision = .062 (run RUN-00187); Rootedness in the residential subdivision = .357 (RUN-00189). When the mean covariance among the remaining items is negative, alpha if item deleted is no longer bounded between 0 and 1, which explains its negative values. Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary cutoff: n = 7 of a target of 100, with data collection still open.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated interpretably, and its results are not presented in tables. With 7 cases and 10 items, the correlation matrix is not invertible, so the overall measure of sampling adequacy, the item-level sampling adequacy, and the test of sphericity could not be computed. Parallel analysis suggested one factor, but the solution showed a Heywood case for R8 and opposite signs for five items; with fewer cases than items, the solution lacks support. These results are recorded in the reproducibility appendix, but they provide no evidence on the dimensionality of the instrument and should not be cited as such.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlation between the mean scores of the two dimensions, based on 7 cases. The relationship was positive and weak, and its interval included zero, ρ = .218, 95% CI [-.647, .838], *p* = .639, so this data cut does not allow us to assert an association between perceived abandonment and rootedness. Because neither dimension showed sufficient internal consistency, this correlation should not be interpreted, and the width of the interval indicates a highly imprecise estimate.

Table 6. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Perceived Abandonment of the Housing Development and Rootedness in the Housing Development	7	.218	[-.647, .838]	.639

Note.α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum residual model, without reversing items. Complete cases per dimension. Source: Own elaboration with analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0032_FZ_HAB_0029. Preliminary cutoff: n = 7 out of a target of 100, with data collection ongoing.

DISCUSSION OF RESULTS

This study aimed to describe the initial behavior of a scale of perceived abandonment and rootedness among residents of social housing developments in Mazatlán. The central finding is that neither dimension behaved as a scale in this cross-section. Perceived Abandonment had an alpha close to zero, attributable mainly to the behavior of R4, and Rootedness had a low alpha, with one item showing the opposite sign.

With 7 cases, all coefficients are provisional: the simulation literature on alpha and omega coefficients has been developed with far larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated.

The descriptive profile of the abandonment dimension is consistent with the literature. The finding that the deterioration of unoccupied dwellings had the highest mean is in line with descriptions of the dilapidated appearance that abandoned housing gives the urban landscape (Chávez-San Juan et al., 2024) and with the experiences of residents of Ciudad Juárez and New Orleans (Holguín Ávila and Maycotte Pansza, 2024; Roude et al., 2024).

The intermediate mean for R3 suggests that, in this sample, the use of empty houses for unsettling activities is not a widespread experience. These correspondences are descriptive: the study did not measure housing vacancy, so it cannot link perceptions to the actual extent of

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vacancy in each housing development.

The behavior of R4 deserves particular attention. Its correlation with the rest of the dimension was strongly negative, and its removal would raise alpha from .062 to .766. A content-based explanation is possible: a person may recognize uninhabited and deteriorated dwellings on their street and, at the same time, believe that most homes in the housing development remain occupied, because R4 refers to the proportion of abandonment rather than its presence.

A technical explanation is also possible, because scales with items worded in both directions require careful reading, and some respondents answer positively and negatively worded items inconsistently (Steinmann et al., 2022; García-Batista et al., 2021).

In the rootedness dimension, the results distinguish the emotional bond and the intention to stay, which were associated with each other, from participation in neighborhood activities, which was low and behaved in the opposite direction.

This pattern is consistent with the warning that the dimensions of place attachment do not behave in the same way (Dang and Weiss, 2021) and suggests that neighbourhood participation is a distinct aspect of rootedness. The literature on subsidised housing associates neighbourhood ties and community activities with greater satisfaction (Tang et al., 2024), and studies of housing developments with vacant dwellings document the social isolation of those who remain (Holguín Ávila and Maycotte Pansza, 2024).

The low participation observed is consistent with this isolation, but the cross-section does not allow this interpretation to be tested.

The intention to remain, which was high in this sample, contrasts with the image of social housing developments as places people leave. The residential mobility literature associates perceived disorder with a greater intention to move and attachment with a lower one (Gu et al., 2025), but with 7 cases and dimensions lacking internal consistency, this relationship cannot be examined. In addition, response quality must be reviewed before the final analysis, because in small samples careless or inconsistent response patterns can markedly distort correlations (Ward and Meade, 2023).

CONCLUSIONS

The study met its objective to the extent permitted by a preliminary sample of 7 cases. In its pilot administration, the perceived abandonment and rootedness scale for housing developments from project FZ-HAB-0029 showed virtually zero internal consistency for Perceived abandonment in the housing development (α = .062) and low internal consistency for Rootedness in the housing development (α = .357). Omega was not interpretable in either dimension because items R4 and R10 had opposite signs.

The exploratory factor analysis could not be estimated interpretably because the sample has fewer cases than items, and the confidence interval for the correlation between the dimensions included zero. The results do not yet provide validity evidence, but they describe residents who perceive deterioration and abandonment in their surroundings, who retain their attachment to their housing development and the intention to remain in it, and who barely participate in neighborhood activities.

The limitations are substantial. The sample of 7 cases, against a target of 100, with 0.7 cases per item, precludes estimating the internal structure and makes all statistics unstable; data collection was still ongoing, and not everyone who opened the questionnaire completed it.

The pilot study was conducted in Mazatlán, so the results are not representative of the housing developments in northwestern Mexico referred to in the project title. No information is available on the participating housing developments, the respondents, or housing tenure, and the study did not measure housing vacancy. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

Several decisions for the authors follow from these results. The first is to review both the recoding and the wording of R4, and to assess whether it should be replaced by an item referring to the presence of abandonment in the immediate surroundings. The second is to assess whether neighborhood participation (R10) should be measured as a separate dimension, distinct from affective attachment and from the intention to stay. The third is to review the case with contradictory responses. The fourth is to confirm the correlation coefficient that Factoriza applied between items. The fifth is to record the housing development, the official source of the vacancy data, housing tenure, and length of residence. None of these decisions was made in the present analysis, which retains the original ten items.

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For future work, we propose completing data collection up to the planned target, extending it to housing developments in other cities in the northwest, repeating the exploratory factor analysis once the number of cases allows, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample.

Linking perceptions to development-level vacancy data would make it possible to examine the correspondence between perceived and recorded abandonment. An instrument with documented validity evidence would also provide useful information for housing recovery programs by incorporating the experience of those who remain in the developments, an aspect that evaluations of social housing policy have identified as neglected (Hernández Ilizaliturri et al., 2025).

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Chapter 12 / Capítulo 12

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Perceived seismic risk and occupant preparedness as a component of a seismic vulnerability assessment methodology

Riesgo sísmico percibido y preparación de los ocupantes como componente de una metodología para la evaluación de la vulnerabilidad sísmica

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ABSTRACT

Seismic vulnerability assessment usually focuses on the physical features of buildings, yet the vulnerability of a household also depends on what its occupants perceive, know and do. This study described the initial behaviour of a perceived seismic risk and preparedness scale, with ten items and two dimensions, as an input for the occupant component of the seismic vulnerability assessment methodology of project FZ-HAB-0031 on the Factoriza UAS platform. With a cross-sectional design, 8 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha and inter-item correlations were estimated. Internal consistency was very low for Perceived seismic risk of the dwelling (α = .203) and low for Earthquake preparedness (α = .464). In the first dimension, affective components and judgements about the dwelling did not vary together; in the second, knowing what to do, a family meeting point and an emergency kit formed a coherent core, and having a meeting point was associated with recognising furniture that could fall (r = -.745 with the recoded item). Occupants reported knowing how to act during an earthquake, whereas a meeting point and an emergency kit scored below the scale midpoint. The technical component of the methodology is not part of the analysed package. The findings guide the revision of the instrument and its link with the technical assessment of buildings.

Keywords: seismic vulnerability; risk perception; earthquake preparedness; internal consistency

RESUMEN

La evaluación de la vulnerabilidad sísmica suele centrarse en las características físicas de las edificaciones, pero la vulnerabilidad de un hogar depende también de lo que sus ocupantes perciben, saben y hacen. Este estudio describió el comportamiento inicial de una escala de riesgo sísmico percibido y preparación, de diez reactivos y dos dimensiones, como insumo para el componente de ocupantes de la metodología de evaluación de la vulnerabilidad sísmica del proyecto FZ-HAB-0031 de Factoriza UAS. Con diseño transversal, se analizaron 8 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach y correlaciones entre reactivos. La consistencia interna fue muy baja en Riesgo sísmico percibido en la vivienda (α = .203) y baja en Preparación ante sismos (α = .464). En la primera dimensión, los componentes afectivos y los juicios sobre la vivienda no variaron juntos; en la segunda, el conocimiento de qué hacer, el punto de reunión y la mochila de emergencia formaron un núcleo coherente, y el punto de reunión se asoció con el reconocimiento de muebles que podrían caer (r = -.745 con el reactivo recodificado). Los ocupantes declararon saber cómo actuar durante un sismo, pero el punto de reunión y la mochila de emergencia obtuvieron medias por debajo del punto medio de la escala. El componente técnico de la metodología no forma parte del paquete analizado. Los resultados orientan la revisión del instrumento y su vinculación con la evaluación técnica de las edificaciones.

Palabras clave: vulnerabilidad sísmica; percepción del riesgo; preparación ante sismos; consistencia interna

INTRODUCTION

Earthquakes are among the natural hazards with the greatest capacity to damage the building stock, and Mexico has a long history of losses associated with them. The magnitude 7.1 earthquake of 19 September 2017 damaged more than 12,000 structures of all occupancy types in Mexico City, according to the authorities cited by Tena-Colunga et al. (2021), who also documented a reconstruction process that was still ongoing years later.

The same event showed that the population's reactions during the shaking and in the hours that followed, dominated by fear and surprise, are part of the response to the disaster: in a survey of 2,400 city residents, Santos-Reyes and Gouzeva (2020) recommended training the public in what to do during and after earthquakes.

Seismic vulnerability assessment of buildings is the basis for risk reduction strategies. For large building stocks, rapid visual screening methods are used. These methods classify the vulnerability of each building based on local seismicity, soil type, construction system and structural features, and they differ in application time and in whether they are oriented toward pre- or post-earthquake assessment (Bektaş and Kegyes-Brassai, 2022).

These methods have shown limitations in accuracy, and recent research is exploring ways to improve them using machine learning trained on post-earthquake inspection data (Bektaş and Kegyes-Brassai, 2025). In self-built housing, checklist-based field assessment is combined with structural modeling and retrofitting proposals (Medrano-Sánchez and Fabian, 2025).

However, the vulnerability of a dwelling does not depend solely on its physical characteristics. It also depends on what its occupants know and do: on whether they recognize the signs of fragility in their home, whether they know how to act during an earthquake, and whether they have taken household preparedness measures.

The literature on risk perception and earthquake preparedness shows that these dimensions do not always align: as Cisternas et al. (2024) note, people with prior experience and high risk perception are not necessarily better prepared. Similarly, among households in high-hazard areas, the vast majority perceive the local risk, whereas only a minority consider themselves sufficiently prepared (Şahin et al., 2026). A methodology for assessing seismic vulnerability that aims to guide household risk reduction therefore needs to incorporate the occupants' perspective alongside the technical assessment of buildings.

Project FZ-HAB-0031 of the Factoriza UAS platform set out to develop a methodology for assessing seismic vulnerability. The project's results package contains the occupant-oriented component: a perceived seismic risk and preparedness scale comprising ten items organized into two dimensions, Perceived Seismic Risk in the Home and Earthquake Preparedness, administered to the occupants of the buildings assessed by the project.

Consequently, this article is limited to the occupant component on perception and preparedness and does not present results on the structural vulnerability of the buildings.

The overall objective was to describe the initial performance of the perceived seismic risk and preparedness scale in the preliminary data cut from its pilot survey, as an input to the occupant component of the seismic vulnerability assessment methodology.

The specific objectives were, first, to describe occupants' perception of the seismic risk of their dwelling and their self-reported level of preparedness; second, to estimate the internal consistency of each dimension and identify items with discrepant behavior; and third, to examine the correlations among the items within each dimension. The project package records no hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

SEISMIC VULNERABILITY AND ASSESSMENT METHODS FOR BUILDINGS

The seismic vulnerability of a building expresses its susceptibility to damage from ground motion of a given intensity. It can be assessed at different levels of detail, ranging from the structural analysis of a single building to the screening of thousands of buildings.

The review by Bektaş and Kegyes-Brassai (2022) compared conventional rapid visual screening methods, seismic risk indices and vulnerability assessments. It noted that some methods require between fifteen and thirty minutes per building, whereas others take around one hour, and that some are intended for pre-earthquake screening and others for post-earthquake assessment.

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The authors proposed machine learning and fuzzy logic as avenues for improvement; in a subsequent study using inspection data from the 2015 Gorkha earthquake in Nepal, a machine-learning-based screening method achieved 73% accuracy in classifying damage states, far higher than that of conventional methods (Bektaş and Kegyes-Brassai, 2025).

Self-built housing poses particular challenges because its construction process often lacks professional supervision and its characteristics are not always visible from the outside.

In a settlement in Lima, Medrano-Sánchez and Fabian (2025) combined field diagnosis using the INDECI checklist to classify seismic vulnerability, structural modeling in accordance with the Peruvian standard E.030, and the design and testing of a steel-section retrofit. Because of the small number of models and specimens, they presented their results descriptively. These studies show that an assessment methodology must be tailored to the building type, the available information, and the purpose of the assessment.

The Mexican experience illustrates the importance of assessing vulnerability before an earthquake occurs. Following the 2017 earthquake, Tena-Colunga et al. (2021) quantified the resilience of Mexico City's built environment on the basis of damage statistics and reconstruction progress; they recommended structural health monitoring programs for representative buildings to detect and correct deficiencies before the next strong earthquake.

Technical assessment, however, informs us about the building but not about how its occupants perceive risk or about their capacity to act.

SEISMIC RISK PERCEPTION

Risk perception is a multidimensional construct. In the area affected by the Wenchuan earthquake, Huang et al. (2022) constructed a risk perception index for secondary hazards from four indicators (possibility, awareness, apprehension and impact). Using 957 valid responses, they found that perception varied with age, educational attainment, marital status and previous disaster experience.

In Concepción, Chile, using a representative sample of 585 people, Cisternas et al. (2024) found that risk perception was directly and positively associated with the intention to prepare for earthquakes and tsunamis, and that risk awareness and risk perception should be treated as distinct concepts.

These distinctions are relevant to the Perceived Seismic Risk of the Dwelling dimension, which brings together aspects of different kinds: concern about damage to the dwelling in an earthquake (R1), the interpretation of cracks as a sign of fragility (R2), confidence that the dwelling would withstand a strong earthquake (R3, reverse-scored), fear of remaining indoors during an earthquake (R4), and doubt about whether a professional was involved in the construction (R5).

Concern and fear express affective components of perception, whereas R2, R3, and R5 refer to judgments about housing conditions. The assumption that all of them covary must be tested empirically.

HOUSEHOLD EARTHQUAKE PREPAREDNESS

Household earthquake preparedness encompasses knowledge, plans, and resources. In a study of 1,193 households in high-hazard districts of Türkiye, Şahin et al. (2026) found that 93.1 % perceived the local seismic risk, but only 19.3 % considered themselves sufficiently prepared, and that financial and time constraints were common barriers; training was associated with greater perceived preparedness, and home ownership with greater knowledge of the dwelling's seismic resistance.

Among university students in the same country, greater earthquake awareness was associated with having an emergency backpack, securing belongings, and participating in training sessions and drills (Gürsoy et al., 2026); among geriatric patients in Istanbul, only 5.4% had received training and 32.1% knew where their emergency backpack was (Solakoglu et al., 2025).

Psychosocial factors also play a role. Among older adults in Japan, loneliness was directly and negatively associated with preparedness, although it slightly increased risk perception, which in turn was positively associated with preparedness (Fukurai and Grant Ludwig, 2025).

Among households in areas affected by the Wenchuan and Lushan earthquakes, trust in the government was associated with greater perceived efficacy of preparedness (Zhang et al., 2022). Recent instruments are available for measuring preparedness: Davarani et al. (2026) developed a

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household earthquake preparedness questionnaire in Iran through a sequential mixed-methods design that progressed from interviews and a systematic review to exploratory and confirmatory factor analysis; the resulting version comprised 36 items in seven factors, including knowledge, self-efficacy and behavioral intention.

The Earthquake Preparedness dimension of the scale used in this study captures knowing what to do inside the home during an earthquake (R6), the existence of a family meeting point (R7), the presence of furniture that could fall (R8, reverse-scored), knowing how to shut off the gas supply (R9), and the availability of an emergency backpack (R10). It therefore combines knowledge, plans, and resources with an item that refers to a hazardous condition within the home rather than to a preparedness behavior.

MEASUREMENT CONSIDERATIONS AT THE INITIAL STAGE

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items; McDonald's omega (McDonald, 1999/2013) does not make this assumption, and simulation studies have compared the performance of both coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis, which first requires verifying that the data are adequate and that the sample size is sufficient (Ferrando et al., 2022; Goretzko et al., 2021).

Scales with items worded in both directions may show wording effects, because some respondents respond inconsistently to the positively and negatively worded items of the same dimension (Steinmann et al., 2022); identifying these responses may reduce such effects (García-Batista et al., 2021).

Moreover, in small samples, a few careless response patterns can distort correlations (Ward and Meade, 2023). Given the cross-sectional design, the relationships between items should be understood as associations.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted as part of the occupant component of the project methodology. The data come from survey LEV-0036, «Piloto · Riesgo sísmicopercibido» (Pilot · Perceived Seismic Risk), of project FZ-HAB-0031 on the Factoriza UAS platform, and from the frozen dataset DST-0034, with a cut-off date of 9 October 2026. The survey is an independent sample and the only survey in the project.

POPULATION, SAMPLE, AND DATA CUTOFF

The population was defined as individuals aged 18 years or older who occupy the buildings assessed by the project, in the area where those buildings are located. According to the Factoriza log, 17 individuals opened the questionnaire and 8 completed it; no cases were excluded on quality-control grounds, so 8 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 8 cases out of a target of 100, and data collection was still open, in the fieldwork phase, as of the cut-off date. With 8 cases for 10 items, the inter-item correlation matrix is not invertible, so it is not possible to conduct an exploratory factor analysis, which also requires a much larger sample (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Perceived Seismic Risk and Preparedness Scale was administered; it comprises ten items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5). The items are organized into two dimensions of five items each: Perceived Seismic Risk in the Home (R1 to R5) and Earthquake Preparedness (R6 to R10).

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Two items, R3 and R8, are reverse-worded and have already been recoded in the data matrix. After recoding, a higher score indicates greater perceived risk in the first dimension and greater preparedness in the second. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Instrumentstructure.

Code	Dimension	Item	Reverse
R1	Perceived seismic risk to the home	I am worried that my home will be damaged in an earthquake	No
R2	Perceived seismic risk to the dwelling	The cracks in my home make me think that it is fragile	No
R3	Perceived seismic risk to the dwelling	I believe my home would withstand a strong earthquake	Yes
R4	Perceived seismic risk in the home	In a strong earthquake, I would be afraid to stay inside my home	No
R5	Perceived seismic risk of the dwelling	I doubt that my home was built with the advice of a professional	No
R6	Earthquake preparedness	I know what to do inside my home during an earthquake	No
R7	Earthquake preparedness	My family has a meeting point in case of an earthquake	No
R8	Earthquake preparedness	In my home, there is furniture that could fall during an earthquake	Yes
R9	Earthquake preparedness	I know how to shut off the gas supply to my home in an emergency	No
R10	Earthquake preparedness	I have an emergency backpack on hand	No

Note. Perceived Seismic Risk and Preparedness Scale. 5-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0031, survey LEV-0036, dataset DST-0034.

PROCEDURE

Responses were collected through the survey questionnaire administered in Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0034 with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00196 to RUN-00200).

DATA ANALYSIS

Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis and percentages of responses at the extreme values for each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), with the corrected item-total correlation and alpha if item deleted; and the Pearson correlations between the items of each dimension, with 95% confidence intervals obtained through Fisher's z transformation.

The project belongs to the technical track of the article-writing workshop, whose data collections are not routed through the complementary psychometric analysis program; for this reason, and because these statistics cannot be estimated with 8 cases for 10 items, neither McDonald's omega nor exploratory factor analysis was computed. The reference values for the psychometric indices are treated as guidelines rather than as decision rules (Ferrando et al., 2022). No item was removed.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit informed consent online and does not collect names, email addresses or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the Factoriza UAS platform was used for data management and for descriptive, internal consistency and inter-item correlation analyses. The Claude Opus language model (Anthropic) was used for assisted literature searching, writing a draft and assembling the document from the results. The authors reviewed, edited and approved

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the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 17 individuals who opened the questionnaire, 8 completed it and were analyzed, with no exclusions for quality control. All 8 analyzed cases answered the ten items.

Table 2. Sample composition.

Indicator	Value
Individuals who opened the questionnaire	17
Completed questionnaires	8
Cases excluded by quality control	0
Cases analyzed	8
Items	10

Note. Survey "Pilot · Perceived Seismic Risk" (LEV-0036); population: persons aged 18 years or older who occupy the buildings assessed by the project; area: zone of the buildings assessed by the project. Dataset DST-0034, fingerprint cc66909686a891b3. Source: Factoriza UAS. Preliminary cut-off: n = 8 of a target of 100, with the survey still open.

PERCEIVED SEISMIC RISK AND SELF-REPORTED PREPAREDNESS

Table 3 and Figure 1 present the descriptive statistics. In the dimension Perceived seismic risk in the dwelling, concern that the dwelling would be damaged in an earthquake had the highest mean (R1: *M* = 3.25, *SD* = 1.91), with the greatest dispersion in the instrument and a kurtosis of -2.48, indicating responses concentrated at the extremes rather than around the mean. Fear of remaining inside the dwelling during a strong earthquake (R4: *M* = 3.13, *SD* = 1.46) and doubt about professional advice during construction (R5: *M* = 3.00, *SD* = 1.07) fell at the midpoint of the scale. Interpreting cracks as a sign of fragility had the lowest mean in the dimension (R2: *M* = 2.50, *SD* = 1.41).

Confidence that the dwelling would withstand a strong earthquake (recoded) barely varied among occupants (R3: *M* = 2.88, *SD* = 0.35), with a skewness of -2.83 and a kurtosis of 8.00.

In the Earthquake Preparedness dimension, knowing what to do inside the home during an earthquake had the highest mean (R6: *M* = 3.50, *SD* = 1.20), followed by knowing how to shut off the gas supply (R9: *M* = 3.38, *SD* = 1.51). The lowest means were for having a family meeting point (R7: *M* = 2.13, *SD* = 1.55) and the availability of an emergency backpack (R10: *M* = 2.25, *SD* = 1.04). The absence of furniture that could fall, once recoded, also scored below the midpoint (R8: *M* = 2.50, *SD* = 0.93).

Overall, the sample is characterized by occupants with an intermediate perception of risk that is polarized with respect to worry. These occupants report knowing how to act during an earthquake, but a family meeting point and an emergency backpack are infrequent measures among them, with means below the midpoint of the scale; they also tend to acknowledge the presence of furniture that could fall.

Table 3. Descriptive statistics of the items.

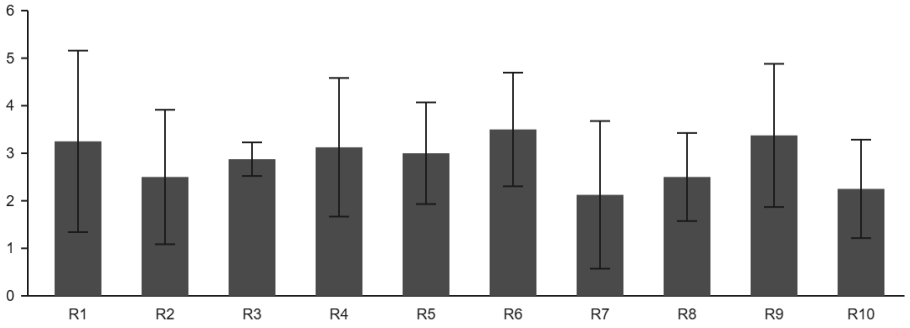
Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.25	1.91	-0.14	-2.48	25%	50%
R2	2.50	1.41	0.81	-0.23	25%	13%
R3	2.88	0.35	-2.83	8.00	13%	88%
R4	3.13	1.46	0.09	-1.19	13%	25%
R5	3.00	1.07	0.94	0.35	38%	13%
R6	3.50	1.20	0.00	-1.46	25%	25%
R7	2.13	1.55	1.25	0.24	50%	13%
R8	2.50	0.93	-0.00	0.00	13%	13%

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Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R9	3.38	1.51	-0.52	-1.34	13%	25%
R10	2.25	1.04	0.39	-0.45	25%	13%

Note.N = 8. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column from the Factoriza descriptive table is omitted because its values do not match those in Table 4, as they are not calculated on the total of each dimension. Factoriza UAS run RUN-00196. Preliminary cut-off: n = 8 of a target of 100, with data collection still open.

Figure 1. Mean scores by item with one-standard-deviation error bars.



INTERNAL CONSISTENCY

Table 4 presents the item analysis by dimension. Perceived seismic risk in the home showed very low internal consistency (α = .203). Only the interpretation of cracks as a sign of fragility (R2: .787) and, to a lesser extent, fear of remaining indoors (R4: .239) were positively related to the rest of the dimension, whereas concern about damage (R1: -.104), recoded confidence in the structural resistance of the home (R3: -.256), and doubt about professional advice (R5: -.163) correlated negatively with it. Deleting R2 would produce a negative alpha (-.893), which indicates that the four remaining items covary, on average, in the opposite direction; in contrast, deleting R1 would raise alpha to .466.

Earthquake preparedness showed low internal consistency (α = .464). Having a family meeting point was the item most consistent with the dimension (R7: .810), followed by having an emergency backpack (R10: .575) and knowing what to do during an earthquake (R6: .562); knowing how to shut off the gas showed a weaker relationship (R9: .298). The recoded item on the absence of furniture that could fall correlated negatively with the dimension (R8: -.735); deleting this item would raise alpha to .791.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Perceived risk	R1	-.104	.466
Perceived risk	R2	.787	-.893
Perceived risk	R3	-.256	.279
Perceived risk	R4	.239	-.014
Perceived risk	R5	-.163	.358
Preparation	R6	.562	.181
Preparation	R7	.810	-.216
Preparation	R8	-.735	.791
Preparation	R9	.298	.370
Preparation	R10	.575	.213

Note.N = 8. Scale from 1 to 5; reverse-scored items R3 and R8 are shown recoded. Run RUN-00196 of Factoriza UAS. Preliminary data cut: n = 8 of a target of 100, with data collection still open.

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INTER-ITEM CORRELATIONS

Tables 5 and 6 present the correlations between the items within each dimension. In the Perceived seismic risk in the home dimension, no correlation had a confidence interval that excluded zero. The largest in absolute value was the negative correlation between concern about damage and doubt about professional advice (R1 and R5: r = -.630, 95% CI [-.924, .134], p = .094), followed by the negative correlation between recoded confidence in the strength of the home and fear of staying inside (R3 and R4: r = -.520, 95% CI [-.896, .292], p = .187) and the positive correlation between cracks and fear (R2 and R4: r = .450, 95% CI [-.372, .877], p = .263).

Table 5. Correlations between the items of Perceived Seismic Risk in the Home.

Variable pair	r	IC 95%	p
R1 and R2	.318	[-.499, .835]	.443
R1 and R3	-.370	[-.853, .452]	.366
R1 and R4	.039	[-.685, .724]	.928
R1 and R5	-.630	[-.924, .134]	.094
R2 and R3	.143	[-.625, .770]	.736
R2 and R4	.450	[-.372, .877]	.263
R2 and R5	.283	[-.526, .824]	.496
R3 and R4	-.520	[-.896, .292]	.187
R3 and R5	.378	[-.445, .855]	.356
R4 and R5	.092	[-.655, .748]	.829

Note.N = 8. Perceived risk = Perceived seismic risk in the home; Preparedness = Earthquake preparedness. The corrected item–total correlation excludes the item itself from the total of its dimension. A negative alpha when an item is deleted indicates that the remaining items covary, on average, in a negative direction. Cronbach's α for each full dimension (5 items each): Perceived risk = .203 (run RUN-00197); Preparedness = .464 (RUN-00199). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 8 out of a target of 100, with data collection ongoing.

In Earthquake Preparedness, two correlations had intervals that excluded zero. Knowing what to do during an earthquake was associated with having a family meeting point (R6 and R7: r = .731, 95% CI [.055, .948], p = .039). The meeting point, in turn, was negatively associated with the absence of furniture that could fall (R7 and R8: r = -.745, 95% CI [-.951, -.086], p = .034); that is, those who reported having a meeting point also tended to acknowledge the presence of furniture that could fall.

The relationships between knowing what to do and having an emergency backpack (R6 and R10: r = .693, 95% CI [-.023, .939], p = .057) and between having a meeting point and knowing how to shut off the gas (R7 and R9: r = .649, 95% CI [-.102, .929], p = .082) were positive and of similar magnitude, but their intervals included zero.

Table 6. Correlations Between Earthquake Preparedness Items.

Variable pair	r	IC 95%	p
R6 and R7	.731	[.055, .948]	.039
R6 and R8	-.516	[-.895, .296]	.190
R6 and R9	.119	[-.639, .760]	.779
R6 and R10	.693	[-.023, .939]	.057
R7 and R8	-.745	[-.951, -.086]	.034
R7 and R9	.649	[-.102, .929]	.082
R7 and R10	.600	[-.181, .917]	.116
R8 and R9	-.564	[-.908, .234]	.146
R8 and R10	-.447	[-.876, .376]	.267
R9 and R10	.206	[-.583, .795]	.624

Note.N = 8. Pearson correlation. Confidence intervals were obtained using Fisher's z transformation. Cross-sectional design: the reported relationships are associations, not causal relationships. Run RUN-00198 of Factoriza UAS. Preliminary cutoff: n = 8 out of a target of 100, with data collection still open.

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DISCUSSION OF RESULTS

The aim of this study was to describe the initial performance of the perceived seismic risk and preparedness scale as an input for the occupant component of a seismic vulnerability assessment methodology.

With only 8 cases, all results are provisional: the literature on internal consistency coefficients has been developed with much larger samples (Malkewitz et al., 2023), the confidence intervals of the correlations are very wide, and the internal structure could not be examined. Even so, this data cut provides useful information for revising the instrument.

The dimension Perceived seismic risk in the dwelling did not behave as a scale. The most plausible explanation lies in its content: the dimension mixes affective components, such as worry and fear, with judgments about the dwelling, such as the interpretation of cracks, confidence in its strength, and doubts about its construction.

The literature treats risk perception as a construct with several components, such as likelihood, awareness, apprehension and impact (Huang et al., 2022), and distinguishes risk awareness from risk perception (Cisternas et al., 2024). The negative correlation between concern about damage and doubt about professional advice, although inconclusive, illustrates that the two items do not measure the same thing. Furthermore, confidence in the structural resistance of the dwelling showed almost no variation among occupants, which limits any correlation involving it.

In Earthquake Preparedness, the coherent core consisted of knowledge of what to do, the meeting point, and the emergency kit, in line with the association among seismic awareness, the availability of an emergency kit, and participation in training observed in other settings (Gürsoy et al., 2026).

The behavior of R8 has a plausible content-based explanation. The item was reverse-scored on the assumption that the presence of furniture that could fall is the opposite of preparedness, but those who are better prepared may be precisely those who recognize this hazard in their home. The negative correlation between the meeting point and the absence of furniture that could fall is consistent with this interpretation.

If this is confirmed in the final data cut, R8 should be treated as an indicator of non-structural hazard recognition or reworded as a behavior, such as having anchored furniture to the wall.

The descriptive profile is consistent with a pattern documented in other countries: self-reported preparedness is concentrated in knowing what to do, whereas measures that require planning or resources, such as a meeting point or an emergency kit, are less common.

In Türkiye, most households in high-hazard areas perceived the risk, but only a minority considered themselves sufficiently prepared, citing financial and time barriers (Şahin et al., 2026); among geriatric patients in Istanbul, only a minority knew where their emergency kit was (Solakoglu et al., 2025).

In Mexico City, after the 2017 earthquake, it was recommended that the population be trained in what to do during and after tremors (Santos-Reyes and Gouzeva, 2020). These similarities are descriptive: with 8 cases, proportions cannot be estimated or compared with those of other populations.

For the methodology used to assess seismic vulnerability, these results suggest two implications. The first is that the occupant component should distinguish, at a minimum, risk perception, recognition of hazards in the dwelling, and preparedness, rather than combining them into two heterogeneous dimensions; recent household preparedness instruments, developed using mixed-methods designs and factor analyses, show that preparedness can be organized into several factors (Davarani et al., 2026).

The second is that the occupant component becomes meaningful when it is linked to the technical assessment of each building: uncertainty about professional advice during construction or the interpretation of cracks can be checked against the technical diagnosis, as is done with checklists in self-built housing (Medrano-Sánchez and Fabian, 2025). This comparison is not possible with the current data, because the package does not include the results of the technical assessment.

CONCLUSIONS

The study achieved its objective to the extent allowed by a preliminary sample of 8 cases. The perceived seismic risk and preparedness scale showed very low internal consistency for Perceived Seismic Risk in the Home (α = .203) and low consistency for Earthquake Preparedness (α = .464).

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In the first dimension, only the interpretation of cracks and the fear of remaining indoors were positively related to the rest of the items; in the second, knowing what to do, the meeting point and the emergency backpack formed a coherent core, whereas the item on furniture that could fall behaved in the opposite direction to that expected.

Occupants reported knowing how to act during an earthquake, whereas the assembly point and the emergency kit had mean scores below the midpoint of the scale. The results do not yet provide evidence of validity, but they guide the revision of the methodology's occupant component.

The limitations are substantial. The sample of 8 cases, compared with a target of 100 and with fewer cases than items, makes all statistics unstable and precludes estimation of omega and of the internal structure; data collection was still ongoing, and of the 17 people who opened the questionnaire, only 8 completed it. No information is available on the locality, the type of buildings, or the characteristics of the occupants.

The package does not include the technical component of the methodology, so this article provides no results on the structural vulnerability of the buildings, nor can it compare the occupants' perceptions with the technical assessment. The cross-sectional design precludes establishing relationships of dependence.

Several decisions for the authors follow from these results. The first is to review the composition of Perceived seismic risk in the dwelling and to consider splitting it into an affective component (worry and fear) and a component of judgment about the dwelling. The second is to review R8, on furniture that could fall, and to decide whether it measures hazard recognition or preparedness behavior. The third is to document the origin of the items and the content review. The fourth is to describe the technical component of the methodology and how its results will be linked to those of the occupant component. None of these decisions was made in the present analysis, which retains the ten original items.

For future work, we propose completing the survey to the planned target, then estimating omega and conducting the exploratory factor analysis, followed by a confirmatory factor analysis in an independent sample. Linking each occupant to the assessed building would make it possible to examine the correspondence between structural vulnerability and risk perception, and to target risk communication and preparedness toward households where the two do not match. A methodology that integrates the technical assessment and the occupants' perspective would bring a more comprehensive view of housing vulnerability to seismic risk reduction.

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Chapter 13 / Capítulo 13

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Application of the Northwest Residential Habitability Scale in Culiacán

Aplicación de la Escala de Habitabilidad Residencial del Noroeste en Culiacán

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ABSTRACT

Housing habitability in northwestern Mexico is shaped by the hot climate and by recent housing production. Using the preliminary data cut from the pilot survey of project FZ-HAB-0034 on the Factoriza UAS platform, this study described the initial behaviour of the Northwest Residential Habitability Scale in Culiacán, with twenty-five items and five dimensions: Dwelling comfort, Space and functionality, Dwelling safety, Dwelling services and Immediate surroundings. With a cross-sectional design, 9 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha, McDonald's omega total and Spearman correlations between dimensions were estimated, and an exploratory factor analysis was attempted. Internal consistency was acceptable for Space and functionality (α = .800; ω = .842), Safety (α = .791; ω = .850) and Services (α = .748; ω = .863), and low for Comfort (α = .490) and Immediate surroundings (α = .288). The factor analysis was not interpretable because the sample had fewer cases than items, and the dwelling-related dimensions were highly intercorrelated. Residents rated their dwellings as safe and well served, but hot in summer and located in streets perceived as unsafe at night. The findings do not yet provide structural validity evidence and point to revisions of the instrument.

Keywords: housing habitability; residential satisfaction; thermal comfort; psychometric evidence

RESUMEN

La habitabilidad de la vivienda en el noroeste de México está marcada por el clima cálido y por la producción habitacional de las últimas décadas. Este estudio describió, en el corte preliminar del levantamiento piloto del proyecto FZ-HAB-0034 de Factoriza UAS, el comportamiento inicial de la Escala de Habitabilidad Residencial del Noroeste en Culiacán, de veinticinco reactivos y cinco dimensiones: Confort de la vivienda, Espacio y funcionalidad, Seguridad de la vivienda, Servicios de la vivienda y Entorno inmediato. Con diseño transversal, se analizaron 9 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach, omega total y correlaciones de Spearman entre dimensiones, y se intentó un análisis factorial exploratorio. La consistencia interna fue aceptable en Espacio y funcionalidad (α = .800; ω = .842), Seguridad (α = .791; ω = .850) y Servicios (α = .748; ω = .863), y baja en Confort (α = .490) y Entorno inmediato (α = .288). El análisis factorial no fue interpretable porque la muestra tiene menos casos que reactivos, y las dimensiones referidas a la vivienda se correlacionaron de manera alta entre sí. Los residentes valoraron sus viviendas como seguras y con servicios adecuados, pero calurosas en verano y en entornos inseguros de noche. Los resultados no aportan todavía evidencias de validez estructural y orientan la revisión del instrumento.

Palabras clave: habitabilidad de la vivienda; satisfacción residencial; confort térmico; evidencias psicométricas

INTRODUCTION

Housing habitability is a central condition of urban well-being. It is not limited to having a roof overhead; rather, it encompasses thermal, acoustic, and lighting comfort, the adequacy and functionality of space, physical safety and security of tenure, access to services, and the quality of the immediate surroundings.

Recent reviews of residential satisfaction and the social sustainability of housing describe this assessment as multidimensional, involving functional, environmental, economic, social and psychological factors that encompass both the dwelling unit and the neighborhood (Alaie et al., 2022; Saleem and Alchalabi, 2025).

In northwestern Mexico, housing habitability is shaped by the hot climate and by the characteristics of housing production over recent decades. During the first two decades of this century, social housing was built on a large scale, with small dwellings, developments far from urban centers, insufficient services, and a high number of abandoned homes (Hernández Ilizaliturri et al., 2025).

In Culiacán, residents of a social housing development described their homes as very hot and kept their air conditioning running, even though most of the dwellings fell within a comfort range calculated for the city (Barraza-Bracamontes et al., 2022).

The city, described as an agro-city, also exhibits surface heat islands whose intensity varies with the season and with land use in the periphery (Borbolla Gaxiola et al., 2024).

Measuring habitability from the perspective of those who live in the dwelling makes it possible to complement census indicators and technical assessments with everyday experience. This requires instruments with validity evidence in the regional context. Project FZ-HAB-0034 of the Factoriza UAS platform set out to administer, in Culiacán, a residential habitability scale designed for northwestern Mexico; the scale comprises twenty-five items organized into five dimensions: Housing Comfort, Space and Functionality, Housing Safety, Housing Services, and Immediate Surroundings.

This article reports the results of the first pilot survey of the scale in Culiacán, based on a very small preliminary data cut. Its scope is therefore limited to an initial examination of the instrument's behavior in that city and does not extend to estimating population parameters.

The overall objective was to describe the initial behavior of the Northwest Residential Habitability Scale in the preliminary data cut from its administration in Culiacán. The specific objectives were: first, to describe the distribution of responses to each item; second, to estimate the internal consistency of each dimension using alpha and omega coefficients; third, to assess the feasibility of an internal structure analysis with the available sample size; and fourth, to explore the relationships among the scores on the five dimensions. The project package records no hypotheses, so the study is descriptive and exploratory in scope.

DEVELOPMENT

RESIDENTIAL HABITABILITY AS A MULTIDIMENSIONAL CONSTRUCT

Research on residential satisfaction has sought to identify which housing and neighborhood conditions are associated with a favorable assessment.

Saleem and Alchalabi (2025) systematically reviewed forty studies and highlighted the quality of architectural design, environmental sustainability and socioeconomic conditions. They grouped the factors into twelve interacting categories, ranging from functional and technical to cultural, psychological and public policy categories.

From a social sustainability perspective, the review by Alaie et al. (2022) organized housing indicators into five dimensions (functional, semantic-perceptual, physical, environmental, and economic) covering aspects that range from services and social interaction to the scale of the housing unit and the neighborhood, natural surveillance, and affordability.

Widely used instruments are available for measuring perceived residential environment quality. In China, the Chinese version of the Perceived Residential Environment Quality Indicators, which covers architectural and urban planning, socio-relational, functional, and contextual aspects, was administered to 1,158 retired residents; perceived quality and its subdimensions were generally positively correlated with sense of community (Zhao et al., 2025).

These instruments show that perceived habitability can be organized into related but distinguishable facets, a premise shared by the scale applied in the present study.

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THE DIMENSIONS OF THE SCALE

The Comfort dimension of housing captures pleasant indoor temperature (R1), low street noise (R2), the entry of natural light (R3), air circulation (R4), and the experience of heat in summer (R5, reverse-scored). In hot climates, thermal comfort is the most demanding facet.

In Hermosillo, a comparison of the predominant social housing type with a dwelling built to energy efficiency standards showed higher emissions for the former (Muñoz López et al., 2023). In Culiacán, heat was the feature most frequently reported by social housing residents (Barraza-Bracamontes et al., 2022).

The Space and functionality dimension captures the adequacy of space for the people living in the dwelling (R6), a place to sleep for each person (R7), the comfort of the kitchen (R8), the lack of space to store belongings (R9, reverse-scored), and a layout that facilitates daily activities (R10).

In northwestern Mexico, studies of social housing users have found moderate levels of satisfaction, associated with the housing development in which each dwelling is located (Valdivia Haro et al., 2023). In Culiacán, most residents reported being satisfied with their homes, although they considered the spaces insufficient (Barraza-Bracamontes et al., 2022).

In subsidized housing estates in Guangzhou, Tang et al. (2024) associated greater satisfaction with larger dwellings, well-equipped neighborhoods, close neighborly ties, and community activities.

The Housing security dimension combines physical security, reflected in the condition of the roofs (R11), the secure locking of the doors (R13) and the absence of cracks in the walls (R14, reversed), with the feeling of safety inside the dwelling (R12) and the security of being able to keep living there (R15), which refers to tenure. The Housing services dimension covers the continuity of the water supply (R16), the stability of the electricity supply (R17), the functioning of the drainage system (R18), frequent water outages (R19, reversed) and the internet connection (R20).

The Immediate Surroundings dimension covers street paving (R21), proximity to a grocery store (R22), street lighting at night (R23), feeling unsafe when walking along the street at night (R24, reverse-scored) and proximity to public transportation (R25). The location and amenities of the surrounding area are a substantive component of habitability: in Mexico City, residents of a peripheral housing development had much longer commuting times than residents of an informal community closer to the city center, which had a well-established local commercial economy (Reyes, 2023).

The vulnerability of housing to extreme events also depends on the surrounding environment. In Culiacán, the 2018 flooding associated with Tropical Depression 19-E affected neighborhoods of different income levels, but recovery was harder for low-income households living in fragile structures (Mancera González, 2021).

Organizing the items into five dimensions assumes that each facet is internally consistent and distinguishable from the others. This assumption must be tested empirically, because items that combine physical conditions with subjective appraisals, or the interior of the dwelling with its surroundings, may behave heterogeneously. In addition, because the design is cross-sectional, the relationships between dimensions must be understood as associations rather than as dependency relationships.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional study with a descriptive and exploratory scope was conducted. The data come from survey LEV-0039, “Piloto Culiacán · Escala de habitabilidadresidencial” (Culiacán Pilot · Residential Habitability Scale), from project FZ-HAB-0034 on the Factoriza UAS platform, and from the frozen dataset DST-0036, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only one in the project; its data are not combined with those from administrations of the scale in other cities.

POPULATION, SAMPLE, AND DATA CUTOFF

The survey population was defined as persons aged 18 years or older residing in a dwelling in Culiacán. The neighborhoods (colonias) were selected by the project lead, so the selection was non-probabilistic. According to the Factoriza log, 14 people opened the questionnaire and

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9 completed it. No cases were excluded for quality control, leaving 9 cases for analysis (Table 2).

The analyzed data cut is preliminary: it comprises 9 cases out of a target of 100, and data collection was still open, in the fieldwork phase, as of the cut-off date. With 9 cases for 25 items, the ratio is 0.4 cases per item, so the inter-item correlation matrix is not invertible. The adequacy of the data and of the sample is the first condition that the methodological literature asks researchers to verify in item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021).

INSTRUMENT

The Culiacán version of the Northwest Residential Habitability Scale (Escala de Habitabilidad Residencial del Noroeste) was administered. It comprises twenty-five items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree (5). The items are organized into five dimensions of five items each: Housing comfort (R1 to R5), Space and functionality (R6 to R10), Housing safety (R11 to R15), Housing services (R16 to R20), and Immediate surroundings (R21 to R25). Five items are reverse-worded, one per dimension (R5, R9, R14, R19, and R24), and are already recoded in the data matrix. After recoding, a higher score indicates better habitability across all dimensions. Table 1 presents the code, dimension, wording, and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Housing comfort	The temperature inside my home is pleasant	No
R2	Housing comfort	Inside my home, I hear little noise from the street	No
R3	Housing comfort	My home receives natural light during the day	No
R4	Housing comfort	Air circulates inside my home	No
R5	Housing comfort	I feel too hot inside my home in summer	Yes
R6	Space and functionality	My home has enough space for those of us who live in it	No
R7	Space and functionality	Each person in my household has a place to sleep	No
R8	Space and functionality	The kitchen in my home is comfortable for preparing food	No
R9	Space and functionality	My home lacks storage space for my belongings	Yes
R10	Space and functionality	The layout of my home facilitates daily activities	No
R11	Housing safety	The roofs of my home are in good condition	No
R12	Housing safety	I feel safe inside my home	No
R13	Home security	The doors of my home close securely	No
R14	Housing safety	The walls of my home have cracks	Yes
R15	Housing security	I feel secure that I will be able to continue living in this dwelling	No
R16	Housing services	Water is supplied to my home continuously	No
R17	Housing services	The electricity supply in my home works reliably	No
R18	Housing services	The drainage system in my home works without problems	No
R19	Housing services	There are frequent water outages in my home	Yes
R20	Housing services	My home has an internet connection	No
R21	Immediate surroundings	My street is paved	No
R22	Immediate surroundings	There is a grocery store near my home	No
R23	Immediate surroundings	My street is lit at night	No
R24	Immediate environment	I feel unsafe walking down my street at night	Yes
R25	Immediate surroundings	There is public transportation near my home	No

Note. Northwest Residential Habitability Scale (Culiacán application). Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0034, survey LEV-0039, dataset DST-0036.

PROCEDURE

Responses were collected through the survey questionnaire administered on Factoriza

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UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0036 with a cryptographic hash, generated the matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00206 to RUN-00216). The complementary analyses were performed using the data file and the item dictionary exported from the platform.

DATA ANALYSIS

In the first stage, Factoriza UAS calculated the mean, standard deviation, skewness, kurtosis, and percentages of responses at the extreme values for each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted; and Pearson correlations between the items of each dimension, with 95% confidence intervals obtained through Fisher's transformation.

In a second stage, the program analisis_psicometrico.py (version 1.0) was run in Python 3.13.16 (Python Software Foundation, 2026) with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5. The program applies fixed, stated procedures, with no manual intervention in the calculations.

The program estimated McDonald's omega total (McDonald, 1999/2013) for each dimension from a one-factor model, without reversing items; when any item correlates or loads negatively relative to the rest of its dimension, the program does not report omega because the coefficient is no longer interpretable. It also attempted an exploratory factor analysis of the twenty-five items, preceded by an assessment of overall and item-level sampling adequacy (Lorenzo-Seva and Ferrando, 2021) and by the test of sphericity. The number of factors was determined by parallel analysis, with minimum residual extraction and oblimin rotation.

Finally, it estimated the correlation between mean dimension scores with Spearman's coefficient and its 95% confidence interval, computed through the Fisher transformation using the standard error of Bonett and Wright (2000).

The reference values for interpreting the psychometric indices are treated as guidelines rather than as decision rules (Ferrando et al., 2022). No items were removed; the program flags problematic items and leaves the decision to the authors. Confirmatory factor analysis was not performed and is proposed as future work.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records express informed consent online and does not collect names, email addresses or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following tools were used: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and inter-dimension correlations; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the flow of cases. Of the 14 individuals who opened the questionnaire, 9 completed it and were analyzed, with no exclusions for quality control. Every analyzed case answered all twenty-five items.

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Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	14
Completed questionnaires	9
Cases excluded by quality control	0
Cases analyzed	9
Items	25

Note. Survey "Piloto Culiacán · Escala de habitabilidadresidencial" (Culiacán Pilot · Residential Habitability Scale) (LEV-0039); population: persons aged 18 years or older living in a dwelling in Culiacán; territory: Culiacán, Sinaloa, in neighborhoods (colonias) selected by the project lead. Dataset DST-0036, fingerprint 52b16fab6f72735e. Source: Factoriza UAS. Preliminary cutoff: n = 9 of a target of 100, with data collection still open.

DESCRIPTIVE STATISTICS

Table 3 and Figure 1 present the descriptive statistics. The highest means on the instrument corresponded to the feeling of safety inside the home (R12: *M* = 4.67, *SD* = 0.50) and to the security of being able to continue living in it (R15: *M* = 4.67, *SD* = 0.50), with 67% of responses at the maximum value in both cases. These were followed by each household member having a place to sleep (R7) and the comfort of the kitchen (R8), both with *M* = 4.56 (*SD* = 0.53).

Services also received high ratings: internet connection (R20: *M* = 4.44, *SD* = 0.53), continuity of the water supply (R16: *M* = 4.33, *SD* = 0.50), and functioning of the drainage system (R18: *M* = 4.33, *SD* = 0.50). The stability of the electricity supply (R17: *M* = 4.00, *SD* = 1.32) showed the greatest dispersion within the dimension, with marked negative skewness (-1.67).

The lowest ratings were concentrated on heat and on insecurity in the surrounding area. The recoded item on experiencing heat in summer had the lowest mean in the instrument (R5: *M* = 2.33, *SD* = 1.12), with 33% of responses at the minimum value, which corresponds to strongly agreeing with feeling hot inside the dwelling in summer. Next came feeling unsafe when walking on the street at night, also recoded (R24: *M* = 2.56, *SD* = 0.88).

Intermediate means were observed for the lack of storage space (R9 recoded: *M* = 3.44, *SD* = 1.01), the presence of cracks in the walls (R14 recoded: *M* = 3.56, *SD* = 1.13) and the entry of natural light (R3: *M* = 3.56, *SD* = 0.88). Overall, this profile describes dwellings their occupants consider safe, with sufficient space and adequate services, but hot in summer and located on streets they find unsafe at night.

Table 3. Descriptive statistics for the items.

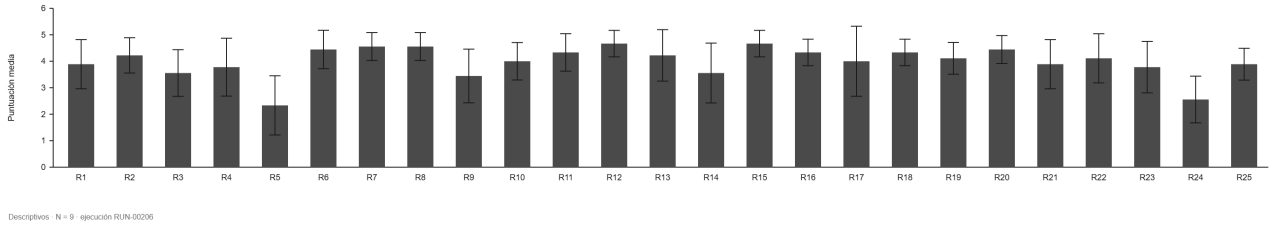
Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	3.89	0.93	-0.94	1.35	11%	22%
R2	4.22	0.67	-0.25	-0.04	11%	33%
R3	3.56	0.88	-0.21	0.14	11%	11%
R4	3.78	1.09	-0.19	-1.23	11%	33%
R5	2.33	1.12	-0.15	-1.49	33%	11%
R6	4.44	0.73	-1.01	0.19	11%	56%
R7	4.56	0.53	-0.27	-2.57	44%	56%
R8	4.56	0.53	-0.27	-2.57	44%	56%
R9	3.44	1.01	-0.27	-0.76	22%	11%
R10	4.00	0.71	0.00	-0.29	22%	22%
R11	4.33	0.71	-0.61	-0.29	11%	44%
R12	4.67	0.50	-0.86	-1.71	33%	67%
R13	4.22	0.97	-1.60	3.19	11%	44%
R14	3.56	1.13	-1.51	3.20	11%	11%
R15	4.67	0.50	-0.86	-1.71	33%	67%
R16	4.33	0.50	0.86	-1.71	67%	33%
R17	4.00	1.32	-1.67	2.95	11%	44%
R18	4.33	0.50	0.86	-1.71	67%	33%

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Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R19	4.11	0.60	0.02	1.13	11%	22%
R20	4.44	0.53	0.27	-2.57	56%	44%
R21	3.89	0.93	-0.94	1.35	11%	22%
R22	4.11	0.93	-1.47	3.28	11%	33%
R23	3.78	0.97	-0.50	-0.01	11%	22%
R24	2.56	0.88	-0.21	0.14	11%	11%
R25	3.89	0.60	-0.02	1.13	22%	11%

Note.N = 9. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column across the twenty-five items is omitted because it combines five dimensions; the item-total correlation by dimension is presented in Table 4. Run RUN-00206 of Factoriza UAS. Preliminary cutoff: n = 9 out of a target of 100, with data collection ongoing.

Figure 1. Mean scores per item with one-standard-deviation error bars.



INTERNAL CONSISTENCY

Table 4 reports the item analysis by dimension computed with Factoriza, and Table 5 presents the coefficients from the complementary software. Three dimensions showed acceptable internal consistency at this time point: Space and Functionality (α = .800; ω = .842), Housing Safety (α = .791; ω = .850), and Housing Services (α = .748; ω = .863).

In Space and functionality, R6 was the most consistent item (.710) and R10 the least (.463), and the highest correlation was between R6 and R7 (r = .907, 95% CI [.610, .980], p < .001). In Housing safety, R12 was the most consistent (.821) and R13 the least (.461); the correlations that stood out were between R12 and R14 (r = .811, 95% CI [.318, .959], p = .008), R11 and R12 (r = .707, 95% CI [.081, .933], p = .033), and R13 and R15 (r = .686, 95% CI [.040, .928], p = .041).

In Housing services, R19 was the most consistent item (.744) and R17 the least (.476); removing R17 would raise alpha to .858. Water continuity (R16) and drainage function (R18) received exactly the same responses in all nine cases, so their correlation was 1.000 and Factoriza reports a degenerate interval for it. Both correlated with internet connection (R20: r = .791, 95% CI [.266, .954], p = .011), and electricity stability correlated with water outages (R17 and R19: r = .786, 95% CI [.255, .953], p = .012).

The other two dimensions did not behave as scales in this round. Housing comfort obtained α = .490; omega is not reported because R3, natural light, correlated negatively with the rest of the dimension (-.060) and R4, air circulation, had the opposite sign in the one-factor model. Removing R3 would raise alpha to .613. The clearest correlation within the dimension was between pleasant temperature and the absence of heat in summer (R1 and R5: r = .763, 95% CI [.201, .947], p = .017).

Immediate Environment had α = .288; omega is not reported because R21 (paving) and R25 (public transport) had the opposite sign to the remaining items. R22, the nearby store, was the most consistent item (.604), whereas R25 correlated negatively with the dimension (-.242) and R24, nighttime insecurity, had a virtually zero correlation (.047). None of the correlations among the Immediate Environment items had a confidence interval that excluded zero.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Comfort	R1	.495	.273
Comfort	R2	.381	.391
Comfort	R3	-.060	.613
Comfort	R4	.515	.222

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Dimension	Item	Corrected item-total r	α if item deleted
Comfort	R5	.127	.543
Space	R6	.710	.720
Space	R7	.700	.744
Space	R8	.700	.744
Space	R9	.539	.809
Space	R10	.463	.797
Security	R11	.537	.763
Security	R12	.821	.718
Safety	R13	.461	.800
Security	R14	.665	.739
Security	R15	.709	.741
Services	R16	.563	.706
Services	R17	.476	.858
Services	R18	.563	.706
Services	R19	.744	.640
Services	R20	.717	.663
Environment	R21	.093	.286
Environment	R22	.604	-.329
Environment	R23	.205	.169
Environment	R24	.047	.324
Environment	R25	-.242	.459

Note.N = 9. Scale from 1 to 5; reverse-scored items R5, R9, R14, R19, and R24 are shown recoded. Run RUN-00206 of Factoriza UAS. Preliminary cutoff: n = 9 of a target of 100, with data collection still open.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Remarks
Housing comfort	5	9	.490		Reverse-worded items: R3, R4; ω not interpretable
Space and functionality	5	9	.800	.842	
Housing security	5	9	.791	.850	
Housing services	5	9	.748	.863	
Immediate surroundings	5	9	.288		Reverse-keyed items: R21, R25; ω not interpretable

Note.N = 9. Comfort = Housing comfort; Space = Space and functionality; Safety = Housing safety; Services = Housing services; Surroundings = Immediate surroundings. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for the complete dimension, with 5 items each: Comfort = .490 (run RUN-00207); Space = .800 (RUN-00209); Safety = .791 (RUN-00211); Services = .748 (RUN-00213); Surroundings = .288 (RUN-00215). Source: Factoriza UAS, Tables 4, 6, 8, 10, and 12 of the package, combined without modifying values. Preliminary cutoff: n = 9 out of a target of 100, with data collection still open.

INTERNAL STRUCTURE

The planned exploratory factor analysis could not be estimated in an interpretable way, and its results are not presented in tables. With 9 cases and 25 items, the correlation matrix is not invertible; consequently, the measure of sampling adequacy could not be computed, and the test of sphericity returned an uninterpretable value. Parallel analysis suggested one factor, which explained 40.24% of the variance in the software's solution, with insufficient loadings on R21, R24 and R25; however, with fewer cases than items, this solution is unsupported. These results are reported in the reproducibility appendix, but they provide no evidence regarding the dimensionality of the instrument and should not be cited as such.

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RELATIONSHIP BETWEEN THE DIMENSIONS

Table 6 presents the Spearman correlations between the mean scores of the five dimensions, based on 9 cases. The four housing-related dimensions were highly and positively correlated with one another, and their intervals excluded zero. The highest correlation was that of Space and Functionality with Housing Services, ρ = .931, 95% CI [.609, .990], p < .001, followed by those of Housing Comfort with Space and Functionality (ρ = .861, 95% CI [.345, .977]), with Services (ρ = .852, 95% CI [.318, .976]), and with Safety (ρ = .841, 95% CI [.284, .973]).

In contrast, none of the correlations involving Immediate surroundings had an interval that excluded zero. For Space and functionality with Immediate surroundings (ρ = .707, 95% CI [-.014, .944]), the p value was less than .05, but the more conservative Bonett and Wright interval included zero, so this relationship is not considered established.

Table 6. Correlationsbetweendimensions.

Dimension pair	n	ρ	IC 95 %	p
Housing comfort and Space and functionality	9	.861	[.345, .977]	.003
Housing Comfort and Housing Security	9	.841	[.284, .973]	.005
Housing Comfort and Housing Services	9	.852	[.318, .976]	.004
Housing Comfort and Immediate Surroundings	9	.609	[-.163, .918]	.082
Space and functionality and Housing safety	9	.769	[.107, .959]	.015
Space and functionality and Housing services	9	.931	[.609, .990]	< .001
Space and functionality and Immediate environment	9	.707	[-.014, .944]	.033
Housing safety and Housing services	9	.803	[.186, .966]	.009
Housing Safety and Immediate Surroundings	9	.402	[-.385, .850]	.284
Housing Services and Immediate Surroundings	9	.586	[-.192, .912]	.097

Note.α = Cronbach's alpha; ω = McDonald's omega total based on a one-factor minimum residual model, without reversing items. Complete cases per dimension. Source: Own calculations using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0036_FZ_HAB_0034. Preliminary cutoff: n = 9 out of a target of 100, with data collection ongoing.

DISCUSSION OF RESULTS

The purpose of this study was to describe the initial performance of the Northwest Residential Habitability Scale as applied in Culiacán. The central finding is uneven across dimensions. Space and Functionality, Housing Safety, and Housing Services showed acceptable internal consistency, whereas Housing Comfort and Immediate Surroundings did not behave as scales.

With only 9 cases, all coefficients are provisional: the simulation literature on the alpha and omega coefficients is based on much larger samples (Malkewitz et al., 2023), and the internal structure could not be estimated.

The descriptive profile is consistent with the regional literature. The low rating for summer comfort matches the description of social housing in Culiacán as very hot (Barraza-Bracamontes et al., 2022) and the evidence of unfavorable thermal and energy performance of social housing in northwestern Mexico (Muñoz López et al., 2023).

The high ratings for safety within the dwelling, for sleeping space, and for services suggest that, in this cross-section, deficiencies are concentrated in thermal comfort and the surrounding environment rather than in the housing unit itself. These correspondences are descriptive: the study did not measure indoor temperature or the physical conditions of the dwellings.

The low consistency of Housing Comfort may have a content-related explanation. The dimension combines thermal, acoustic, lighting and ventilation aspects that do not necessarily vary together: a dwelling may receive a great deal of natural light while also being hot, because the solar radiation that illuminates it also heats it.

The negative correlation between natural light and the absence of heat in summer, although not conclusive, points in that direction. Immediate Surroundings, for its part, brings together street infrastructure, access to shops and transport, and perceived safety, aspects that may be distributed independently across neighborhoods. Both dimensions might require revising their composition or splitting them into facets.

The very high correlations among the four housing-related dimensions warrant cautious interpretation. They may indicate an overall assessment of habitability that people apply to all

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aspects of their dwelling, consistent with the multidimensional yet integrated view of residential satisfaction (Alaie et al., 2022; Saleem and Alchalabi, 2025) and with the positive association among the subdimensions of perceived residential environment quality (Zhao et al., 2025).

They may also reflect general differences between cases that the questionnaire did not record, such as housing type or socioeconomic status, or a response style. With 9 cases, these explanations cannot be told apart, and confirming that the dimensions are distinct will require factor analysis of the final sample.

The reverse-scored items showed no general problematic pattern: R9, R14 and R19 had positive, moderate-to-high item-total correlations, and R5 correlated with pleasant temperature. The exception was R24, feeling unsafe at night, which had a near-zero correlation with its dimension.

Scales with items keyed in both directions require careful interpretation (Steinmann et al., 2022), but for R24 the most likely explanation lies in the item's content: feeling unsafe when walking at night depends on social conditions that do not necessarily coincide with street infrastructure. The exact match between R16 and R18, meanwhile, should be reviewed before the final analysis, because in small samples poorly differentiated response patterns can distort the correlations (Ward and Meade, 2023).

CONCLUSIONS

The study achieved its objective to the extent permitted by a preliminary data cut of 9 cases. When applied in Culiacán, the Northwest Residential Habitability Scale showed acceptable internal consistency for Space and Functionality (α = .800; ω = .842), Housing Safety (α = .791; ω = .850), and Housing Services (α = .748; ω = .863), and low internal consistency for Housing Comfort (α = .490) and Immediate Surroundings (α = .288).

Exploratory factor analysis could not be estimated interpretably because the sample has fewer cases than items, and the four housing-related dimensions were highly intercorrelated. The results do not yet provide evidence of structural validity, but they describe dwellings rated as safe, with adequate space and services, yet hot in summer and located in surroundings perceived as unsafe at night.

The limitations are substantial. The sample of 9 cases (against a target of 100), with 0.4 cases per item, precludes estimation of the internal structure and makes all statistics unstable; data collection was still ongoing, and not everyone who opened the questionnaire completed it.

The neighborhoods (colonias) were selected by the project leader, and no information is available on the respondents, housing tenure or dwelling type. The study did not measure the physical conditions of the dwellings, and its results refer only to perception. The cross-sectional design precludes establishing dependence relationships, and no confirmatory factor analysis was performed.

These results lead to several decisions for the authors. The first is to review the composition of Housing comfort, particularly the role of R3 and R4, and to assess whether thermal comfort should be separated from the other aspects. The second is to review Immediate surroundings, whose infrastructure, access and safety items did not behave as a scale.

The third is to verify the agreement between the responses to R16 and R18. The fourth is to record housing tenure and dwelling type, the number of occupants, and the administration period. The fifth is to clarify the relationship between this instrument and the scale of project FZ-HAB-0024. None of these decisions was made in the present analysis, which retains the original twenty-five items.

For future work, we propose completing data collection to the planned target, repeating the exploratory factor analysis once the number of cases allows, and then evaluating the resulting structure through confirmatory factor analysis in an independent sample.

If the scale is administered in other cities in northwestern Mexico, each survey should be analyzed as an independent sample before any comparison between cities. An instrument with documented validity evidence would make it possible to monitor housing habitability in Culiacán and to steer housing policy toward the aspects, such as thermal comfort, that residents rate less favorably, in line with the critical assessment of social housing policy in Mexico (Hernández Ilizaliturri et al., 2025).

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Chapter 14 / Capítulo 14

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Habitability and second-home tourism of North Americans in northwestern Mazatlán: Presentation of a scale and pilot results

Habitabilidad y turismo de segundas residencias de norteamericanos en el noroeste de Mazatlán: presentación de una escala y resultados de un piloto

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ABSTRACT

Residential tourism and seasonal housing are transforming the coastal neighbourhoods of Mazatlán, yet the experience of their permanent residents has received little attention. This study presented the Seasonal Housing and Local Habitability Scale, with fifteen items and three dimensions, Presence of seasonal housing, Living conditions for local residents and Relationship with seasonal residents, and described its behaviour in the pilot survey of project FZ-HAB-0035 on the Factoriza UAS platform in northwestern Mazatlán. With a cross-sectional design, 6 cases out of a target of 100 were analysed while data collection remained open. Descriptive statistics, Cronbach's alpha and Spearman inter-item correlations were estimated; omega, factor analysis and the correlation between dimensions could not be estimated because the correlation matrix is singular with fewer cases than items. Internal consistency was high for Relationship with seasonal residents (α = .818), moderate for Living conditions (α = .612) and negative for Presence of seasonal housing (α = -.064), whose items did not vary together. Residents rated services and shops favourably, described a distant relationship with seasonal residents and leaned towards having considered moving. With 6 cases, the findings provide no validity evidence, but they identify the items to revise before completing data collection.

Keywords: residential tourism; second homes; housing habitability; tourism gentrification

RESUMEN

El turismo residencial y la vivienda de temporada transforman las colonias costeras de Mazatlán, pero la experiencia de sus residentes permanentes ha recibido poca atención. Este estudio presentó la Escala de vivienda de temporada y habitabilidad local, de quince reactivos y tres dimensiones, Presencia de vivienda de temporada, Condiciones de vida para los residentes locales y Relación con residentes de temporada, y describió su comportamiento en el levantamiento piloto del proyecto FZ-HAB-0035 de Factoriza UAS en el noroeste de Mazatlán. Con diseño transversal, se analizaron 6 casos de una meta de 100, con el levantamiento abierto. Se estimaron descriptivos, alfa de Cronbach y correlaciones de Spearman entre reactivos; el omega, el análisis factorial y la correlación entre dimensiones no fueron estimables porque la matriz de correlaciones es singular con menos casos que reactivos. La consistencia interna fue alta en Relación con residentes de temporada (α = .818), moderada en Condiciones de vida (α = .612) y negativa en Presencia de vivienda de temporada (α = -.064), cuyos reactivos no variaron juntos. Los residentes valoraron favorablemente los servicios y el comercio, describieron una relación poco estrecha con los residentes de temporada y una tendencia a haber pensado en mudarse. Con 6 casos, los resultados no aportan evidencias de validez, pero identifican los reactivos que conviene revisar antes de completar el levantamiento.

Palabras clave: turismo residencial; segundas residencias; habitabilidad de la vivienda; gentrificación turística

INTRODUCTION

Mazatlán is undergoing an urban transformation driven by tourism and by its associated real estate market. The boom in high-rise construction aimed at second homes and residential tourism has generated social tensions, pressure on infrastructure, and the replacement of traditional land uses along the coastal strip (Bojorquez Luque et al., 2023; Bojórquez Luque and Osuna Covarrubias, 2025). Recent studies also describe processes of touristification and tourism gentrification with sociocultural impacts on the local population (Mendieta Vega and Roldán Clarà, 2024).

In this context, housing ceases to be merely a place to live and also becomes an asset that can be allocated to seasonal residents.

Mexico is one of the main destinations for North American migration to Latin America. In Chapala, Jalisco, a leading destination for North American retirees, residential tourism development has been analyzed as an agent of social change that reconfigures local identities and community dynamics (Zepeda-Hernández, 2024).

Home purchases by foreigners in the country's coastal and border areas are concentrated in a small number of localities, and destinations differ in buyers' nationality and in the size of the properties acquired, according to records from the Secretaría de RelacionesExteriores (Ministry of Foreign Affairs) analyzed by Colorado Giraldo (2022) for the period 2008 to 2019. These processes raise direct questions about the livability of neighborhoods (colonias) for those who live there permanently.

The literature on tourism gentrification has documented the rising cost of land and of everyday life, the transformation of commerce and of the uses of space, and the weakening of the resident population's attachment to place (Nikšić Radić and Dragičević, 2025; Zarza Ballina and Cruz Jiménez, 2024).

In Mexican coastal cities, however, the experience of permanent residents who live alongside seasonal housing has received less attention, and no brief instruments were identified that jointly measure the perceived presence of such housing, the living conditions of local residents, and their relationship with seasonal residents.

Project FZ-HAB-0035 of the Factoriza UAS platform set out to study habitability and second-home tourism by North Americans in northwestern Mazatlán. To this end, the Seasonal Housing and Local Habitability Scale was designed, comprising fifteen items organized into three dimensions: Presence of Seasonal Housing, Living Conditions for Local Residents, and Relationship with Seasonal Residents. The items refer to seasonal residents and foreign residents, without specifying their origin.

This article presents the instrument and its performance in the preliminary data cut of the pilot survey, which comprises only six cases. Given this sample size, the scope of the study is limited to describing the instrument, its administration procedure and the initial responses; it does not permit the estimation of population parameters or a reliable evaluation of its psychometric properties.

The overall objective was to describe the Seasonal Housing and Local Habitability Scale and its initial performance among permanent residents of northwestern Mazatlán. The specific objectives were, first, to present the structure and rationale of the instrument; second, to describe the responses to each item and the internal consistency of each dimension in the data available so far; and third, to document the conditions that the survey must meet for psychometric analysis to be possible. The project package records no hypotheses, so the study is descriptive in scope.

DEVELOPMENT

RESIDENTIAL TOURISM, LIFESTYLE MIGRATION AND GENTRIFICATION

Touristification refers to the process whereby an urban space is reorganized around tourism, such that its land uses, commerce and housing become increasingly oriented toward visitors.

When this process is accompanied by rising land prices and the arrival of temporary or more affluent residents, the literature refers to it as tourism gentrification. Zarza Ballina and Cruz Jiménez (2024) reviewed the scientific literature published between 2008 and 2022 on tourism-driven gentrification and organized it into four lines of research: socio-spatial and sociocultural impacts, the relationship between capitalism and displacement, gentrification in rural areas, and the relationship between gentrification and governance.

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The integrative review by Nikšić Radić and Dragičević (2025) found that tourism gentrification and lifestyle migration can produce displacement and inequality, but also opportunities for regeneration when accompanied by inclusive governance and local participation.

Residential tourism, in which housing is occupied seasonally by people who are not permanent residents of the locality, shares features with tourism gentrification but adds the prolonged presence of new neighbors whose lifestyles, languages and economic capacities differ from those of local residents.

In Chapala, Zepeda-Hernández (2024) used qualitative techniques to analyze residential tourism development and concluded that its economic base has produced economic subordination, cultural imposition, inequality, and symbolic barriers, reshaping local identities and community dynamics.

Among coastal localities in other countries, the case of Marsascala, Malta, shows the transition from a fishing village to a site of intense tourism consolidation, marked by overdevelopment, pressure on infrastructure and declining quality of life. The authors proposed adding a stage of "real-estatization" to touristification models, one in which speculation and short-term rentals reconfigure the locality beyond tourism (Agius et al., 2025).

Digital platforms have changed how housing is incorporated into the tourism circuit. Sequera (2025) proposed the concept of platform gentrification to describe how rental platforms, social media, app-based transport services and coworking spaces mediate, valorize and restructure urban life.

The conversion of residential housing into short-term accommodation also responds to economic incentives that can be estimated: in the central wards of Tokyo, this conversion was more profitable when the prior rent was lower, when the dwelling was close to high-ridership stations, and when there were many tourist attractions nearby (Murota et al., 2025).

TOURISM AND HOUSING IN MAZATLÁN

Studies on Mazatlán consistently describe an accelerated transformation of coastal urban space.

Bojorquez Luque et al. (2023) analyzed the production of vertical tourism space and the social tensions associated with it, and Bojórquez Luque and Osuna Covarrubias (2025) examined the Playa Norte area between 2009 and 2024 from the perspective of creative destruction. Mendieta Vega and Roldán Clarà (2024) characterized the sociocultural impacts of touristification and tourism gentrification in the city.

Taken together, these studies place Mazatlán among the Mexican coastal cities in which tourism and the real estate market are redefining who lives in their neighborhoods and under what conditions.

What the local literature documents in less detail is the everyday experience of permanent residents. In other Mexican cities, tourism designation has been accompanied by gated developments, rising land and housing prices, and the replacement of traditional commerce, with little direct displacement but physical and symbolic segregation (Hernández Flores, 2023).

In the historic center of Zacatecas, Ramos-Jiménez and De La Barrera-Medina (2025) linked tourist-use housing to a shrinking supply of traditional rental housing, rising rents, the displacement of residents, and the loss of traditional commerce; they also noted that the city's planning instruments did not take this type of housing into account.

THE DIMENSIONS OF THE SCALE

The Seasonal Housing Presence dimension captures five indicators from the residents' perspective: dwellings in the neighborhood occupied only seasonally (R1), the construction of buildings for seasonal residents (R2), the recent arrival of new foreign residents (R3), the retention of long-standing neighbors (R4, reverse-scored), and English-language advertisements for home sales (R5).

After recoding R4, a higher score indicates greater perceived presence. The items combine changes in the housing stock, changes in the population, and signals from the real estate market, which do not necessarily move at the same pace.

The Living conditions for local residents dimension captures the ability to afford the cost of living in the neighborhood (R6), the adequacy of services (R7), the availability of necessary retail

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(R8), whether the household has considered moving away (R9, reverse-coded), and enjoyment of living in the neighborhood (R10). It thus links affordability, services, and rootedness, which the literature identifies as the domains in which tourism gentrification becomes a matter of livability.

In Guangzhou, a study based on 1,568 questionnaires administered in 74 communities found that perceived neighborhood disorder was positively associated with the intention to move, whereas community attachment and satisfaction were negatively associated with it (Gu et al., 2025).

The Relationship with seasonal residents dimension covers greeting seasonal residents (R11), their participation in the life of the neighborhood (R12), the feeling of displacement in public spaces (R13, reverse-scored), seasonal residents' respect for the neighborhood's customs (R14), and comfort in sharing spaces with them (R15).

In a traditional industrial area of Beijing, Lin et al. (2023) used Q methodology to identify the privatization of public spaces, the reorientation of services toward visitors, and the weakening of community ties as sources of stress linked to the desire to relocate. In the Chinese-language literature, Xing (2026) analyzed the case of the ancient city of Pingyao and proposed that the emotions of residents in heritage destinations be understood as the lived expression of tensions between heritage protection, local life, and commercial development.

The review by Kamani Fard and Paydar (2024) on place attachment in urban settings, for its part, noted that social interaction is associated with a stronger bond with place.

REQUIREMENTS FOR EVALUATING THE INSTRUMENT

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items; McDonald's omega (McDonald, 1999/2013) does not make this assumption, and simulation studies have compared the performance of the two coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis, which first requires verifying the adequacy of the data and having a sufficient sample size (Ferrando et al., 2022; Goretzko et al., 2021). When there are fewer cases than items, the correlation matrix cannot be inverted and these analyses cannot be estimated. In a cross-sectional design, moreover, any observed relationship must be interpreted as an association and not as a dependence relationship.

METHODOLOGY

DESIGN

A quantitative, non-experimental, cross-sectional, descriptive study was conducted. The data come from survey LEV-0040, "Piloto noroeste de Mazatlán · Vivienda de temporada," of project FZ-HAB-0035 on the Factoriza UAS platform, and from frozen dataset DST-0037, with a data cutoff date of 9 October 2026. The survey is an independent sample and the only one in the project.

POPULATION, SAMPLE AND DATA CUT-OFF

The population was defined as individuals aged 18 years or older who permanently reside in northwestern Mazatlán, Sinaloa. The neighborhoods (colonias) included were documented using a territorial or real estate source. According to the Factoriza log, 14 individuals opened the questionnaire and 6 completed it; no cases were excluded on quality-control grounds, so 6 cases were analyzed (Table 2).

The data cut analyzed here is preliminary: it comprises 6 cases out of a target of 100, and data collection was still open, in the field, as of the cut-off date. With 6 cases for 15 items, the ratio is 0.4 cases per item, so the inter-item correlation matrix is not invertible.

INSTRUMENT

The Seasonal Housing and Local Habitability Scale was administered. It comprises fifteen items with a five-point response format, ranging from Strongly disagree (1) to Strongly agree

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(5), organized into three dimensions of five items each: Presence of Seasonal Housing (R1 to R5), Living Conditions for Local Residents (R6 to R10), and Relationship with Seasonal Residents (R11 to R15).

Three items are reverse-worded, one per dimension (R4, R9 and R13), and have been recoded in the data matrix. After recoding, a higher score indicates greater perceived presence of seasonal housing, better living conditions and a more favorable relationship with seasonal residents. Table 1 presents the code, dimension, wording and direction of each item.

Table 1. Structure of the instrument.

Code	Dimension	Item	Reverse
R1	Presence of seasonal housing	In my neighborhood, there are homes that are occupied only seasonally	No
R2	Presence of seasonal housing	In my neighborhood, buildings are being constructed for seasonal residents	No
R3	Presence of seasonal housing	In recent years, new foreign residents have arrived in my neighborhood	No
R4	Presence of seasonal housing	My neighborhood retains its long-time residents	Yes
R5	Presence of seasonal housing	Home sale listings in my neighborhood are in English	No
R6	Living conditions for local residents	I can afford the cost of living in my neighborhood	No
R7	Living conditions for local residents	The services in my neighborhood are sufficient for the residents	No
R8	Living conditions for local residents	I can find the shops I need in my neighborhood	No
R9	Living conditions for local residents	My family has considered moving out of the neighborhood	Yes
R10	Living conditions for local residents	I like living in my neighborhood	No
R11	Relationship with seasonal residents	I greet the seasonal residents of my neighborhood	No
R12	Relationship with seasonal residents	Seasonal residents participate in the life of the community	No
R13	Relationship with seasonal residents	I feel displaced in the public spaces of my neighborhood	Yes
R14	Relationship with seasonal residents	Seasonal residents respect the customs of the colony	No
R15	Relationship with seasonal residents	I feel comfortable sharing the community's spaces with seasonal residents	No

Note. Seasonal Housing and Local Habitability Scale. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0035, survey LEV-0040, dataset DST-0037.

PROCEDURE

Responses were collected through the survey questionnaire administered in Factoriza UAS, which records explicit online informed consent before the first item and does not collect identifying data. Factoriza froze dataset DST-0037 with a cryptographic hash, generated the data matrix with reverse-scored items recoded, and produced the descriptive, internal-consistency, and within-dimension correlation analyses (runs RUN-00217 to RUN-00223).

DATA ANALYSIS

Factoriza UAS computed the mean, standard deviation, skewness, kurtosis and the percentages of responses at the extreme values of each item; the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), together with the corrected item-total correlation and alpha if item deleted; and the Spearman correlations between the items of each dimension, with 95% confidence intervals obtained by Fisher's z transformation. In addition, the project's complementary analysis program, analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy (Harris et al., 2020), SciPy (Virtanen et al., 2020) and pandas, to estimate McDonald's omega (McDonald, 1999/2013), perform the exploratory factor analysis and estimate the correlation between dimensions.

The program stopped when computing the measure of sampling adequacy because, with 6 cases for 15 items, the correlation matrix is singular; consequently, these results were not obtained. The execution log is provided in the reproducibility appendix.

Given the cohort size, the Factoriza coefficients are reported to document how the instrument functions and not as estimates of its properties. Reference values for the psychometric indices are treated as guidelines and not as decision rules (Ferrando et al., 2022). No item was removed, and

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no confirmatory factor analysis was performed.

ETHICAL CONSIDERATIONS

Participation was voluntary and anonymous. Factoriza UAS records explicit informed consent online and does not collect names, email addresses, or any other identifying data.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

The following tools were used in preparing this manuscript: the Factoriza UAS platform, for data management and for descriptive, internal consistency and inter-item correlation analyses; a Python analysis program with fixed and validated procedures, whose execution was halted because of the size of the data cut; and the Claude Opus language model (Anthropic), for running that program, assisted literature searching, preparing a draft, and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference, and assume full responsibility for the content of the article.

RESULTS

SAMPLE COMPOSITION

Table 2 summarizes the case flow. Of the 14 individuals who opened the questionnaire, 6 completed it and were analyzed, with no exclusions for quality control. The 6 analyzed cases answered all fifteen items.

Table 2. Sample composition.

Indicator	Value
People who opened the questionnaire	14
Completed questionnaires	6
Cases excluded by quality control	0
Cases analyzed	6
Items	15

Note. Survey “Northwest Mazatlán Pilot · Seasonal Housing” (LEV-0040); population: persons aged 18 years or older who permanently reside in northwest Mazatlán; territory: northwest zone of Mazatlán, Sinaloa, in neighborhoods (colonias) documented with a territorial or real-estate source. Dataset DST-0037, fingerprint cff0333d73566415. Source: Factoriza UAS. Preliminary cutoff: n = 6 of a target of 100, with the survey still open.

ITEM RESPONSES

Table 3 and Figure 1 present the descriptive statistics. With 6 cases, each response carries considerable weight in the mean, and three items (R5, R7 and R8) show kurtosis values of 6.00, indicating responses concentrated on a single value. In Presence of seasonal housing, all means fell below the scale midpoint: the existence of dwellings occupied only seasonally (R1: M = 2.83, SD = 0.98), the arrival of new foreign residents (R3: M = 2.67, SD = 1.21), the loss of long-time neighbors, in its recoded version (R4: M = 2.50, SD = 1.22), the construction of buildings for seasonal residents (R2: M = 2.17, SD = 1.17) and for-sale advertisements in English (R5: M = 1.83, SD = 0.41).

In Living conditions for local residents, the adequacy of services had the highest mean on the instrument (R7: M = 4.17, SD = 0.41), followed by the availability of shops (R8: M = 3.67, SD = 0.82), the ability to afford the cost of living in the neighborhood (R6: M = 3.50, SD = 1.05), and enjoyment of living there (R10: M = 3.33, SD = 1.03).

The absence of the idea of moving, in its recoded version, had a low mean (R9: M = 2.17, SD = 0.98), indicating a tendency for the family to have considered moving out of the neighborhood. Regarding Relationship with Seasonal Residents, the recoded item on the absence of displacement in public spaces was at the midpoint (R13: M = 3.17, SD = 0.75), as was respect for customs (R14: M = 3.00, SD = 0.89). In contrast, the participation of seasonal residents in neighborhood life (R12: M =

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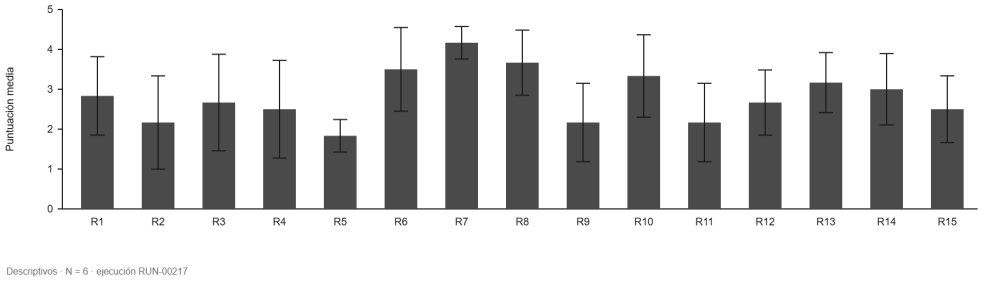
2.67, *SD* = 0.82), comfort when sharing spaces (R15: *M* = 2.50, *SD* = 0.84), and greeting (R11: *M* = 2.17, *SD* = 0.98) had low means.

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.83	0.98	0.46	-2.39	50%	33%
R2	2.17	1.17	0.67	-0.45	33%	17%
R3	2.67	1.21	-0.08	-1.55	17%	33%
R4	2.50	1.22	0.49	-1.47	17%	33%
R5	1.83	0.41	-2.45	6.00	17%	83%
R6	3.50	1.05	-0.00	-0.25	17%	17%
R7	4.17	0.41	2.45	6.00	83%	17%
R8	3.67	0.82	-2.45	6.00	17%	83%
R9	2.17	0.98	1.44	3.60	17%	17%
R10	3.33	1.03	-0.97	-1.88	33%	67%
R11	2.17	0.98	1.44	3.60	17%	17%
R12	2.67	0.82	0.86	-0.30	50%	17%
R13	3.17	0.75	-0.31	-0.10	17%	33%
R14	3.00	0.89	0.00	-1.88	33%	33%
R15	2.50	0.84	1.54	1.43	67%	17%

Note.N = 6. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column from the Factoriza descriptive table is omitted, as its values do not match those in Table 4 because they are not calculated from the total of each dimension. Factoriza UAS run RUN-00217. Preliminary cut-off: n = 6 out of a target of 100, with data collection still open.

Figure 1. Mean scores by item with error bars representing one standard deviation.



INTERNAL CONSISTENCY

Table 4 presents the item analysis by dimension. Presence of seasonal housing yielded a negative alpha (α = -.064), indicating that its items covary, on average, in opposite directions. The arrival of new foreign residents correlated negatively with the rest of the dimension (R3: -.364), and its removal would raise alpha to .424. The recoded loss of neighbors showed a virtually null correlation (R4: -.041), and the other three items had low correlations (between .109 and .267).

Living conditions for local residents yielded α = .612. Enjoying living in the neighborhood was the most consistent item (R10: .828), whereas the ability to afford the cost of living there was barely related to the rest (R6: .076); its removal would raise alpha to .723. Relationship with seasonal residents showed the highest consistency (α = .818), with comfort in sharing spaces (R15: .850), the participation of seasonal residents (R12: .828), and greeting (R11: .812) as the most consistent items; the recoded absence of displacement was weakly related to the dimension (R13: .235), and its removal would raise alpha to .873.

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Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
PVT	R1	.240	-.449
PVT	R2	.109	-.290
PVT	R3	-.364	.424
PVT	R4	-.041	-.023
PVT	R5	.267	-.214
CVL	R6	.076	.723
CVL	R7	.443	.573
CVL	R8	.458	.513
CVL	R9	.290	.602
CVL	R10	.828	.229
RRT	R11	.812	.712
RRT	R12	.828	.717
RRT	R13	.235	.873
RRT	R14	.398	.844
RRT	R15	.850	.708

Note.N = 6. Scale from 1 to 5; reverse-scored items R4, R9, and R13 are shown recoded. Run RUN-00217 of Factoriza UAS. Preliminary cutoff: n = 6 out of a target of 100, with data collection still open.

CORRELATIONS BETWEEN ITEMS

Tables 5, 6, and 7 present the Spearman correlations between the items of each dimension. With 6 cases, the confidence intervals are very wide, and only two correlations had intervals lying entirely on one side of zero. In Presence of Seasonal Housing, the existence of seasonally occupied dwellings was related to the loss of long-standing neighbors (R1 and R4: ρ = .867, 95% CI [.186, .985], *p* = .025), whereas the arrival of new foreign residents was negatively related to seasonal housing (R1 and R3: ρ = -.524) and to signs in English (R3 and R5: ρ = -.539), although the intervals for these correlations were not conclusive.

For Relationship with seasonal residents, the participation of seasonal residents was associated with comfort in sharing spaces (R12 and R15: ρ = .822, 95% CI [.030, .980], *p* = .045). For Living conditions, no correlation had an interval that excluded zero; the highest was between the availability of shops and the absence of any thought of moving (R8 and R9: ρ = .775, 95% CI [-.100, .974], *p* = .070). Three correlations were exactly zero, with *p* = 1.000, a result to be expected when there are few cases and many tied responses.

Table 5. Correlations among the Presence of Seasonal Housing items.

Variable pair	r	IC 95%	p
R1 and R2	-.127	[-.851, .763]	.810
R1 and R3	-.524	[-.937, .500]	.285
R1 and R4	.867	[.186, .985]	.025
R1 and R5	.424	[-.591, .919]	.402
R2 and R3	.409	[-.603, .916]	.421
R2 and R4	-.318	[-.898, .665]	.539
R2 and R5	.539	[-.484, .940]	.269
R3 and R4	-.429	[-.920, .587]	.396
R3 and R5	-.539	[-.940, .484]	.269
R4 and R5	.141	[-.757, .855]	.789

Note.N = 6. PVT = Presence of seasonal housing; CVL = Living conditions for local residents; RRT = Relationship with seasonal residents. The corrected item-total correlation excludes the item itself from the total of its dimension. A negative alpha indicates that the items covary, on average, in opposite directions. Cronbach's α for the full dimensions, with 5 items each: PVT = -.064 (run RUN-00218); CVL = .612 (RUN-00220); RRT = .818 (RUN-00222). Source: Factoriza UAS, Tables 4, 6, and 8 of the package, combined without modifying values. Preliminary cutoff: n = 6 out of a target of 100, with data collection still open.

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Table 6. Correlations between the Living Conditions items for local residents.

Variable pair	r	IC 95%	p
R6 and R7	.674	[-.303, .960]	.142
R6 and R8	-.270	[-.887, .694]	.605
R6 and R9	-.348	[-.904, .646]	.499
R6 and R10	.320	[-.664, .898]	.537
R7 and R8	.200	[-.730, .870]	.704
R7 and R9	.000	[-.812, .812]	1.000
R7 and R10	.316	[-.666, .897]	.541
R8 and R9	.775	[-.100, .974]	.070
R8 and R10	.632	[-.368, .954]	.178
R9 and R10	.612	[-.396, .951]	.196

Note.N = 6. Spearman correlation coefficient, labeled r in the Factoriza table. Confidence intervals were obtained using Fisher's z transformation. Cross-sectional design: the reported relationships are associations. Factoriza UAS run RUN-00219. Preliminary data cut: n = 6 of a target of 100, with data collection still ongoing.

Table 7. Correlations among the items of Relationship with seasonal residents.

Variable pair	r	IC 95%	p
R11 and R12	.730	[-.200, .968]	.099
R11 and R13	.456	[-.564, .925]	.363
R11 and R14	.000	[-.812, .812]	1.000
R11 and R15	.700	[-.258, .964]	.121
R12 and R13	.033	[-.800, .823]	.950
R12 and R14	.516	[-.508, .936]	.294
R12 and R15	.822	[.030, .980]	.045
R13 and R14	.000	[-.812, .812]	1.000
R13 and R15	.055	[-.792, .829]	.918
R14 and R15	.495	[-.529, .932]	.318

Note.N = 6. Spearman's correlation coefficient, labeled r in the Factoriza table. Confidence intervals were obtained using Fisher's z transformation. Cross-sectional design: the reported relationships are associations. Factoriza UAS run RUN-00221. Preliminary cutoff: n = 6 of a target of 100, with data collection still open.

DISCUSSION OF RESULTS

The purpose of this study was to present the Seasonal Housing and Local Habitability Scale and to describe its initial performance among permanent residents of northwestern Mazatlán.

With only 6 cases, no result can be generalized or taken as an estimate of the instrument's properties: the literature on internal consistency coefficients has been developed with far larger samples (Malkewitz et al., 2023), and the internal structure could not be examined. Nevertheless, this data cut provides useful signals for revising the instrument before data collection continues.

The first indication is that Presence of Seasonal Housing did not behave as a scale. The dimension combines changes in the housing stock, such as seasonally occupied dwellings and new buildings, with changes in the population, such as the arrival of foreign residents and the loss of long-standing neighbors, and with market signals, such as advertisements in English. These processes do not necessarily move together: a neighborhood may receive new permanent foreign residents without an increase in seasonal housing, or vice versa.

The positive relationship between seasonal housing and the loss of long-standing neighbors, the only conclusive one in this dimension, is consistent with the association between touristification and displacement described in the literature (Nikšić Radić and Dragičević, 2025; Ramos-Jiménez and De La Barrera-Medina, 2025), but with only 6 cases it cannot be interpreted further.

The second sign is that Relationship with Seasonal Residents showed a coherent core made up of greeting, the participation of seasonal residents and comfort when sharing spaces, whereas the sense of displacement, which was reverse-worded, diverged from the rest.

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This is consistent with the view that everyday coexistence and symbolic displacement are distinct aspects of the relationship with new neighbors, as suggested by studies that distinguish community ties from the privatization or appropriation of public spaces (Lin et al., 2023) and that describe symbolic barriers in residential tourism (Zepeda-Hernández, 2024).

In Living Conditions, affordability separated from the rest of the dimension, a result that warrants careful examination because affordability is one of the central mechanisms of tourism gentrification (Nikšić Radić and Dragičević, 2025).

Finally, the descriptive profile should be interpreted with caution. The low mean scores for the presence of seasonal housing may indicate that the first respondents' neighborhoods have little exposure to this phenomenon, which would be relevant to the selection of neighborhoods for the final wave.

The combination of favorably rated services and commerce, a weak relationship with seasonal residents and a tendency to have considered moving is consistent with the literature linking residential tourism to changes in community life (Zepeda-Hernández, 2024) and perceptions of the surrounding environment to the intention to move (Gu et al., 2025). With 6 cases, however, it does not constitute a finding.

CONCLUSIONS

The study presented the Seasonal Housing and Local Habitability Scale from project FZ-HAB-0035 and described its performance in a preliminary sample of 6 cases. The Relationship with seasonal residents dimension showed high internal consistency (α = .818), Living conditions for local residents had moderate consistency (α = .612), and Presence of seasonal housing yielded a negative alpha (α = -.064), with items that do not covary.

The supplementary analysis program could not estimate omega, fit the factor analysis, or compute the correlation between dimensions, because the correlation matrix is singular when there are fewer cases than items. These results do not provide validity evidence, but they identify the items that warrant revision.

The limitations are decisive. The sample of 6 cases, against a target of 100 (0.4 cases per item), precludes estimation of the instrument's properties and makes all statistics unstable. Data collection was still ongoing, and of the 14 individuals who opened the questionnaire, only 6 completed it.

No information is available on the participating neighborhoods or on the survey respondents, and the instrument does not identify the nationality of the seasonal residents, so the study cannot refer specifically to North American residents. The cross-sectional design precludes establishing dependence relationships.

Several decisions for the authors follow from these results. The first is to complete data collection before any inferential or psychometric analysis. The second is to revise Presence of seasonal housing and consider splitting it into indicators of the housing stock, the population and the real estate market, or reformulating R3. The third is to revise R6, affordability, and R13, displacement in public spaces, which departed from their dimensions.

The fourth is to decide whether the instrument should document the nationality of seasonal residents, so that the project title matches what is measured. The fifth is to document the neighborhoods, the origin of the items, and the content review. None of these decisions was made in the present analysis, which retains the original fifteen items.

For future research, we propose completing the survey to the planned target, with neighborhoods (colonias) that differ in their exposure to seasonal housing, documented through territorial or real estate sources. Omega and the exploratory factor analysis would then be estimated, and the resulting structure subsequently evaluated by confirmatory factor analysis in an independent sample.

Combining the scale with records of property purchases by foreigners, such as those used by Colorado Giraldo (2022), or with short-term rental records would make it possible to contrast perceived presence with recorded presence. It would also give Mazatlán an instrument for monitoring the livability of its neighborhoods as residential tourism expands.

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Chapter 15 / Capítulo 15

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Acoustic habitability in inhabited spaces of Mazatlán: A preliminary review of a scale of experience and control of the sound environment

Habitabilidad acústica en espacios habitables de Mazatlán: revisión preliminar de una escala de experiencia y control del ambiente sonoro

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ABSTRACT

Sound is part of the experience of any inhabited space, and acoustic habitability depends both on sound levels and on how users experience and control the sound environment. This instrumental, cross-sectional and exploratory study reviewed the preliminary functioning of a five-item scale of experience and control of the sound environment, administered in the survey of project FZ-EX-0002 of the Factoriza UAS platform among users of inhabited spaces in Mazatlán, Mexico. A preliminary cut of 5 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha, item analysis and Pearson inter-item correlations; McDonald's omega and exploratory factor analysis were attempted with a fixed analysis program. Feeling safe because of the sound environment obtained the highest mean (M = 4.20). Three items on the contribution of design, materials and pleasant sounds to the experience of the space were strongly intercorrelated and had the highest corrected item-total correlations, and the scale reached α = .681. The safety item was unrelated to that core, and the reverse-worded item on control and appropriation had a negative item-total correlation, so omega could not be interpreted. Exploratory factor analysis could not be estimated with five cases. The results identify revisions needed before the final data cut: defining the space being evaluated, rewording the control item, reviewing items that ask for causal attributions, and adding an independent measure of stress.

Keywords: acoustic habitability; soundscape; perceived control; scale development

RESUMEN

El sonido forma parte de la experiencia de cualquier espacio que se habita, y la habitabilidad acústica depende tanto de los niveles sonoros como de la manera en que los usuarios experimentan y controlan el ambiente sonoro. Este estudio instrumental, transversal y exploratorio revisó el funcionamiento preliminar de una escala de cinco reactivos sobre la experiencia y el control del ambiente sonoro, aplicada en el levantamiento del proyecto FZ-EX-0002 de Factoriza UAS a usuarios de espacios habitables de Mazatlán. Se analizó un corte preliminar de 5 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach, análisis de reactivos y correlaciones de Pearson entre reactivos; el omega de McDonald y el análisis factorial exploratorio se intentaron con un programa de análisis fijo. La sensación de seguridad que produce el ambiente sonoro obtuvo la media más alta (M = 4.20). Tres reactivos sobre la contribución del diseño, de los materiales y de los sonidos agradables a la experiencia del espacio se relacionaron entre sí con correlaciones altas y tuvieron las correlaciones ítem-total más elevadas, y la escala alcanzó un α = .681. El reactivo de seguridad no se relacionó con ese núcleo, y el reactivo inverso sobre el control y la apropiación tuvo una correlación ítem-total negativa, por lo que el omega no fue interpretable. El análisis factorial exploratorio no pudo estimarse con cinco casos. Los resultados identifican las revisiones necesarias antes del corte final: definir el espacio evaluado, reformular el reactivo de control, revisar los reactivos que piden atribuciones de efecto e incorporar una medida independiente de estrés.

Palabras clave: habitabilidad acústica; paisaje sonoro; control percibido; desarrollo de escalas

INTRODUCTION

Sound is part of the experience of any inhabited space. People do not merely hear the noise of traffic, neighbors or shops; they interpret the sounds of a place as a whole, evaluate them as pleasant or annoying, safe or threatening, familiar or alien, and act either to protect themselves from them or to enjoy them.

The acoustic habitability of a space therefore depends both on sound levels and on how its users experience the sound environment and how much control they have over it.

Research on environmental noise has extensively documented its associations with health. An umbrella review of 23 systematic reviews and meta-analyses found that high exposure to environmental noise was associated with an increased risk of cardiovascular disease, high blood pressure, diabetes and adverse reproductive outcomes, and that the risk of anxiety and depression increased with exposure, although most of the evidence was of low or very low quality (Chen et al., 2023).

The updated World Health Organization systematic review on noise and sleep found moderate-quality evidence that the probability of being highly sleep-disturbed increases with the level of nighttime aircraft, road traffic and railway noise when the question names noise as the source (Smith et al., 2022). Another meta-analysis, including eleven studies and 15,525 adults aged 35 years or older, found an association between long-term exposure to environmental noise and the risk of depressive and anxiety symptoms (Hu, 2025).

However, the relationship between sound and well-being is not limited to noise exposure. A meta-analytic synthesis of 18 publications found that natural sounds were associated with lower stress and annoyance and with better health outcomes and positive affect (Buxton et al., 2021). In addition, a survey of 216 residents of high-density residential areas in China showed that a low sound pressure level did not necessarily lead to an experience of tranquility, that tranquility comprised perceived restorativeness and pleasantness, and that commercial loudspeakers, machinery and traffic reduced it (Zhao et al., 2025).

This shift in perspective, from noise as a pollutant to the sound environment as a resource, lies at the core of the soundscape approach, which examines how people perceive, experience and understand the acoustic environment in context.

Mazatlán offers a setting in which this perspective is relevant.

The city is undergoing a tourism-related transformation: the boom in high-rise construction aimed at tourism and second homes has generated social tensions and pressure on infrastructure along the coastal strip (Bojorquez Luque et al., 2023); recent studies describe processes of touristification and tourism gentrification with sociocultural impacts on the local population (Mendieta Vega and Roldán Clarà, 2024).

Nightlife in emblematic spaces such as Plazuela Machado has been studied from the perspective of women's experience in public space (Cruz Coria, 2024). In a city where housing, commerce, leisure, and tourism coexist, the soundscape of living spaces is a dimension of habitability that deserves to be measured through the experience of the people who use them.

Most of the instruments available for this purpose come from other contexts and tend to focus on annoyance caused by specific noise sources. Studies of European and Asian cities measure exposure using noise maps or acoustic measurements rather than users' experience (Chen et al., 2023; Smith et al., 2022). Among the recently developed soundscape scales is one designed to assess the restorative potential of acoustic environments from children's perspective (Qin et al., 2024).

There is no brief Spanish-language instrument that captures how users of the habitable spaces of a Mexican city evaluate the acoustic environment of those spaces, the contribution of design and materials to making it bearable, and the control they can exert over it.

To this end, project FZ-EX-0002 of the Factoriza UAS platform designed a brief five-item scale organized into a single dimension, Experience and control of the sound environment. The project's title in Factoriza refers to acoustic habitability and environmental stress. However, the questionnaire does not include an independent measure of stress: stress appears only in the content of one of the items.

Moreover, the available data cut comprises 5 cases. For these two reasons, this article does not examine the relationship between acoustic habitability and stress; rather, it offers a preliminary review of how the scale functions. Its title reflects that scope.

The general objective was to examine the preliminary functioning of the scale of experience and control of the sound environment among users of living spaces in Mazatlán. The specific objectives were: (a) to describe the distribution of responses to each item; (b) to estimate the

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internal consistency of the scale using Cronbach's alpha and, when interpretable, McDonald's omega, and to analyze the contribution of each item; (c) to describe the correlations among the items; and (d) to identify aspects of the instrument and procedure that should be revised before the final data cutoff. The project did not state any hypotheses, so the study is framed as exploratory.

DEVELOPMENT

FROM NOISE TO SOUNDSCAPE

Traditional noise research treats noise as a pollutant whose intensity is measured and compared against limit values. This perspective has produced the strongest evidence on the effects of transportation noise on sleep and on cardiovascular and mental health (Chen et al., 2023; Smith et al., 2022), but it leaves out part of the experience.

In an area near an open-pit mine in Central Europe, exposed residents reported high annoyance and a perceived quality of life more than twice as poor as in the control area, although noise levels remained within permitted limits (Stanovská et al., 2025).

In three residential areas adjacent to motorways, noise barriers reduced exposure by 4.4 to 11.7 dBA at nearby points, but annoyance decreased directly in only one of the three cases; the authors discussed contextual factors such as the history of complaints and coping, and distrust of the authorities (Barros et al., 2024).

The soundscape approach takes these discrepancies as its starting point. What matters for habitability is not only the sound level but also the meaning of the sounds, the activity being performed, and the person's relationship with the place. Real-time mobile measurement in Hong Kong showed that momentary annoyance was nonlinearly associated with sound level and with its sudden increases, and that this relationship varied according to the activity microenvironment, individual characteristics, and time of day (Cai et al., 2023).

In the home, an analysis of descriptions provided by London residents during lockdown examined how the acoustic environment related to activities such as work, rest and physical activity, and identified the characteristics of an ideal indoor soundscape (Torresin et al., 2022). In an online survey of 942 participants in India, a larger proportion of people perceived the interior of their home as noisier during the 2020 lockdown, whereas the outdoor environment was perceived as quieter (Mimani and Nama, 2022).

SOUNDS THAT ENHANCE THE EXPERIENCE OF SPACE

The sound environment can also be a resource. In addition to the synthesis on natural sounds (Buxton et al., 2021), recent research from China has examined the links between soundscape perception and well-being in leisure spaces.

In a cross-sectional study of twelve urban parks in Foshan, the cognitive image of the soundscape was positively associated with emotional pleasure and with several dimensions of perceived restoration; the authors caution that their results are associations rather than causal effects (Liao et al., 2026).

Among 446 older adults in a park in Zhengzhou, soundscape perception was positively correlated with well-being; place attachment and perceived restorativeness mediated this relationship (Li et al., 2025).

In communities beneath flight paths in Shenzhen with similar levels of aircraft noise, those with more birdsong and fountain sounds had a lower proportion of highly annoyed people and better soundscape ratings (Qu et al., 2023).

These results indicate that an acoustic habitability scale should not be limited to recording annoyance. A habitable space may contain sounds that improve its users' experience; this positive contribution is a facet distinct from the absence of noise. The project's scale incorporates this idea in the item asking whether some sounds in the space improve the experience of using it.

CONTROL, COPING, AND APPROPRIATION OF SPACE

Recent evidence places control over and coping with the acoustic environment at the center of the relationship between noise and health. In a sample of 1251 schoolchildren from the

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Tyrol region, greater noise-coping efforts during schoolwork were associated with more mental health and sleep problems, and the structural equation model placed these efforts between the built environment and the health problems (Lercher et al., 2024).

Noise sensitivity and attitudes toward the source also modify the relationship between exposure and annoyance. In addition, the way the questionnaire is presented can influence responses: in a study of residents living near wind farms, those who knew the purpose of the research reported more adverse health effects than those who completed a version with the purpose masked (Qu and Tsuchiya, 2021).

Control is also related to the appropriation of space. The review by Kamani Fard and Paydar (2024) on place attachment in urban settings noted that social interaction and local characteristics that express history and culture are associated with a stronger bond. In the Zhengzhou park, place attachment mediated the relationship between soundscape perception and well-being (Li et al., 2025).

The project scale expresses this relationship in a conditional item: when people cannot control the sounds of a space, they find it difficult to feel that it is their own. As discussed below, this type of statement measures something different from the appraisal of the sound environment, because agreement with it reflects the importance people attach to control, and not necessarily an unfavorable experience of the space.

DESIGN, MATERIALS, AND SAFETY

The shape and materials of a space influence its acoustic behavior, and users may perceive them as resources for making noise more bearable. In Tomakomai, Japan, a strip of trees between a main road and nearby homes was associated with a lower proportion of residents who were highly sleep-disturbed; the authors linked the larger difference in summer to bedroom windows being opened more often in that season (Morihara et al., 2026).

However, the perception that design or materials reduce annoyance is not equivalent to a measured reduction in noise, as experience with noise barriers shows (Barros et al., 2024). Two items on the project scale address precisely this attribution: whether the design of the space reduces stress from everyday noise and whether its materials help make noise less annoying.

The soundscape is also related to the sense of safety. Sounds convey information about the presence of other people, the activity of a place and potential threats. In Mazatlán, qualitative studies have shown that the experience of public space, including nightlife, differs between residents and tourists and between men and women (Cruz Coria, 2024; Cruz-Coria, 2024).

The first item of the scale asks whether the sound environment of the space makes the person feel safe, which introduces safety-related content into the dimension that does not necessarily coincide with the content of acoustic comfort.

MEASURING ACOUSTIC EXPERIENCE USING SCALES

The internal consistency of a scale is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared the performance of both coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined with exploratory factor analysis; current recommendations for this analysis call for verifying the adequacy of the data and ensuring a sufficient sample size before interpreting its results (Ferrando et al., 2022; Goretzko et al., 2021).

Scales with positively and negatively worded items may show wording-related biases, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022); identifying these responses can reduce such biases (García-Batista et al., 2021). Finally, in measurement theory, indicators that form a construct, rather than reflect it, are termed formative, and their implications for factor analysis and reliability theory differ from those of reflective indicators (Bollen and Diamantopoulos, 2017).

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METHODOLOGY

DESIGN

An instrumental study with a quantitative approach, a cross-sectional design and an exploratory scope was conducted to examine the preliminary performance of a scale. Because the design was cross-sectional, the relationships reported are associations and do not allow causal inferences.

POPULATION, SAMPLE, AND DATA CUTOFF

The data come from the survey "FZ-EX-0002 · Acoustic Habitability and Environmental Stress" (LEV-0048), part of project FZ-EX-0002 on the Factoriza UAS platform, and from the frozen dataset DST-0043, with a cutoff date of 14 October 2026. The population defined on the platform is any user of a habitable space in Mazatlán, Sinaloa.

Table 1 shows the composition of the sample. Eight people opened the questionnaire and 5 completed it; no cases were excluded by the platform's quality control, and 5 cases with 5 items were analyzed. This is a preliminary data cut: n = 5 out of a target of 100, with data collection still open. At this sample size, the results describe only the initial performance of the items among the five people who responded and do not allow stable estimates; the analysis will need to be repeated with the final data cut.

Table 1. Sample composition.

Indicator	Value
Individuals who opened the questionnaire	8
Completed questionnaires	5
Cases excluded due to quality control	0
Cases analyzed	5
Items	5

Note. Survey "FZ-EX-0002 · Acoustic habitability and environmental stress" (LEV-0048); population: any user of a habitable space in Mazatlán; territory: Mazatlán, Sinaloa. Dataset DST-0043, fingerprint 46c5856a737eb2f2. Source: Factoriza UAS. Preliminary cut-off: n = 5 out of a target of 100, with the survey still open.

INSTRUMENT

The sound environment experience and control scale consists of five items that form a single dimension and are rated on a 5-point response scale ranging from Strongly disagree to Strongly agree. The items ask whether the sound environment of the space makes the person feel safe (R1), whether the design of the space reduces the stress they experience from everyday noise (R2), whether the materials help make noise less bothersome (R3), whether they find it difficult to feel the space as their own when they cannot control its sounds (R4), and whether some sounds in the space improve their experience when using it (R5).

Item R4 is reverse-scored and has been recoded in the data matrix, so that a high value indicates a favorable rating across all items. Table 2 presents the wording of each item.

Table 2. Structure of the instrument.

Code	Item	Reverse
R1	The sound environment of this space makes me feel safe.	No
R2	The design of this space reduces the stress I experience from everyday noise.	No
R3	The materials in this space help make the noise less bothersome to me.	No
R4	When I cannot control the sounds in this space, I find it hard to feel it as my own.	Yes
R5	Some sounds in this space enhance my experience when using it.	No

Note. The five items make up the Experience and Control of the Sound Environment dimension; the dimension column, which is identical in all rows, is omitted. A 5-point response scale was used (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). The reverse-scored item has already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-EX-0002, survey LEV-0048, dataset DST-0043.

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PROCEDURE

The questionnaire was administered through the Factoriza UAS platform, which records explicit online informed consent before the first question and does not collect data that could identify individuals. The platform performs a quality control check on completed questionnaires before incorporating them into the dataset; for this data cut, no cases were excluded.

DATA ANALYSIS

Factoriza UAS calculated the descriptive statistics for each item (mean, standard deviation, skewness, kurtosis, and percentages of responses at the minimum and maximum values), the internal consistency of the scale using Cronbach's alpha (Cronbach, 1951), the corrected item-total correlation and the alpha if item deleted, and the Pearson correlations between items, with 95% confidence intervals obtained through Fisher's z transformation.

In addition, the project's supplementary analysis program, analisis_psicometrico.py, version 1.0, was run in Python 3.13.16 (Python Software Foundation, 2026), with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020), and pandas 3.0.5; this program estimates Cronbach's alpha and McDonald's omega total (McDonald, 1999/2013) from a one-factor minimum residual model without reverse-scoring items. The program does not report omega when any item correlates negatively with the rest of the dimension, because in that case the coefficient is not interpretable.

The same program performs an exploratory factor analysis, preceded by the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974) and Bartlett's test of sphericity (Bartlett, 1950), with the number of factors determined by parallel analysis (Horn, 1965).

With 5 cases for 5 items, the correlation matrix is not of full rank: the program could not compute the measure of sampling adequacy or Bartlett's test, and the factor solution showed communalities greater than 1 (Heywood cases) for two items. For this reason, the factor analysis is neither interpreted nor reported in the article; its complete output is retained in the reproducibility appendix.

With a single theoretical factor, the software did not estimate correlations between dimensions. No confirmatory factor analysis was performed. The methodological literature holds that item factor analysis requires much larger samples (Ferrando et al., 2022; Goretzko et al., 2021).

ETHICAL CONSIDERATIONS

Participation was voluntary, with explicit informed consent recorded online by the platform, which does not collect names, addresses or other identifying data. The data were analysed in aggregate. Because there were only five cases, the presentation of the results should avoid any combination of data that could allow an individual to be recognised.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following tools were used: the Factoriza UAS platform, for data management and the descriptive and internal consistency analyses; a Python analysis program with fixed and validated procedures, for omega and the exploratory factor analysis, the latter of which could not be estimated with the data available at the cut-off; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, drafting, and assembling the document from the results. The authors reviewed, corrected, and approved the entire text, verified each reference, and take full responsibility for the content of the article.

RESULTS

DESCRIPTION OF RESPONSES

Table 3 and Figure 1 present the descriptive statistics for the five items. The sense of safety provided by the space's soundscape had the highest mean (R1: M = 4.20, SD = 0.84), followed by sounds that improve the experience of the space (R5: M = 4.00, SD = 0.71) and materials that make

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noise less annoying (R3: *M* = 3.80, *SD* = 0.84).

The item on design that reduces stress from everyday noise had a mean at the midpoint of the scale and the greatest dispersion (R2: *M* = 3.00, *SD* = 1.58). The reverse-scored item had the lowest mean (R4: *M* = 1.80, *SD* = 0.84); once recoded, this value indicates that respondents tended to agree that they find it difficult to experience the space as their own when they cannot control its sounds.

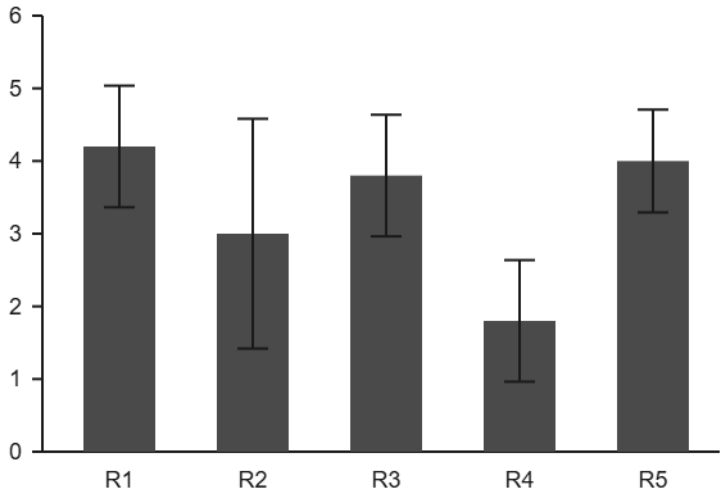
With five cases, the floor and ceiling percentages correspond to one or two individuals, and the skewness and kurtosis indices are not stable estimates of the shape of the distributions. As in other packages on the platform, the floor and ceiling percentages appear to be calculated from the observed values, as indicated in the table note.

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	4.20	0.84	-0.51	-0.61	20%	40%
R2	3.00	1.58	0.00	-1.20	20%	20%
R3	3.80	0.84	0.51	-0.61	40%	20%
R4	1.80	0.84	0.51	-0.61	40%	20%
R5	4.00	0.71	0.00	2.00	20%	20%

Note.N = 5. Reverse-worded item R4 is shown recoded, so that a high value always indicates a favorable rating. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column is omitted, as it is identical to that in Table 4. Run RUN-00243 of Factoriza UAS. Preliminary cut-off: n = 5 of a target of 100, with data collection still ongoing.

Figure 1. Mean scores per item with one-standard-deviation error bars.



INTERNAL CONSISTENCY

Table 4 presents the item analysis. Cronbach's alpha for the scale was .681. Three items had high corrected item-total correlations: design that reduces stress (R2: .972), materials that make noise less bothersome (R3: .938), and sounds that enhance the experience (R5: .764).

The sense of safety showed a virtually zero correlation (R1: .037), and the reverse-scored item on control and appropriation of space showed a negative correlation (R4: -.090). Deleting R4 would raise alpha to .800, and deleting R1 would raise it to .764; deleting any of the other three items would lower it.

Table 4. Item analysis.

Item	Corrected item-total r	α if item deleted
R1	.037	.764
R2	.972	.250

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Item	Corrected item-total r	α if item deleted
R3	.938	.431
R4	-.090	.800
R5	.764	.537

Note.N = 5. Scale from 1 to 5; reverse-scored item R4 is shown recoded. Run RUN-00243 of Factoriza UAS. Preliminary data cut: n = 5 out of a target of 100, with data collection still open.

Table 5 presents the output of the supplementary analysis program. The alpha matches the value obtained with Factoriza (.681). The program did not report omega because R4 correlates negatively with the rest of the dimension even after recoding, which renders the coefficient uninterpretable. It also warns that when an item behaves in this way, the definition of the instrument should be reviewed; in this case, the item is indeed flagged as reverse-scored, so the review concerns its content rather than its coding.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω	Observation
Experience and control	5	5	.681		Reverse-direction items: R4; ω not interpretable

Note.N = 5. The corrected item-total correlation excludes the item itself from the total. Cronbach's α for the full scale = .681 with 5 items. Factoriza UAS run RUN-00244. Preliminary data cut: n = 5 of a target of 100, with data collection ongoing.

CORRELATIONS BETWEEN ITEMS

Table 6 shows the correlations among the five items. The highest correlations were between the design that reduces stress and the materials that make noise less bothersome (R2 and R3: r = .945, 95% CI [.377, .996], p = .015) and between the design and the sounds that enhance the experience (R2 and R5: r = .894, 95% CI [.058, .993], p = .041); the correlation between the materials and these sounds was also high, but its interval included zero (R3 and R5: r = .845, 95% CI [-.146, .990], p = .071).

The sense of safety was weakly related to the materials (R1 and R3: r = .429) and to the design (R1 and R2: r = .189), was not related to the experience-enhancing sounds (R1 and R5: r = .000), and was negatively correlated with the reverse-scored item (R1 and R4: r = -.643, 95% CI [-.973, .553], p = .242). The reverse-scored item was not related to the experience-enhancing sounds (R4 and R5: r = .000) or to the materials (R3 and R4: r = -.071). With five cases, all intervals are very wide; only the first two coefficients mentioned excluded zero.

Table 6. Correlations between items.

Variable pair	r	IC 95%	p
R1 and R2	.189	[-.832, .918]	.761
R1 and R3	.429	[-.730, .951]	.472
R1 and R4	-.643	[-.973, .553]	.242
R1 and R5	.000	[-.882, .882]	1.000
R2 and R3	.945	[.377, .996]	.015
R2 and R4	.189	[-.832, .918]	.761
R2 and R5	.894	[.058, .993]	.041
R3 and R4	-.071	[-.897, .865]	.909
R3 and R5	.845	[-.146, .990]	.071
R4 and R5	.000	[-.882, .882]	1.000

Note.α = Cronbach's alpha; ω = McDonald's omega total from a one-factor minimum residual model, without reversing items. Complete cases per dimension. Experience and control = Experience and control of the sound environment. The program does not report α when any item correlates negatively with the rest of the dimension, as occurs with R4 after recoding. Source: prepared by the authors with analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0043_FZ_EX_0002. Preliminary cut-off: n = 5 out of a target of 100, with data collection ongoing.

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INTERNAL STRUCTURE

The exploratory factor analysis is not interpretable with this data cut. With 5 cases for 5 items, the correlation matrix is not of full rank, and the software could not compute the measure of sampling adequacy or Bartlett's test of sphericity.

The solution the program produced showed communalities greater than 1 for R1 and R2, an indication that the model cannot be estimated with these data. Therefore, its loadings and explained variance are not reported; they are retained in the reproducibility appendix. The structure of the scale will need to be examined with the final cutoff.

DISCUSSION OF RESULTS

This study examined the preliminary functioning of a brief scale of experience and control of the acoustic environment, based on a data cut of 5 cases. With a sample of this size, no figure in this article can be read as an estimate of the scale's properties in the population of users of habitable spaces in Mazatlán.

What the data do allow is to identify patterns in item behavior that guide the revision of the instrument before the final data collection wave; on that front, the results are clear.

The first pattern is the coherence of a three-item core: design that reduces noise-related stress, materials that make noise less bothersome, and sounds that improve the experience of the space were highly intercorrelated and showed the highest item-total correlations.

All three items refer to what the space contributes to its users' acoustic experience, both by attenuating noise and by offering pleasant sounds. This core is consistent with the soundscape approach, which views the acoustic environment as a resource as well as a source of annoyance (Buxton et al., 2021; Zhao et al., 2025), and with evidence that positive soundscape appraisal is associated with well-being and perceived restoration (Li et al., 2025; Liao et al., 2026).

Two of these items, however, ask respondents to make an attribution: that the design reduces their stress and that the materials make the noise less annoying. Experience with noise barriers shows that the perception of such attributions does not necessarily match the measured changes in the acoustic environment (Barros et al., 2024); moreover, wording the items with verbs that imply an effect may make it difficult for people without technical knowledge to answer them accurately.

The second pattern is the separation of the sense of safety. The item on the sense of safety produced by the sound environment had the highest mean but was not related to the rest of the scale. This result admits a content-based explanation: safety depends on the presence of people, lighting, the activity of the place, and its history, and the sound environment is only one of its cues.

Studies conducted in Mazatlán have shown that the experience of public space differs across user groups (Cruz Coria, 2024; Cruz-Coria, 2024), so acoustic safety might require several dedicated items or constitute a distinct facet of the sonic experience.

The third pattern concerns the reverse-scored item. A respondent who agrees that it is difficult to feel that a space is their own when they cannot control its sounds is not necessarily expressing a negative appraisal of the space being evaluated: the agreement may reflect the importance they attach to control over the sound environment, which the literature places at the core of the relationship between noise and well-being (Lercher et al., 2024).

The statement is also conditional and combines two components, control and appropriation, which makes it difficult to interpret. Recoding it as a reverse-scored item assumes that agreement with it is equivalent to an unfavorable experience; the data from this wave, with a negative item-total correlation and an alpha that would increase without it, do not support that assumption.

The result is consistent with a wording-related bias (García-Batista et al., 2021; Steinmann et al., 2022), but the content-based explanation appears more straightforward. It would be advisable to rephrase perceived control as a statement about the space being evaluated, for example, one about the possibility of regulating the sounds that reach it, and to cover appropriation in a separate item.

The fourth pattern is methodological and concerns the referent of the scale. The items refer to "this space," but the survey population is defined as any user of a habitable space in Mazatlán, and the data do not record which space is involved. A dwelling, a public square and a workplace differ in their sound sources, in the control they afford and in people's attachment to them; the literature shows that the relationship between sound and annoyance varies with the activity microenvironment (Cai et al., 2023).

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Without this information, responses from different people may refer to non-comparable spaces. Finally, the project title mentions environmental stress, but the questionnaire does not include an independent measure of stress; if the project aims to study this relationship, it will need to incorporate an established instrument, such as those used in the literature linking noise annoyance to mental health (Gong et al., 2022; Hu, 2025), and to consider the focusing bias that may arise from a questionnaire whose purpose is evident to respondents (Qu and Tsuchiya, 2021).

CONCLUSIONS

The study examined the preliminary performance of a five-item scale assessing the experience and control of the acoustic environment among users of habitable spaces in Mazatlán, based on a preliminary data cut of 5 cases out of a target of 100.

Three items, concerning the contribution of design, materials and pleasant sounds to the experience of the space, were highly intercorrelated and produced an alpha of .681 for the full scale. The sense of safety was not related to this core, and the reverse-scored item on control and appropriation had a negative item-total correlation, which precluded reporting omega. Exploratory factor analysis could not be estimated with this sample cut.

The limitations of the study are severe and must be taken into account when interpreting all of its results. The first is the size of the data cut: with 5 cases, the correlations have very wide confidence intervals, the alpha and the item-level indices are unstable, and the factor structure cannot be examined.

The second is the lack of a common referent: the scale asks about “this space” without recording which space is being referred to.

The third concerns the sample: the recruitment procedure, the type of sampling, and the characteristics of the respondents are unknown; the results cannot be generalized.

The fourth concerns measurement: the study does not include an independent measure of stress or measurements of the acoustic environment; the floor and ceiling percentages of Factoriza need to be verified; and no confirmatory factor analysis was performed.

The fifth is a design limitation: because the study is cross-sectional, it does not allow causal inferences to be drawn.

Directions for future work follow from these limitations. Before data collection continues, it would be advisable to specify in the instructions which space is being assessed, or to record it in a preliminary question; to rephrase the item on control and appropriation; to revise the items that ask respondents to attribute effects to the design and the materials; and to expand the scale with items that better represent the facets of annoyance, safety, and control.

With the final data collection wave, it will be advisable to repeat the item analysis, explore the structure of the scale if sampling adequacy permits, and then test it using confirmatory factor analysis in an independent sample. Incorporating an established stress instrument and sound level measurements in a subsample of spaces would make it possible to gather validity evidence based on relations to other variables and to answer the question posed in the project’s title.

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Perceived walkability and pedestrian environmental stress in Mazatlán: Preliminary psychometric properties of a scale

Caminabilidad percibida y estrés ambiental del peatón en Mazatlán: propiedades psicométricas preliminares de una escala

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ABSTRACT

Walking is the most basic way of moving through the city, and its quality depends on street conditions and on the tension pedestrians experience along the route. This instrumental, cross-sectional and exploratory study examined the preliminary psychometric properties of a ten-item scale with two dimensions, walking conditions and tension while walking, administered in the pilot survey of project FZ-HAB-0010 of the Factoriza UAS platform among adults who usually walk along an urban segment of Mazatlán, Mexico. A preliminary cut of 13 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha, item analysis, Pearson inter-item correlations, exploratory factor analysis with parallel analysis, and a Spearman correlation between dimensions. All walking-condition items had means below the scale midpoint, and shade obtained the lowest mean (M = 2.38). Internal consistency was low (α = .469 and .322), and omega could not be interpreted because sidewalk continuity, obstacles, perceived traffic danger and exhaustion contributed little to their dimensions. Sampling adequacy was very low (KMO = .295); parallel analysis suggested one bipolar factor on which favorable conditions and tension loaded in opposite directions. Walking conditions and tension were negatively correlated, ρ = -.621, with a confidence interval that excluded zero. These results document the initial functioning of the items and must be re-examined with the final data cut.

Keywords: perceived walkability; pedestrian stress; urban habitability; psychometric properties

RESUMEN

Caminar es la forma más elemental de moverse por la ciudad, y su calidad depende de las condiciones de la calle y de la tensión que el peatón experimenta durante el recorrido. Este estudio instrumental, transversal y exploratorio examinó las propiedades psicométricas preliminares de una escala de diez reactivos, con dos dimensiones, Condiciones para caminar y Tensión al caminar, aplicada en el levantamiento piloto del proyecto FZ-HAB-0010 de Factoriza UAS a personas adultas que caminan habitualmente por un tramo urbano de Mazatlán. Se analizó un corte preliminar de 13 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach, análisis de reactivos, correlaciones de Pearson entre reactivos, análisis factorial exploratorio con análisis paralelo y correlación de Spearman entre dimensiones. Todos los reactivos de condiciones tuvieron medias inferiores al punto medio, y la sombra obtuvo la media más baja (M = 2.38). La consistencia interna fue baja (α = .469 y .322), y el omega no fue interpretable porque la continuidad de las banquetas, los obstáculos, el peligro percibido por el tráfico y el agotamiento contribuyeron poco a su dimensión. La adecuación muestral fue muy baja (KMO = .295); el análisis paralelo sugirió un factor bipolar en el que las condiciones favorables y la tensión cargaron en sentidos opuestos. Las condiciones para caminar y la tensión se correlacionaron en negativo, ρ = -.621, con un intervalo de confianza que excluyó el cero. Estos resultados documentan el funcionamiento inicial de los reactivos y deben revisarse con el corte final.

Palabras clave: caminabilidad percibida; estrés del peatón; habitabilidad urbana; propiedades psicométricas

INTRODUCTION

Walking is the most basic way of moving around the city and, for a substantial part of the population, the only one available or the one that connects to public transport. The experience of walking depends on street conditions: on sidewalks that are continuous and free of obstacles, on shade, on safe crossings, and on traffic and noise not turning the journey into a source of stress.

Walkability, understood as the extent to which the urban environment supports travel on foot, is therefore a dimension of urban livability that is experienced bodily, stretch by stretch.

Research on the urban environment and health has linked walkability to various outcomes. A systematic review of 112 studies found that physical neighborhood characteristics, including walkability, were associated with lower levels of loneliness, and that subjective perceptions of the neighborhood generally showed stronger associations than objective measures (Schepers et al., 2025).

The evidence on mental health is less conclusive: in a review of the moderation of neighborhood socioeconomic inequalities, findings on walkability were inconsistent, and the authors suggested that they might reflect unmeasured factors such as safety and environmental quality (Reid et al., 2026). These results indicate that what matters for well-being is not only the availability of pedestrian infrastructure, but also how people experience it.

In Latin America, walking entails risks that research has clearly documented. In Bogotá, pedestrians accounted for approximately 25% of people injured and 50% of those killed in traffic between 2015 and 2019, and neighborhoods with more street trees, traffic lights, and bus stops were associated with lower pedestrian mortality (Zewdie et al., 2024).

In Guadalajara, observation of 1018 pedestrian crossings showed that 14.0 % of pedestrians combined two or more risky behaviors, and that this accumulation was associated with the number of traffic directions, the presence of curbs, and the absence of traffic lights (Del Moral-Trinidad et al., 2026).

Heat adds a further burden: across 272 cities in six Latin American countries, the risk of traffic-related mortality increased on extremely hot days, with higher risks in cities with warmer climates (Hsu et al., 2025).

Mazatlán combines several of these conditions. It is a city with a warm climate that is undergoing an urban transformation associated with tourism: the boom in high-rise construction aimed at tourism and second homes has generated social tensions and placed pressure on the infrastructure of the coastal strip (Bojorquez Luque et al., 2023). Recent studies also describe touristification processes with sociocultural impacts on the local population (Mendieta Vega and Roldán Clarà, 2024).

In this context, the conditions under which residents walk and the stress they experience while doing so are aspects of livability that warrant measurement from the perspective of those who move through the city on foot.

The most widely used perceived walkability instruments focus on neighborhood attributes and their relationship with physical activity. In Chile, the abbreviated version of the Neighborhood Environment Walkability Scale showed that greater perceived traffic safety was associated with more transport-related and leisure-time physical activity (Kloss et al., 2025). In the Balearic Islands, a questionnaire on perceived urban walkability administered on healthy routes achieved an internal consistency of 0.8 across all its sections (Artigues et al., 2020).

However, these instruments rarely capture both the conditions of a specific street segment and the stress that pedestrians experience while walking along it, and none has been examined in a coastal city in northwestern Mexico.

To this end, project FZ-HAB-0010 of the Factoriza UAS platform designed a ten-item scale organized into two dimensions: Walking Conditions and Walking Tension. The project's current title in Factoriza, which this article adopts, refers to perceived walkability and pedestrian environmental stress. Environmental stress is addressed here through the tension that people report while walking along the segment, rather than through physiological indicators.

With a preliminary sample of 13 cases, this study can offer no more than an initial body of evidence on how the scale functions, which is why its title refers to preliminary psychometric properties.

The overall aim was to examine the preliminary psychometric properties of the perceived walkability and pedestrian stress scale among people who habitually walk along an urban stretch of Mazatlán.

The specific objectives were: (a) to describe the distribution of responses to each item; (b) to estimate the internal consistency of each dimension using Cronbach's alpha and, where

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interpretable, McDonald's omega, and to analyze the contribution of each item; (c) to explore the internal structure of the item set through exploratory factor analysis; and (d) to estimate the relationship between walking conditions and walking strain. The project did not state any hypotheses, so the study is framed as exploratory.

DEVELOPMENT

OBJECTIVE WALKABILITY AND PERCEIVED WALKABILITY

Walkability has been measured in two ways. The first, objective walkability, combines indicators of the built environment, such as density, land-use mix, street connectivity and pedestrian infrastructure. The second, perceived walkability, records how people rate those same attributes and others that objective indicators do not capture, such as safety or aesthetics. The two do not necessarily coincide, and evidence on well-being suggests that perceptions may be more informative than objective measures (Schepers et al., 2025).

In the Gulf countries, a review of 79 studies found positive associations between neighborhood accessibility and physical activity, walkability, and quality of life, and identified car-oriented urban development and extreme heat as contextual factors (Janahi et al., 2026).

Perceived walkability questionnaires are usually organized into thematic blocks. The urban walkability perception questionnaire administered in the Balearic Islands assessed pedestrian facilities, the infrastructure of the surrounding environment, perceived safety and an overall opinion. It found that the safety and pedestrian facility items were the most strongly related to the final rating, whereas the items on noise and traffic density had the lowest coefficients (Artigues et al., 2020).

This result foreshadows an issue relevant at the project scale: not all attributes of the street segment contribute equally to the overall assessment of the walking experience.

STREET CONDITIONS IN LATIN AMERICAN CITIES

In Latin American cities, sidewalk quality and road safety are recurring barriers to walking. In Bogotá, unpaid caregivers identified poor-quality or absent sidewalks, limited personal safety, and the risk of being struck by a vehicle as barriers to accessing an urban care program (Guevara-Aladino et al., 2024). In the baseline assessment of a green corridor in the same city, 66 participants in a citizen science exercise documented through 1123 photo-narratives that deficient pedestrian infrastructure and safety concerns were the most frequently mentioned barriers (Gómez-García et al., 2026).

In Guadalajara, road characteristics were associated with the accumulation of risk behaviors among pedestrians crossing the street (Del Moral-Trinidad et al., 2026).

These conditions are not randomly distributed. Sidewalk continuity, the absence of obstacles that force pedestrians to step down into the street, and the safety of crossings depend on the design and maintenance of public space, and their absence exposes pedestrians to traffic. In Bogotá, the presence of street trees, traffic lights, and bus stops was associated with lower pedestrian mortality, whereas a higher density of wide roads was associated with more pedestrian injuries (Zewdie et al., 2024).

The project's scale captures these conditions through items on sidewalk continuity, the possibility of walking without stepping down into the street, obstacles that force pedestrians to detour, and the safety of crossings.

HEAT AND SHADE ALONG THE PEDESTRIAN ROUTE

In hot cities, shade is a condition for walkability. In an experiment on route choice in a tropical city, distance walked in the shade was discounted by a factor of 0.86 relative to distance walked in the sun, and shade cast by buildings had a stronger effect than shade from trees (Melnikov et al., 2022).

The temperature of the surfaces pedestrians walk on varies at a fine scale, mainly because of instantaneous shade, so cooling metrics derived from satellite imagery may overestimate the effective benefit of shade at street level (Stumpe et al., 2026). In the open spaces of university campuses, tree shade was identified as the most important factor for thermal comfort in summer

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(Ding et al., 2023).

In Austin, Texas, tree cover around bus stops was associated with a smaller decline in ridership during high temperatures (Lanza and Durand, 2021).

Heat is not only a matter of comfort. A systematic review and meta-analysis of 88 studies found that heatwaves and extremely high temperatures were associated with a higher risk of mental and behavioral disorders (Li et al., 2023). In Latin American cities, the relationship between heat and traffic mortality (Hsu et al., 2025) suggests that, for pedestrians, exposure to the sun and exposure to traffic combine.

The project's scale includes an item on shade along the route segment and another on exhaustion upon finishing the walk, which, in a hot city, may reflect both exertion and heat exposure.

PEDESTRIAN STRAIN AS ENVIRONMENTAL STRESS

Pedestrian environmental stress refers to responses of strain, alertness or discomfort experienced in the street environment. Studies using physiological measurements have shown that these responses are associated with specific route characteristics.

In Perugia, Italy, fourteen older adults walked five routes wearing portable devices: streets that were narrower relative to their height and higher concentrations of nitrogen dioxide and particulate matter were associated with poorer perceived air quality and with changes in skin conductance and emotional indicators, whereas a higher visible greenery index was associated with more relaxed states (Mahia et al., 2026).

Traffic noise is part of that experience: in a tourist city in Bangladesh, more than 95% of the 675 people surveyed perceived an increase in noise during the peak season, and most reported annoyance and headaches (Nath et al., 2024).

Walking stress can be understood as the affective component of walkability: the flip side of street conditions. A systematic review of 45 observational studies on commuting found that long commutes and congestion were consistently associated with lower satisfaction and well-being (Liu et al., 2022). In Chile, perceived road safety was associated with more transport-related physical activity (Kloss et al., 2025).

The project's scale captures this tension through items on nervousness, perceived traffic danger, discomfort from vehicle noise, calmness while walking, and exhaustion upon completing the trip.

SCALE-BASED MEASUREMENT

The internal consistency of each dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items, and with McDonald's omega (McDonald, 1999/2013), which does not; simulation studies have compared how the two coefficients perform under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis. Current recommendations for this analysis call for first verifying the adequacy of the data, including at the item level, determining the number of factors with procedures such as parallel analysis, and treating cutoff values as guidelines rather than rules (Ferrando et al., 2022; Goretzko et al., 2021; Lorenzo-Seva and Ferrando, 2021).

Scales with positively and negatively worded items may show wording-related biases, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022). Identifying these responses can reduce such biases (García-Batista et al., 2021).

METHODOLOGY

DESIGN

An instrumental study with a quantitative approach, a cross-sectional design and an exploratory scope was conducted to examine the preliminary psychometric properties of a scale. Because the design was cross-sectional, the relationships reported are associations and do not allow causal inferences.

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POPULATION, SAMPLE, AND DATA CUTOFF

The data come from the survey "Piloto Mazatlán · Caminabilidad y estrés del peatón" [Mazatlán Pilot · Walkability and Pedestrian Stress] (LEV-0015) of project FZ-HAB-0010 on the Factoriza UAS platform, and from the frozen dataset DST-0044, with a cutoff date of 16 October 2026. The survey population consists of people aged 18 years or older who habitually walk along the study segment in Mazatlán, Sinaloa, an urban segment selected by the project lead.

Table 1 shows the composition of the sample. A total of 26 people opened the questionnaire and 13 completed it; no cases were excluded by the platform's quality control, and 13 cases with 10 items were analyzed. This is a preliminary data cut: n = 13 out of a target of 100, with data collection still open. The results reported in this article describe this cut and should not be taken as definitive; the analysis will need to be repeated with the final data cut.

Table 1. Sample composition.

Indicator	Value
People who opened the questionnaire	26
Completed questionnaires	13
Cases excluded by quality control	0
Cases analyzed	13
Items	10

Note. Survey "Piloto Mazatlán · Caminabilidad y estrés del peatón" [Mazatlán Pilot · Walkability and Pedestrian Stress] (LEV-0015); population: people aged 18 years or older who regularly walk along the study segment in Mazatlán; area: Mazatlán, Sinaloa, an urban segment selected by the project lead. Dataset DST-0044, fingerprint 3d2458bf3c6f25f5. Source: Factoriza UAS. Preliminary cut-off: n = 13 of a target of 100, with data collection still open.

INSTRUMENT

The scale consists of ten items with a 5-point response format, ranging from Strongly disagree to Strongly agree, organized into two dimensions of five items each. Walking conditions (R1 to R5) assesses the continuity of sidewalks, the possibility of walking without stepping down into the street, shade along the route segment, obstacles that force pedestrians to detour, and the safety of crossings.

Tension while walking (R6 to R10) addresses nervousness when walking along the segment, perceived danger from traffic, discomfort due to vehicle noise, calmness while walking, and exhaustion at the end of the walk. Two items (R4 and R9) are reverse-worded relative to their dimension and are recoded in the data matrix. Thus, in Conditions a high score indicates favorable conditions, and in Tension a high score indicates greater tension, so a negative relationship between the two dimensions is expected. Table 2 presents the wording of each item.

Table 2. Structure of the instrument.

Code	Item	Reverse
R1	The sidewalks along the stretch where I walk are continuous	No
R2	I can walk along this stretch without stepping down into the street	No
R3	There is shade along the stretch where I walk	No
R4	Obstacles on the sidewalk force me to go around them	Yes
R5	Crossing the streets along this section is safe for pedestrians	No
R6	Walking along this stretch makes me nervous	No
R7	The traffic on this road section makes me feel unsafe	No
R8	Vehicle noise bothers me when I walk	No
R9	I walk calmly along this stretch	Yes
R10	After walking along this section, I feel exhausted	No

Note. R1 to R5 = Walking conditions; R6 to R10 = Walking stress. The dimension column is omitted to preserve table readability. 5-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the matrix provided. Source: Factoriza UAS, project FZ-HAB-0010, survey LEV-0015, dataset DST-0044.

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PROCEDURE

The questionnaire was administered through the Factoriza UAS platform, which records express informed consent online before the first question and does not collect data that could identify individuals. The platform runs a quality check on completed questionnaires before adding them to the dataset; in this data collection wave, no cases were excluded.

DATA ANALYSIS

Factoriza UAS calculated the descriptive statistics for each item (mean, standard deviation, skewness, kurtosis, and percentages of responses at the minimum and maximum values); the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951) and the corrected item-total correlation; and the Pearson correlations among the items within each dimension, with 95% confidence intervals obtained by Fisher's z transformation.

The project's supplementary analysis program, analisis_psicometrico.py (version 1.0), was also run in Python 3.13.16 (Python Software Foundation, 2026) with NumPy 2.5.3 (Harris et al., 2020), SciPy 1.18.1 (Virtanen et al., 2020) and pandas 3.0.5.

The program estimated the internal consistency of each dimension using Cronbach's alpha and McDonald's omega total (McDonald, 1999/2013), based on a one-factor model fitted by minimum residual without reversing items. It does not report omega when any item has a negative item-rest correlation or a negative loading in that model.

The internal structure was examined by exploratory factor analysis of the ten items based on the Pearson correlation matrix of the 13 complete cases, preceded by the overall Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974) and the item-level measure (Lorenzo-Seva and Ferrando, 2021), and by Bartlett's test of sphericity (Bartlett, 1950).

The number of factors was determined by parallel analysis (Horn, 1965) with 100 simulations and a seed of 2026; extraction was by minimum residual, and the planned oblimin rotation was not applied because a single factor was retained. The relationships between the dimensions were estimated using Spearman's coefficient between the mean scores of each dimension, with its 95% confidence interval obtained through the Fisher transformation and the Bonett and Wright standard error (Bonett and Wright, 2000).

The program does not remove items automatically: it flags those with a loading below .30, a cross-loading, an opposite sign, or a measure of sampling adequacy below .50, and leaves the decision to the authors. These values, like the .60 value for the overall measure of sampling adequacy, are used as guidelines from the methodological literature and not as rules (Ferrando et al., 2022; Lorenzo-Seva and Ferrando, 2021). No confirmatory factor analysis was performed.

With 13 cases for 10 items, the case-to-item ratio is far below what the methodological literature considers adequate for item factor analysis (Ferrando et al., 2022; Goretzko et al., 2021). The factor analysis of this cohort is therefore presented as documentation of the items' initial functioning, and its results are not interpreted as evidence of the scale's structure.

ETHICAL CONSIDERATIONS

Participation was voluntary, with express informed consent recorded online by the platform, which does not collect names, addresses or other identifying data. The data were analyzed in aggregate.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the following tools were used: the Factoriza UAS platform, for data management and for descriptive and internal consistency analyses; a Python analysis program with fixed and validated procedures, for omega, exploratory factor analysis and the correlations between dimensions; and the Claude Opus language model (Anthropic), for running that program, assisted literature search, writing a draft and assembling the document from the results. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

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RESULTS

DESCRIPTION OF RESPONSES

Table 3 and Figure 1 present the descriptive statistics for the ten items. All Walking Conditions items had means below the scale midpoint: shade along the route had the lowest mean (R3: *M* = 2.38, *SD* = 0.96), followed by the possibility of walking without stepping down into the street (R2: *M* = 2.46, *SD* = 1.39), which showed the greatest dispersion in the instrument, and by the reverse-scored item on obstacles that force pedestrians to detour (R4: *M* = 2.46, *SD* = 0.88). The recoded mean of this last item indicates that responses leaned toward agreement with encountering obstacles. Sidewalk continuity (R1: *M* = 2.62, *SD* = 1.19) and crossing safety (R5: *M* = 2.77, *SD* = 1.01) had somewhat higher means, though these were also below 3.

In the Tension while walking dimension, the means fell around the midpoint. The reverse-scored item on feeling calm while walking had the highest mean (R9: *M* = 3.15, *SD* = 0.99); once recoded, this indicates a slight tendency toward not feeling calm while walking. Nervousness (R6: *M* = 3.08, *SD* = 0.64) and perceived traffic danger (R7: *M* = 3.08, *SD* = 1.04) had the same mean, and exhaustion at the end of the walk (R10: *M* = 3.00, *SD* = 1.15) was at the midpoint. Discomfort from vehicle noise had the lowest mean in the dimension (R8: *M* = 2.62, *SD* = 1.04).

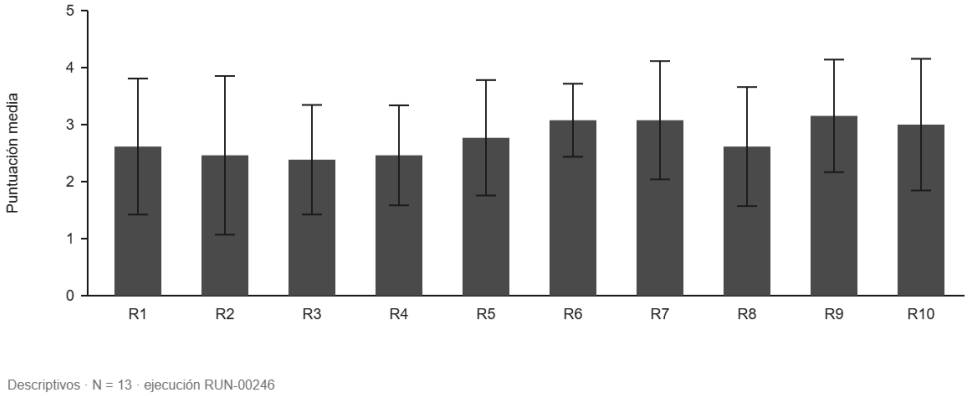
R9 had the flattest distribution (kurtosis = -2.12), which reflects responses split between two values; this item's floor of 38% and ceiling of 54% correspond to the observed values, as indicated in the table note.

Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.62	1.19	-0.15	-1.50	23%	31%
R2	2.46	1.39	0.53	-1.10	31%	8%
R3	2.38	0.96	0.39	-0.44	15%	15%
R4	2.46	0.88	0.58	-0.12	8%	15%
R5	2.77	1.01	-0.03	-1.21	8%	31%
R6	3.08	0.64	-0.05	0.06	15%	23%
R7	3.08	1.04	-0.70	-0.72	8%	46%
R8	2.62	1.04	-0.10	-0.99	15%	23%
R9	3.15	0.99	-0.35	-2.12	38%	54%
R10	3.00	1.15	-0.00	-0.82	8%	8%

Note.N = 13. R1 to R5 = Walking Conditions; R6 to R10 = Walking Strain. Reverse-scored items R4 and R9 are shown recoded: in Conditions, a high value indicates favorable conditions, and in Strain, a high value indicates greater strain. Floor and ceiling indicate the percentage of responses at the minimum and maximum values. The item-total correlation column of the Factoriza descriptive table is omitted because it is computed on the total of all ten items, whose dimensions run in opposite directions. Factoriza UAS run RUN-00246. Preliminary cut-off: n = 13 out of a target of 100, with data collection still open.

Figure 1. Mean item scores with one-standard-deviation bars.



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INTERNAL CONSISTENCY

Table 4 presents the item analysis for each dimension. For Walking conditions, alpha was .469. Shade (R3: .624), crossing safety (R5: .486), and the possibility of walking without stepping down into the street (R2: .378) had the highest corrected item-total correlations; sidewalk continuity had a near-zero correlation (R1: .034), and the reverse-scored item on obstacles had a negative correlation (R4: -.134). Removing R4 would raise alpha to .603, and removing R1 would raise it to .565.

For Tension While Walking, alpha was .322. Nervousness (R6: .353), discomfort due to noise (R8: .338), and calmness while walking (R9: .302) showed moderate item-total correlations; exhaustion had a null correlation (R10: .000), and perceived traffic danger a negative one (R7: -.062). Removing R7 would raise alpha to .459, and removing R10 would raise it to .430.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Conditions	R1	.034	.565
Conditions	R2	.378	.303
Conditions	R3	.624	.168
Conditions	R4	-.134	.603
Conditions	R5	.486	.255
Tension	R6	.353	.173
Tension	R7	-.062	.459
Tension	R8	.338	.088
Tension	R9	.302	.137
Tension	R10	.000	.430

Note.N = 13. Scale from 1 to 5; reverse-scored items R4 and R9 are shown recoded. Run RUN-00246 of Factoriza UAS. Preliminary cutoff: n = 13 of a target of 100, with data collection still open.

Table 5 presents the alpha and omega coefficients estimated by the supplementary analysis program. The alpha values match those from Factoriza (.469 and .322). The program did not report omega for either dimension because, in the one-factor model of each, two items had a negative item-rest correlation or loading: R1 and R4 in Conditions, and R7 and R10 in Tension. Since R4 is flagged as reverse-scored and recoded, this result is not due to a coding error but to the behavior of the items in this data cut.

Table 5. Internal consistency by dimension.

Dimension	Items	n	α	ω
Conditions	5	13	.469	
Tension	5	13	.322	

Note.N = 13. Conditions = Walking conditions; Strain = Strain when walking. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension, with 5 items each: Conditions = .469 (run RUN-00247); Strain = .322 (RUN-00249). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary cutoff: n = 13 out of a target of 100, with data collection still open.

INTER-ITEM CORRELATIONS

Correlations between items within each dimension, computed with Factoriza (runs RUN-00248 and RUN-00250), refine the preceding pattern. In Walking Conditions, only the correlation between the possibility of walking without stepping down into the street and shade excluded zero (R2 and R3: r = .729, 95% CI [.297, .913], p = .005); the correlations of shade with crossing safety (R3 and R5: r = .527, 95% CI [-.034, .835], p = .064) and of the possibility of walking without stepping down into the street with crossing safety (R2 and R5: r = .496, 95% CI [-.076, .822], p = .085) were moderate, with intervals that included zero.

Sidewalk continuity showed near-zero correlations with the other items, ranging from -.078 to .104. The recoded obstacles item was negatively related to the possibility of walking without stepping down into the street (R2 and R4: r = -.462, 95% CI [-.808, .119], p = .112).

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In Tension While Walking, no correlation excluded zero. The highest were between nervousness and recoded calmness (R6 and R9: r = .375) and between nervousness and traffic danger (R6 and R7: r = .366), and between noise discomfort and exhaustion (R8 and R10: r = .346). Traffic danger was negatively related to exhaustion (R7 and R10: r = -.278) and weakly related to noise discomfort (R7 and R8: r = -.124), whereas recoded calmness was not related to exhaustion (R9 and R10: r = .000).

INTERNAL STRUCTURE

The overall Kaiser-Meyer-Olkin measure of sampling adequacy was .295, well below the value of .60 commonly cited as a guideline (Ferrando et al., 2022; Lorenzo-Seva and Ferrando, 2021). The item-level measure was below .50 for all items except the shadow item, with values ranging from .151 (R1) to .526 (R3).

Bartlett's test of sphericity rejected the hypothesis of an identity matrix, $\chi^2(45) = 67.16$, p = .018. Given these values, the correlation matrix for this cohort is poorly suited to factor analysis, and the following results are reported as documentation of item functioning.

Parallel analysis suggested retaining one factor (Figure 2), which explained 28.55% of the variance, with a sum of squared loadings of 2.86 (Table 6). Table 7 reports the loadings. The factor was bipolar: crossing safety (R5: .813), the possibility of walking without stepping down into the street (R2: .798), and shade (R3: .705) loaded positively, whereas recoded calmness (R9: -.760), discomfort due to noise (R8: -.483), and nervousness (R6: -.407) loaded negatively. Because the Tension items are oriented in the opposite direction to the Conditions items, their negative sign is as expected, and the opposite-sign flag that the software issues for them reflects this orientation rather than a problem with the items. Four items had loadings below .30 in absolute value: traffic danger (R7: -.260), sidewalk continuity (R1: .102), obstacles (R4: -.073), and exhaustion (R10: .042). The software did not remove any items, and the decision on them rests with the authors once the final data cut is available.

Figure 2. Scree plot with parallel analysis.

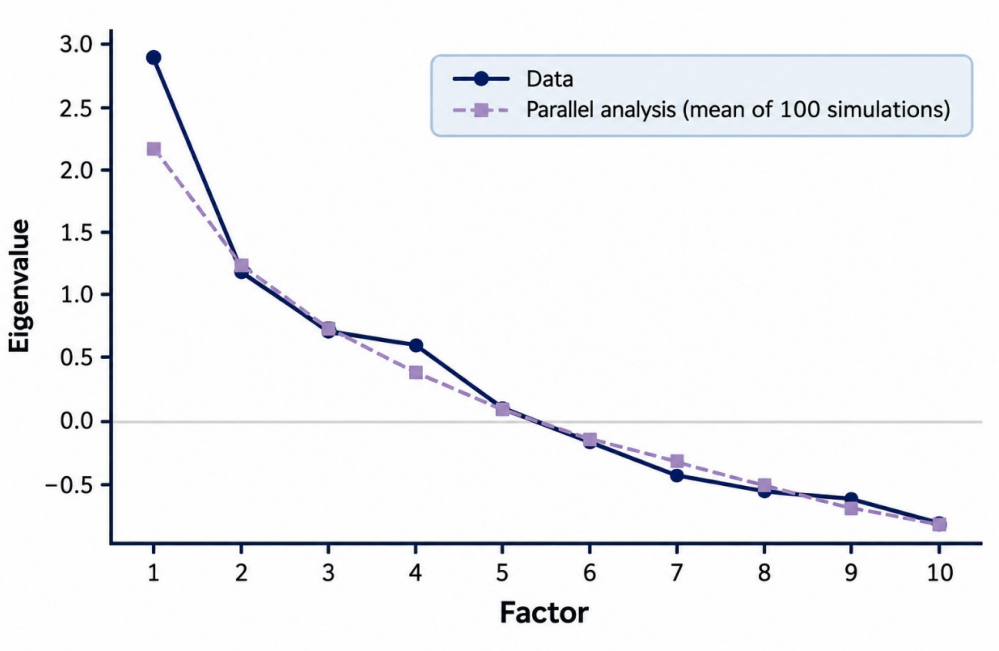


Table 6. Variance explained by the factors.

Factor	Sums of squared loadings	% of variance	Cumulative %
1	2.86	28.55	28.55

Note. Eigenvalues of the reduced data matrix compared with the mean of 100 simulated matrices of the same size (seed 2026). Source: Prepared by the author using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0044_FZ_HAB_0010. Preliminary data cut: n = 13 out of a target of 100, with data collection still ongoing.

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Table 7. Factor loadings from the exploratory factor analysis.

	Factor		
Item	1	h^2	MSA
R1	.102	.010	.151
R2	.798	.636	.355
R3	.705	.497	.526
R4	-.073	.005	.153
R5	.813	.660	.387
R6	-.407	.166	.333
R7	-.260	.068	.419
R8	-.483	.233	.257
R9	-.760	.578	.344
R10	.042	.002	.170

Note. KMO = .295; Bartlett's test of sphericity: $\chi^2(45) = 67.16$, p = .018. Number of factors by parallel analysis: 1. Source: prepared by the authors using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0044_FZ_HAB_0010. Preliminary data cut: n = 13 of a target of 100, with data collection still ongoing.

RELATIONSHIP BETWEEN THE DIMENSIONS

Table 8 presents the Spearman correlation between the mean scores of the two dimensions. The relationship was negative and large in magnitude, and its confidence interval excluded zero, ρ = -.621, 95% CI [-.886, -.049], *p* = .024, with 13 cases: people who rated the walking conditions on the segment more favorably reported less stress when walking along it. The interval is wide, so the magnitude of the relationship is highly imprecise, but its direction is as expected.

Table 8. Correlations between dimensions.

Dimension pair	n	ρ	IC 95 %	p
Conditions and Tension	13	-.621	[-.886, -.049]	.024

Note. Pattern matrix. Minimum residual extraction and oblimin rotation (γ = 0) on the Pearson correlation matrix; 13 complete cases. h^2 = communality; MSA = item-level measure of sampling adequacy. All loadings are shown. Source: Authors' own elaboration using analisis_psicometrico.py 1.0 (Python 3.13.16), dataset DST-0044_FZ_HAB_0010. R1 to R5 = Walking conditions; R6 to R10 = Walking stress. With a single factor retained, there is no rotation to apply. The dimension and observation columns are omitted; the program flagged low MSA for all items except R3, insufficient loading for R1, R4, R7 and R10, and an opposite sign for R4, R6, R7, R8 and R9. Because the factor is oriented by walking conditions, the negative sign of the Walking stress items is as expected. Preliminary cut: n = 13 out of a target of 100, with data collection still open.

DISCUSSION OF RESULTS

This study examined the preliminary psychometric properties of a scale of perceived walkability and pedestrian stress using a data cut of 13 cases along an urban segment in Mazatlán.

The first finding is descriptive: respondents rated walking conditions unfavorably, with means below the midpoint on all five items of the dimension, and shade was the lowest-rated aspect. This pattern is consistent with the importance the literature attaches to shade in hot cities (Ding et al., 2023; Melnikov et al., 2022) and with the barriers documented in other Latin American cities, where poor pedestrian infrastructure and safety are the most frequently mentioned (Gómez-García et al., 2026; Guevara-Aladino et al., 2024).

With 13 cases from a single segment, however, these means describe the experience of those who responded rather than the walkability of the city.

The second finding is the negative relationship between the two dimensions: those who rated the conditions of the segment more favorably reported less tension when walking it. This relationship, though imprecise, is the first evidence of the scale's validity based on the relations among its parts, and it is consistent with the notion that tension while walking is the affective component of walkability.

Studies using physiological measurement have associated route characteristics with indicators of stress and relaxation (Mahia et al., 2026), and perceived traffic safety has been associated with transport-related physical activity (Kloss et al., 2025). The factor analysis, which

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yielded a bipolar factor on which favorable conditions and tension loaded in opposite directions, points in the same direction, although with sampling adequacy this low (KMO = .295) it cannot be taken as evidence of the structure.

The third finding concerns internal consistency, which was low in both dimensions (α = .469 and .322) and did not allow omega to be reported. The behavior of each item is more informative than the overall coefficient.

In Walking conditions, three items (shade, crossing safety, and the possibility of walking without stepping down into the street) were related to one another and to the factor, whereas sidewalk continuity and obstacles were not. Sidewalk continuity describes a physical attribute of the segment that, if the segment is the same for everyone, should vary little across individuals; its dispersion suggests that participants may have referred to different parts of the route or interpreted continuity in different ways.

The obstacles item was negatively related to the possibility of walking without stepping down into the street, which lends itself to a content-based interpretation: a person who navigates around obstacles may detour within the sidewalk itself without stepping off it. This result is also consistent with a bias associated with reverse wording (García-Batista et al., 2021; Steinmann et al., 2022).

In Stress while walking, exhaustion and perceived danger from traffic were the items with zero or negative contributions. Exhaustion at the end of the walk may depend on distance, physical effort, each person's condition, and heat, rather than on the stress associated with the environment. In a warm city, its relationship with sun exposure is plausible (Hsu et al., 2025; Li et al., 2023).

Traffic danger, with a ceiling of 46% at the highest observed value, may reflect a concern shared by most respondents, which reduces its ability to covary with the other items.

This result is consistent with the Balearic Islands questionnaire, in which the noise and traffic density items had the lowest coefficients with the final rating (Artigues et al., 2020). It also suggests that pedestrian stress may have facets, such as alertness to traffic and fatigue, that do not behave as indicators of a single dimension.

The results suggest several adjustments for the next stage. As for the instrument, it would be advisable to specify in the instructions which stretch is being assessed and, if it is long, to divide it into segments; to revise the wording of the obstacles item to distinguish between swerving while staying on the sidewalk and stepping down into the street; and to consider whether exhaustion and danger from traffic should be retained within Tension or form facets of their own.

For the procedure, it would be useful to record the time of day of the walk and the temperature and shade conditions, and to complement the scale with an audit of the segment or with measurements of noise level and traffic. This would make it possible to gather validity evidence based on relations with other variables and to compare pedestrians' perceptions with the observed conditions, as has been done with perceived and objective walkability in other contexts (Schepers et al., 2025).

CONCLUSIONS

The study examined the preliminary psychometric properties of a scale of perceived walkability and pedestrian stress among people who habitually walk along an urban segment of Mazatlán, using an interim data cut of 13 cases out of a target of 100. Respondents rated walking conditions unfavorably, particularly shade, and walking stress fell around the midpoint.

The relationship between the two dimensions was negative, in the expected direction, and its interval excluded zero (ρ = -.621). Internal consistency was low for both dimensions (α = .469 and .322), and omega was not interpretable. The exploratory factor analysis, with very low sampling adequacy (KMO = .295), suggested a bipolar factor that documents only the initial functioning of the items.

The study has limitations that should be kept in mind when interpreting all of its results. The first concerns the size and nature of the data cut: 13 cases out of a target of 100, with data collection still ongoing, are insufficient to estimate internal consistency, correlations, and factor structure with precision.

The second concerns the sample and the reference population: the study segment, the contact procedure, the type of sampling and the characteristics of the respondents have yet to be documented, and the results cannot be generalized to other segments or to the city as a whole.

The third concerns measurement: environmental stress was assessed only through self-

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reported tension, without physiological indicators or environmental measurements; the floor and ceiling percentages from Factoriza need to be verified, and no confirmatory factor analysis was performed.

The fourth concerns design: because the study is cross-sectional, it does not allow causal inferences.

Future lines of work follow from these limitations. With the final data cut, the item analysis and the exploratory factor analysis should be repeated and, if sampling adequacy allows, used to examine whether the two-dimensional structure holds. The resulting structure should then be tested through confirmatory factor analysis in an independent sample, ideally across several segments with different conditions.

It will also be advisable to decide, using content criteria and not only statistical ones, what to do with the low-contribution items, and to complement the scale with a pedestrian audit of the street segment and with measurements of temperature, shade, noise and traffic. This combination would make it possible to determine the extent to which pedestrians' perceptions reflect street conditions and to guide urban design interventions that make walking in a hot city more livable.

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Chapter 17 / Capítulo 17

Habitability, territory, and sustainability: Interdisciplinary studies on housing, environment, and society in northwestern Mexico
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Environmental comfort in adobe housing in southern Sinaloa: A preliminary review of a scale of thermal comfort and residential appraisal

Confort ambiental en vivienda de adobe del sur de Sinaloa: revisión preliminar de una escala de confort térmico y valoración residencial

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ABSTRACT

Earthen construction, and adobe in particular, has long been the material of much rural housing in Mexico, and its continuity depends both on its thermal properties and on how residents value it. This instrumental, cross-sectional and exploratory study reviewed the preliminary functioning of a ten-item scale with two dimensions, thermal comfort in the adobe dwelling and appraisal of the adobe dwelling, administered in the pilot survey of project FZ-HAB-0015 of the Factoriza UAS platform among adults living in adobe houses in southern Sinaloa, Mexico. A preliminary cut of 16 cases, out of a target of 100, was analyzed with descriptive statistics, Cronbach's alpha, item analysis and Spearman inter-item correlations; as a technical-route project, no omega, factor analysis or correlation between dimensions was estimated. Residents rated night-time temperature (M = 3.50) and coolness in the hot months more favorably than daytime temperature, tended to agree that their houses feel icy in the cold season, and expressed pride in living in an adobe house (M = 3.94), while low wall maintenance was rated least favorably within its dimension. Internal consistency was moderate for thermal comfort (α = .566) and low for appraisal (α = .468); the two reverse-worded items contributed nothing to their dimensions, and inter-item correlations suggest distinct seasonal and daily facets of comfort and heterogeneous aspects of appraisal. The perception component must be integrated with technical measurements of the dwellings.

Keywords: adobe housing; thermal comfort; earthen architecture; residential appraisal

RESUMEN

La construcción con tierra, y en particular el adobe, ha sido durante siglos el material de buena parte de la vivienda rural de México, y su continuidad depende tanto de sus propiedades térmicas como de la valoración de sus habitantes. Este estudio instrumental, transversal y exploratorio revisó el funcionamiento preliminar de una escala de diez reactivos, con dos dimensiones, Confort térmico en la vivienda de adobe y Valoración de la vivienda de adobe, aplicada en el levantamiento piloto del proyecto FZ-HAB-0015 de Factoriza UAS a personas adultas que habitan viviendas de adobe en el sur de Sinaloa. Se analizó un corte preliminar de 16 casos, de una meta de 100, con estadísticos descriptivos, alfa de Cronbach, análisis de reactivos y correlaciones de Spearman entre reactivos; por tratarse de un proyecto de ruta técnica, no se estimaron el omega, el análisis factorial ni la correlación entre dimensiones. Las personas encuestadas valoraron mejor la temperatura por las noches (M = 3.50) y en los meses de calor que durante el día, tendieron a percibir sus casas heladas en la temporada de frío y expresaron orgullo por vivir en una casa de adobe (M = 3.94), mientras que el poco mantenimiento de las paredes fue el aspecto peor valorado de su dimensión. La consistencia interna fue moderada en Confort térmico (α = .566) y baja en Valoración (α = .468); los dos reactivos inversos no contribuyeron a su dimensión, y las correlaciones entre reactivos sugieren facetas estacional y cotidiana del confort y aspectos heterogéneos de la valoración. El componente de percepción deberá integrarse con las mediciones técnicas de las viviendas.

Palabras clave: vivienda de adobe; confort térmico; arquitectura de tierra; valoración residencial

INTRODUCTION

Earth construction is one of the most widespread building traditions in the world, and adobe, the sun-dried, molded earth block, has been the material of much of the rural housing in Mexico and Latin America for centuries.

In recent decades, however, adobe has lost ground to concrete block and other industrialized materials, in a process that combines economic, regulatory, technical, and symbolic factors.

In Colombia, the knowledge associated with adobe has been described as heritage at risk of disappearing due to the use of conventional materials (Rivera-Salcedo et al., 2021). In Jojutla, Morelos, numerous adobe houses in the historic center were lost after the 2017 earthquakes, amid construction deficiencies, poor urban planning and weak risk management (Sánchez Calvillo et al., 2021).

At the same time, research on building materials has renewed interest in earth because of its thermal and environmental properties. Experimental studies on adobe blocks with fibers or agricultural residues have documented reductions in thermal conductivity and increases in heat capacity, indicating greater thermal inertia (Banaba et al., 2025; Sanou et al., 2024). In climatic chamber tests, a stabilized rammed earth wall showed a thermal lag of up to 90 minutes and a decrement factor of 0.85 (Fouad et al., 2025).

These properties suggest that earthen housing can dampen temperature fluctuations, a relevant attribute in hot regions.

Mass-produced social housing built with industrialized materials offers a contrast. In northwestern Mexico, residents of a social housing development in Culiacán described their homes as very hot (Barraza-Bracamontes et al., 2022); in Hermosillo, the predominant social housing showed less favorable energy performance than a house built to energy efficiency standards (Muñoz López et al., 2023); and in Ensenada, a cast-in-place concrete house with thermal coating had poor thermal performance in winter (Bacelis et al., 2024).

Housing policy in the first decades of this century favored the mass production of this type of housing (Hernández Ilizaliturri et al., 2025), and space cooling has become one of the main sources of residential energy demand in the country's hot climates (Galindo-Borbón et al., 2024; Treviño Hernández and Hernández Rejón, 2026).

In southern Sinaloa, adobe dwellings persist in rural communities and small localities. Little is known about their thermal performance, their state of conservation, or how their inhabitants value them. Residents' experience is a necessary part of that assessment: the comfort they perceive, the durability they attribute to their houses, the maintenance these houses demand of them, and their willingness to preserve them or replace them with concrete block houses are as relevant to the future of this type of housing as their physical properties.

Project FZ-HAB-0015 of the Factoriza UAS platform, classified under the technical track of the article-writing workshop, aims to study the environmental performance and comfort of adobe housing.

The dataset package available for this article contains the project's perception component: a ten-item scale organized into two dimensions (Thermal Comfort in the Adobe Dwelling and Appraisal of the Adobe Dwelling) and administered in a pilot survey. Technical measurements of dwelling performance are not part of the package, so this study is limited to the perception component and offers a preliminary review of how the scale functions.

The overall objective was to examine the preliminary functioning of the thermal comfort and adobe housing appraisal scale among people living in adobe dwellings in southern Sinaloa.

The specific objectives were: (a) to describe the distribution of responses to each item; (b) to estimate the internal consistency of each dimension using Cronbach's alpha and to analyze the contribution of each item; (c) to describe the correlations among the items within each dimension; and (d) to identify the aspects of the instrument and the procedure that should be revised before the final data cutoff and their integration with the technical measurements. The project did not state any hypotheses, so the study is framed as exploratory.

DEVELOPMENT

THERMAL PROPERTIES OF EARTHEN CONSTRUCTION

The ability of earth walls to moderate indoor temperature is attributed to their thermal mass and hygric behavior. In a rammed earth wall stabilized with construction waste and calcium

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oxide, climate chamber tests showed a time lag of up to 90 minutes and a decrement factor of 0.85, values that the authors interpreted as indicating favorable thermal inertia (Fouad et al., 2025).

In adobe blocks with rice husk, thermal conductivity decreased by up to 35% in a calcareous soil and 20% in a siliceous soil, specific heat capacity increased, and moisture buffering capacity, which was already high in the soils without additives, improved (Banaba et al., 2025).

In adobe blocks with cement and coconut fibers, thermal conductivity decreased with increasing fiber content, and the authors considered these units suitable for thermally comfortable housing (Sanou et al., 2024).

Housing performance does not depend solely on the walls. In rural dwellings in the Purépecha region of Michoacán, a thermal model showed that roof type was associated with increases in indoor temperature, which were greatest with black cardboard roofs, followed by asbestos and cement roofs; it also showed that the thermal mass of cement kept those dwellings cold during the low temperatures of the plateau (Espinosa-Gómez et al., 2026).

In the traditional architecture of other hot regions, envelope configuration and the layering of materials have been associated with lower indoor temperatures (Arminda and Darmayanti, 2026), and in Mexico, the revival of bioclimatic strategies in historic buildings has been explored through simulation (Aguilar Osante et al., 2026).

A scale of perceived comfort in adobe dwellings therefore captures the experience of a complete system, of which the walls are only one part.

ADAPTIVE THERMAL COMFORT IN RURAL HOUSING

The adaptive approach to thermal comfort has shown that people living in rural dwellings tolerate and evaluate indoor conditions according to their experience and resources. In rural dwellings in southwestern China, the occupants' neutral operative temperature was 29.33 °C, higher than that reported in previous studies in the same climate zone, and adaptive behaviors improved their ability to endure demanding indoor conditions; most occupants were unwilling to use energy-intensive cooling equipment (Wei et al., 2022).

In naturally ventilated rural dwellings in China, a study of 251 people from 98 households found that older adults tolerated heat better than younger adults (Gong et al., 2025). In a village in Guangzhou with a hot, humid climate, older adults adapted mainly by opening windows, using curtains and fans, and moving to other spaces (Tian et al., 2022).

In the state of Campeche, which has a warm subhumid climate, adaptive comfort models reduced estimated energy consumption compared with the static approach, and the authors concluded that local models are needed (May-Tzuc et al., 2023).

These results have two implications for the study of adobe housing. The first is that occupants' perception of comfort may be favorable even under conditions that a standards-based assessment would classify as demanding, a finding related to adaptation and expectations.

The second is that comfort is experienced differently depending on the time of day and the season: during the day, at night, in the hot season and in the cold season. The project's scale captures this variation with items on daytime temperature, nighttime, the hot months and the cold season, as well as an item on how comfortable the dwelling is for resting.

SOCIAL VALUATION OF EARTHEN HOUSING

Whether adobe housing persists also depends on how its inhabitants value it. In the municipalities of Pore and Nunchía, in Casanare, Colombia, survey respondents most frequently cited the benefits of industrialized materials (57%) and a lack of knowledge about adobe maintenance (37%) as reasons for abandoning adobe houses, although they described these dwellings as comfortable (Rivera-Salcedo et al., 2021).

In Jojutla, the poor performance of altered adobe buildings during the earthquakes was associated with a loss of confidence in traditional techniques and with reconstruction using new materials (Sánchez Calvillo et al., 2021). In the state of Guerrero, an assessment of perceived risk in adobe houses led to proposals for mixes reinforced with maguey fibers, coconut fibers or straw, which met the quality requirements of the masonry standard, and for a housing design based on the minimum spaces the inhabitants required (Jerónimo-Vargas et al., 2022).

The appraisal of earthen housing therefore combines very different aspects: pride in

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traditional knowledge, confidence in its strength, the burden of its maintenance, the willingness to recommend it and the desire to replace it with a concrete block house.

These aspects may be related to place attachment, which the literature associates with local characteristics that express history and culture (Kamani Fard and Paydar, 2024), but they need not vary together. A person may feel proud of their adobe house and, at the same time, wish to replace it with a concrete block house for maintenance or safety reasons.

SCALE-BASED MEASUREMENT

The internal consistency of a dimension is usually estimated with Cronbach's alpha (Cronbach, 1951), which assumes equivalent loadings across items. McDonald's omega does not make this assumption, and simulation studies have compared the performance of the two coefficients under different data conditions (Malkewitz et al., 2023).

Internal structure is examined through exploratory factor analysis, for which current recommendations call for verifying the adequacy of the data and ensuring a sufficient sample size before interpreting the results (Ferrando et al., 2022; Goretzko et al., 2021).

Scales with positively and negatively worded items may show wording-related biases, because some respondents respond inconsistently to the positive and negative items of the same dimension (Steinmann et al., 2022), and identifying these responses can reduce such biases (García-Batista et al., 2021).

Finally, in measurement theory, indicators that form a construct, rather than reflect it, are called formative, and their implications for factor analysis and reliability theory differ from those of reflective indicators (Bollen and Diamantopoulos, 2017). This distinction is relevant to an appraisal dimension that combines heterogeneous aspects of housing.

METHODOLOGY

DESIGN

An instrumental, quantitative, cross-sectional study with an exploratory scope was conducted to examine the preliminary functioning of a scale. Because the design was cross-sectional, the relationships reported are associations and do not allow causal inferences.

POPULATION, SAMPLE, AND DATA CUTOFF

The data come from the survey "Southern Sinaloa Pilot · Comfort in Adobe Housing" (LEV-0020) of project FZ-HAB-0015 on the Factoriza UAS platform, and from the frozen dataset DST-0045, with a data cut-off date of 16 October 2026. The survey population consists of people aged 18 years or older who live in adobe dwellings in southern Sinaloa, in communities with adobe housing selected by the project lead.

Table 1 shows the composition of the sample. Of the 22 people who opened the questionnaire, 16 completed it; no cases were excluded by the platform's quality control, and 16 cases with 10 items were analyzed. This is a preliminary data cut: n = 16 out of a target of 100, with data collection still ongoing. The results reported in this article describe that data cut and should not be taken as definitive.

Table 1. Sample composition.

Indicator	Value
People who opened the questionnaire	22
Completed questionnaires	16
Cases excluded by quality control	0
Cases analyzed	16
Items	10

Note. Survey "Piloto sur de Sinaloa · Confortenvivienda de adobe" (Southern Sinaloa Pilot · Comfort in Adobe Housing) (LEV-0020); population: individuals aged 18 years or older living in adobe dwellings in southern Sinaloa; territory: southern Sinaloa, in communities with adobe dwellings selected by the project lead. Dataset DST-0045, fingerprint 5d3938cfb7bd6b05. Source: Factoriza UAS. Preliminary cutoff: n = 16 of a target of 100, with the survey still open.

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INSTRUMENT

The perceived comfort scale for adobe housing consists of ten items with a 5-point response scale, ranging from Strongly disagree to Strongly agree, organized into two dimensions of five items each.

Thermal comfort in the adobe dwelling (R1 to R5) covers a pleasant temperature during the day, a mild temperature at night, coolness during the hot months, the sensation of intense cold during the cold season, and comfort for resting. Appraisal of the adobe dwelling (R6 to R10) covers pride in living in an adobe house, the perceived sturdiness of the house, the desire to exchange it for a concrete-block house, the low maintenance its walls require, and willingness to recommend adobe construction in the community.

Two items are reverse-worded (R4 and R8) and are recoded in the data matrix, so that for all items a high value indicates a favorable appraisal of the dwelling. Table 2 presents the wording of each item.

Table 2. Structure of the instrument.

Code	Item	Reverse
R1	Inside my adobe house, the temperature is pleasant during the day	No
R2	At night, my adobe house stays warm	No
R3	During the hot months, my adobe house feels cool	No
R4	In the cold season, my adobe house feels freezing	Yes
R5	Inside my adobe house I can rest comfortably	No
R6	I am proud to live in an adobe house	No
R7	My adobe house is resistant	No
R8	I would like to replace my adobe house with a concrete block one	Yes
R9	The adobe walls of my house require little maintenance	No
R10	I would recommend building with adobe in my community	No

Note. R1 to R5 = Thermal comfort in the adobe house; R6 to R10 = Appraisal of the adobe house. The dimension column is omitted to preserve table readability. Five-point response scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree). Reverse-scored items have already been recoded in the delivered data matrix. Source: Factoriza UAS, project FZ-HAB-0015, survey LEV-0020, dataset DST-0045.

TECHNICAL COMPONENT OF THE PROJECT

The project belongs to the technical track, whose planned article in the project bank addresses environmental performance and comfort in adobe housing. The Factoriza package does not contain measurements of the dwellings' performance, so this article does not report technical results.

PROCEDURE

The questionnaire was administered through the Factoriza UAS platform, which records explicit online informed consent before the first question and does not collect data that could identify individuals. The platform applies a quality control check to completed questionnaires before adding them to the dataset; in this data cut, it did not exclude any cases.

DATA ANALYSIS

Factoriza UAS calculated the descriptive statistics for each item (mean, standard deviation, skewness, kurtosis, and percentages of responses at the minimum and maximum values), the internal consistency of each dimension using Cronbach's alpha (Cronbach, 1951), and the corrected item-total correlation and alpha if item deleted. It also computed the inter-item correlations within each dimension, which the notes to its tables identify as Spearman correlations, with 95% confidence intervals obtained through Fisher's z transformation.

The project belongs to the technical track of the article-writing workshop, whose data collections are not routed through the complementary psychometric analysis program; for this

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reason, McDonald's omega, exploratory factor analysis, and the correlation between dimensions were not estimated. In addition, with 16 cases for 10 items, factor analysis would not be defensible (Ferrando et al., 2022; Goretzko et al., 2021). No confirmatory factor analysis was performed.

ETHICAL CONSIDERATIONS

Participation was voluntary, with express informed consent recorded online by the platform, which does not collect names, addresses or other identifying data. The data were analyzed in aggregate.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, the Factoriza UAS platform was used for data management and for the descriptive, internal consistency and inter-item correlation analyses. The Claude Opus language model (Anthropic) was used for assisted literature searching, writing a draft and assembling the document from the results. As this was a technical-track project, the complementary psychometric analysis software was not used. The authors reviewed, corrected and approved the entire text, verified every reference and take full responsibility for the content of the article.

RESULTS
DESCRIPTION OF RESPONSES

Table 3 and Figure 1 present the descriptive statistics for the ten items. For Thermal comfort, mild temperatures at night had the highest mean (R2: *M* = 3.50, *SD* = 0.82), followed by coolness during the hot months (R3: *M* = 3.31, *SD* = 0.95) and comfort when resting (R5: *M* = 3.06, *SD* = 1.06).

Pleasant daytime temperature had a mean close to the midpoint and the greatest dispersion in the instrument (R1: *M* = 2.94, *SD* = 1.44). The reverse-scored item on cold had the lowest mean on the scale (R4: *M* = 2.44, *SD* = 1.09); in its recoded version, this value indicates that responses leaned toward agreement that the house feels freezing during the cold season.

In Appreciation, pride in living in an adobe house had the highest mean on the instrument (R6: *M* = 3.94, *SD* = 1.12), with a distribution skewed toward high values (skewness = -1.47). It was followed by willingness to recommend adobe construction (R10: *M* = 3.63, *SD* = 0.96). The strength attributed to the house (R7: *M* = 3.25, *SD* = 1.00) and the recoded item on the desire to replace it with a concrete block house (R8: *M* = 3.19, *SD* = 1.33) were slightly above the midpoint, the latter with high dispersion. The low maintenance required by the walls had the lowest mean in the dimension (R9: *M* = 2.88, *SD* = 1.02). The 69% ceiling for R2 corresponds to the highest observed value, as indicated in the table note.

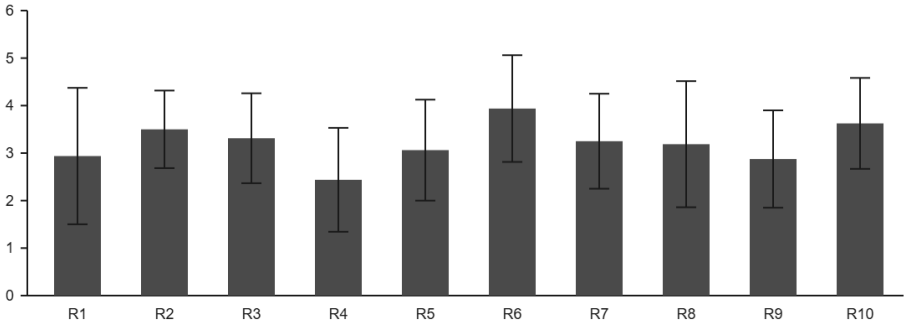
Table 3. Descriptive statistics of the items.

Item	M	SD	Skewness	Kurtosis	Floor	Ceiling
R1	2.94	1.44	-0.19	-1.36	25%	13%
R2	3.50	0.82	-1.26	-0.12	19%	69%
R3	3.31	0.95	-0.19	-1.03	25%	6%
R4	2.44	1.09	1.06	0.76	13%	6%
R5	3.06	1.06	-0.90	-0.26	13%	44%
R6	3.94	1.12	-1.47	2.27	6%	31%
R7	3.25	1.00	0.34	-0.74	25%	13%
R8	3.19	1.33	-0.19	-0.95	13%	19%
R9	2.88	1.02	-0.15	0.76	13%	6%
R10	3.63	0.96	-0.15	-0.68	13%	19%

Note.N = 16. R1 to R5 = Thermal comfort in the adobe dwelling; R6 to R10 = Appraisal of the adobe dwelling. The reverse-scored items R4 and R8 are shown recoded, so that a high value always indicates a favorable appraisal of the dwelling. Floor and ceiling indicate the percentage of responses at the minimum and maximum values, respectively. The item-total correlation column from the Factoriza descriptive table is omitted; its values do not match those in Table 4 because they are not calculated on the total of each dimension. Factoriza UAS run RUN-00251. Preliminary cut-off: n = 16 of a target of 100, with data collection still open.

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Figure 1. Mean scores per item with one-standard-deviation error bars.



INTERNAL CONSISTENCY

Table 4 presents the item analysis for each dimension. For Thermal comfort, alpha was .566. Pleasant daytime temperature (R1: .531), coolness during the hot months (R3: .500), and mild temperature at night (R2: .493) had the highest corrected item-total correlations, followed by comfort when resting (R5: .308). The reverse-scored item on cold had a slightly negative correlation (R4: -.052), and removing it would raise alpha to .701.

For Appraisal, alpha was .468. Willingness to recommend adobe construction (R10: .517), the low maintenance required by the walls (R9: .442), and pride (R6: .408) had the highest corrected item-total correlations. The strength attributed to the house had a low correlation (R7: .156), and the reverse-scored item on the desire to exchange the house for a concrete-block one had a slightly negative correlation (R8: -.087). Removing R8 would raise alpha to .670.

Table 4. Item analysis by dimension.

Dimension	Item	Corrected item-total r	α if item deleted
Thermal comfort	R1	.531	.355
Thermal comfort	R2	.493	.445
Thermal comfort	R3	.500	.422
Thermal comfort	R4	-.052	.701
Thermal comfort	R5	.308	.519
Assessment	R6	.408	.293
Assessment	R7	.156	.471
Assessment	R8	-.087	.670
Assessment	R9	.442	.282
Assessment	R10	.517	.242

Note.N = 16. Scale from 1 to 5; reverse-scored items R4 and R8 are shown recoded. Run RUN-00251 of Factoriza UAS. Preliminary data cut: n = 16 out of a target of 100, with data collection still open.

CORRELATIONS BETWEEN ITEMS

Table 5 presents the correlations between items within each dimension. For Thermal comfort, only the correlation between pleasant daytime temperature and mild nighttime temperature excluded zero (R1 and R2: r = .583, 95% CI [.123, .837], p = .018). The correlation between nighttime temperature and comfort for resting was moderate, but its interval included zero (R2 and R5: r = .477, 95% CI [-.025, .787], p = .062).

The recoded item on cold was moderately related to coolness during the hot months (R3 and R4: r = .413, 95% CI [-.104, .754], p = .112), but not to nighttime temperature (R2 and R4: r = -.013) or to comfort for resting (R4 and R5: r = .064).

In Appraisal, none of the correlations excluded zero. The recoded item on the desire to exchange the house for a concrete-block one was positively related to the willingness to recommend adobe (R8 and R10: r = .440, 95% CI [-.071, .768], p = .088) and negatively related to

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the strength attributed to the house (R7 and R8: r = -.436, 95% CI [-.766, .076], p = .091) and to low maintenance (R8 and R9: r = -.272).

Low maintenance was related to willingness to recommend adobe (R9 and R10: r = .436) and to durability (R7 and R9: r = .375), and pride was related to durability (R6 and R7: r = .395). Pride, however, was not related to willingness to recommend adobe (R6 and R10: r = .034) or to the desire to replace the house (R6 and R8: r = .067). With 16 cases, all of these intervals are wide.

Table 5. Correlations between the items of each dimension.

Dimension	Variable pair	r	IC 95%	p
Thermal comfort	R1 and R2	.583	[.123, .837]	.018
Thermal comfort	R1 and R3	.370	[-.154, .731]	.159
Thermal comfort	R1 and R4	.104	[-.413, .570]	.703
Thermal comfort	R1 and R5	.381	[-.141, .738]	.145
Thermal comfort	R2 and R3	.353	[-.173, .722]	.180
Thermal comfort	R2 and R4	-.013	[-.505, .486]	.962
Thermal comfort	R2 and R5	.477	[-.025, .787]	.062
Thermal comfort	R3 and R4	.413	[-.104, .754]	.112
Thermal comfort	R3 and R5	.240	[-.290, .658]	.370
Thermal comfort	R4 and R5	.064	[-.446, .542]	.814
Assessment	R6 and R7	.395	[-.125, .745]	.130
Assessment	R6 and R8	.067	[-.443, .545]	.805
Assessment	R6 and R9	.220	[-.310, .645]	.413
Assessment	R6 and R10	.034	[-.469, .521]	.900
Assessment	R7 and R8	-.436	[-.766, .076]	.091
Assessment	R7 and R9	.375	[-.148, .734]	.153
Assessment	R7 and R10	.148	[-.375, .600]	.585
Assessment	R8 and R9	-.272	[-.677, .258]	.307
Assessment	R8 and R10	.440	[-.071, .768]	.088
Assessment	R9 and R10	.436	[-.076, .766]	.091

Note.N = 16. Thermal comfort = Thermal comfort in the adobe dwelling; Appraisal = Appraisal of the adobe dwelling. The corrected item-total correlation excludes the item itself from the total of its dimension. Cronbach's α for each full dimension (5 items each): Thermal comfort = .566 (run RUN-00252); Appraisal = .468 (RUN-00254). Source: Factoriza UAS, Tables 4 and 6 of the package, combined without modifying values. Preliminary data cut: n = 16 out of a target of 100, with data collection still open.

DISCUSSION OF RESULTS

This study examined the preliminary performance of a scale measuring thermal comfort and appraisal of adobe housing in a sample of 16 cases from communities in southern Sinaloa. The first finding is descriptive and concerns comfort: respondents rated the temperature of their homes more favorably at night and during the hot months than during the day, and most tended to agree that the house feels freezing during the cold season.

This pattern is consistent with the thermal inertia that the literature attributes to earthen construction (Banaba et al., 2025; Fouad et al., 2025), which buffers outdoor heat, but also with the role that roofs and other elements of the dwelling play in indoor temperature (Espinosa-Gómez et al., 2026).

Without technical measurements, the study cannot separate the role of the adobe walls from that of the roofs, openings or modifications made to each dwelling, nor can it compare perception with recorded temperature.

The second finding concerns the cold item. Its moderate association with coolness during the hot months, but not with the other items, suggests that both capture the same seasonal facet of the dwelling's thermal performance: a house that stays cool in summer and does not feel freezing in winter, which corresponds to the damping of temperature fluctuations. The items on daytime, nighttime and rest, by contrast, refer to everyday comfort.

This distinction between seasonal and daily comfort is consistent with the adaptive approach, which shows that thermal experience varies with time and with occupants' expectations (Gong

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et al., 2025; Wei et al., 2022). It further suggests that the dimension could be organized into two facets. The slightly negative item-total correlation of the cold item is also compatible with a bias associated with reverse wording (García-Batista et al., 2021; Steinmann et al., 2022).

The third finding concerns housing appraisal, whose internal consistency was low. Pride in living in an adobe house was the most highly rated aspect, but it was not related to willingness to recommend adobe or to the desire to exchange the house for one made of concrete block. The desire to keep the adobe house, for its part, was positively related to willingness to recommend adobe, as would be expected, but negatively related to the strength attributed to the house and to its low maintenance requirements.

Although uncertain, this pattern is consistent with the literature describing the appraisal of earthen housing as a combination of appreciation for its qualities and practical reasons for abandoning it, such as maintenance and safety (Rivera-Salcedo et al., 2021; Sánchez Calvillo et al., 2021).

In measurement terms, these are aspects that make up the valuation of the dwelling rather than manifestations of a single attitude, and they behave more like formative indicators, for which internal consistency is not the appropriate criterion (Bollen and Diamantopoulos, 2017).

The low maintenance required by the walls was the lowest-rated aspect of the dimension. This is consistent with the lack of knowledge about adobe maintenance reported as a reason for abandonment in other contexts (Rivera-Salcedo et al., 2021) and with the importance of construction and reinforcement techniques for the safety of these dwellings (Jerónimo-Vargas et al., 2022; Sánchez Calvillo et al., 2021).

The relationship between this item and willingness to recommend adobe suggests that the maintenance burden could be a decisive aspect of the assessment, one that would be worth exploring in greater detail in the final data collection wave.

The results can also be read comparatively against social housing in northwestern Mexico, albeit with caution, since they do not come from the same study or use the same instrument. Whereas residents of social housing in Culiacán described their homes as very hot (Barraza-Bracamontes et al., 2022) and the concrete housing evaluated in Ensenada performed poorly in winter (Bacelis et al., 2024), people living in adobe houses in southern Sinaloa rated the temperature at night and during the hot months relatively favorably, though not the temperature during the cold season.

This difference, if confirmed by the final data cutoff and by technical measurements, would be relevant to the discussion of housing materials in hot climates, where the cooling demand and energy performance of social housing have already been documented (Galindo-Borbón et al., 2024; Muñoz López et al., 2023). A valid comparison would, however, require applying the same instrument to both housing types and controlling for the season, orientation, roofs, and ventilation habits of each household.

The results suggest several adjustments for the next stage. For the instrument, it would be advisable to separate the seasonal comfort items from the everyday comfort items, revise the wording of the reverse-scored items, and consider treating the housing evaluation as a set of aspects analyzed separately or as a formative index, rather than as a reflective scale.

In terms of procedure, it would be necessary to record the season in which participants respond, because comfort ratings could vary with it. The responses would also need to be linked to the characteristics of each dwelling and to the project's technical measurements, which would make it possible to gather validity evidence based on relations to other variables.

CONCLUSIONS

The study examined the preliminary performance of a ten-item scale on thermal comfort and the appraisal of adobe housing among people living in this type of dwelling in southern Sinaloa, based on an interim sample of 16 cases out of a target of 100.

Respondents rated the temperature of their homes more favorably at night and during the hot months than during the day, tended to perceive them as freezing in the cold season, and expressed pride in living in an adobe house, although they rated its maintenance less favorably. Internal consistency was moderate for Thermal Comfort (α = .566) and low for Appraisal (α = .468); the reverse-scored items contributed nothing, and the inter-item relationships suggest distinct facets within each dimension.

The study has limitations that should be kept in mind when reading all of its results. The first concerns the size and nature of the data cut: 16 cases out of a target of 100, with data collection

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still ongoing, are insufficient to estimate internal consistency and correlations precisely.

The second concerns the sample: the communities, the contact procedure, the type of sampling, and the characteristics of the participants and their dwellings have yet to be documented, and the results cannot be generalized.

The third concerns the absence of the technical component: the package contains no measurements of housing performance, so perceptions could not be compared with the recorded conditions.

The fourth concerns the analysis: because this was a technical-pathway project, omega, exploratory factor analysis and the correlation between dimensions were not estimated; the floor and ceiling percentages from Factoriza need to be verified; and no confirmatory factor analysis was performed.

The fifth concerns design: because the study is cross-sectional, it does not allow causal inferences.

Directions for future work follow from these limitations. The most important is integrating the perception component with the project's technical measurements: recording indoor temperature and humidity in a subsample of dwellings, together with their construction characteristics, would show the extent to which the occupants' experience reflects the performance of adobe housing and which features of the dwelling are associated with it.

Once the final data cutoff is reached, it will be advisable to repeat the item analysis, conduct the supplementary analyses if the Professor so decides, and examine whether the comfort dimension is organized into seasonal and everyday facets. This information would help guide the conservation and improvement of earthen housing in southern Sinaloa, at a time when residents' appraisal of it combines pride with practical reasons for replacing it.

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