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Building Performance Criteria Based Sustainability Assessment of Rural Mass Housing: The Case of Günyurdu Village

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Abstract

New housing developments in rural areas not only address the need for housing but also have a significant effect on the region's social, cultural, and economic frameworks. The inability of these efforts to align with local social norms and the natural environment threatens both individual well-being and long-term sustainability. This study aims to evaluate the sustainability performance of rural mass housing projects from the perspective of user satisfaction by putting forth the levels of compliance with building performance criteria. Within the scope of the research, a mass housing project in Günyurdu Village, was selected as a case study. The survey conducted employing Post-Occupancy Evaluation (POE) method reveals the satisfaction levels of occupants with their housing units while providing data on areas for improvement. Results show that satisfaction with the housing units is lower than average. This work aims to contribute to future policy development processes for sustainable rural mass housing.

Keywords: *Rural mass housing, sustainability, post-occupancy evaluation, building performance criteria.*

Kırsal Toplu Konutların Yapı Performans Kriterleri Üzerinden Sürdürülebilirlik Değerlendirmesi: Günyurdu Köyü Örneği

Öz

Kırsal alanlardaki yeni konut projeleri yalnızca barınma ihtiyacını karşılamakla kalmaz, aynı zamanda bölgenin sosyal, kültürel ve ekonomik yapıları üzerinde de önemli etkiye sahiptir. Bu çabaların yerel sosyal normlarla ve doğal çevreyle uyumlu olmaması hem bireysel refahı hem de uzun vadeli sürdürülebilirliği tehdit etmektedir. Bu çalışma, kullanıcı memnuniyeti perspektifinden kırsal toplu konut projelerinin sürdürülebilirlik performansını değerlendirmeyi amaçlayarak yapı performans kriterlerine uyum düzeylerini ortaya koymaktadır. Araştırma kapsamında, Günyurdu Köyü'nde yer alan bir toplu konut projesi vaka çalışması olarak seçilmiştir. Kullanım sonrası değerlendirme (POE) yöntemi bazlı anket çalışması, sakinlerin konutlarla ilgili memnuniyet düzeylerini ortaya koyarken, aynı zamanda geliştirilmesi gereken alanlar hakkında veriler sunmaktadır. Bulgular, yeni toplu konutlarla ilgili memnuniyetin ortalamanın altında olduğunu göstermektedir. Bu çalışma, kırsal alanlarda sürdürülebilir toplu konut politikalarının gelecek geliştirilme süreçlerine katkı sağlamayı hedeflemektedir.

Anahtar kelimeler: *Kırsal toplu konut, sürdürülebilirlik, kullanım sonrası değerlendirme, yapı performans kriterleri.*

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1. Introduction

The escalating population and rapid urbanization in Turkey have exacerbated the demand for housing, thereby catalyzing the proliferation of mass housing projects in recent years. Within the framework of rural development policies, these projects are implemented not only in urban centers but also in rural regions. They aim to address challenges such as demographic decline, the contraction of agricultural activities, and the migration of young populations to urban areas, as well as respond to security concerns and dam construction initiatives. Although rural mass housing projects have the potential to improve the quality of life for local communities, their success in adapting to local culture and environmental conditions remains debatable. These projects do not merely fulfill the need for shelter but also profoundly impact the social, cultural, and economic structures of the region (Gkartzios & Scott, 2012; Gkartzios & Scott, 2010). Failure of such initiatives to integrate with local lifestyles and the natural environment jeopardizes both individual quality of life and regional long-term sustainability (Ghose, 2004; Solana-Solana, 2010; Avcı & Topçu, 2019; Koç & Kejanlı, 2020). Solana-Solana (2010) and Avcı & Topçu (2019) emphasize in their studies that similar projects weaken social fabric and erode local identity, while Koç & Kejanlı (2020) highlight the environmental impacts of these projects and the depletion of natural resources. In this context, the principles of locality and building performance criteria are of critical importance in the design and implementation of rural mass housing projects (Arpacıoğlu, 2016). Ensuring that these projects align with local cultural and environmental conditions while addressing users' physical and psychosocial needs will not only foster social cohesion but also support sustainability by preserving natural resources and the existing cultural fabric. This approach enables the production of long-lasting housing that enhances the quality of life, in line with rural development objectives. Although literature provides guidelines on village design and individual housing developments, comprehensive studies specifically addressing the principles of rural mass housing production remain scarce (Antalya Metropolitan Municipality, 2015). While institutions such as the Housing Development Administration of Turkey (TOKİ) offer standardized housing prototypes for rural areas, a fully developed approach that adequately reflects the unique conditions and complexities of rural mass housing has yet to be established. Reports from international organizations such as the United Nations (UN) and the Organisation for Economic Co-operation and Development (OECD) emphasize the strong relationship between rural mass housing projects and rural development goals, underscoring the significance of research in this field (Abreu & Mesias, 2020; Akder, 2003; Bryden, 2002; Cirik, 2011). This highlights the need for further research and implementation of rural mass housing projects at both local and international levels.

This study aims to evaluate the sustainability performance and user satisfaction of rural mass housing projects in Turkey based on building performance criteria. To achieve this, the Günyurdu Village TOKİ project, located in Pazaryeri District of Bilecik Province, has been selected as a case study. The suitability of the mass housing project in terms of sustainability criteria—considering factors such as residents' quality of life, social impacts, and environmental performance—has been examined through a user survey. The study employs the Post-Occupancy Evaluation (POE) methodology to assess the performance of rural mass housing projects. POE is a systematic evaluation method based on user experiences and feedback, aiming to identify the strengths and shortcomings of a project (Preiser, 1995; Xue et al., 2015; Mustafa, 2017)

The survey questions developed using the POE methodology measure user assessments regarding the physical characteristics of the housing units, social amenities, energy consumption, indoor environmental comfort, social interactions, and overall residential satisfaction. The research workflow is illustrated in Figure 1. The ultimate goal of this study is to contribute to the development of user-centered, sustainable, and socially responsive rural settlements while providing scientific data for rural development policies (Figure 1).

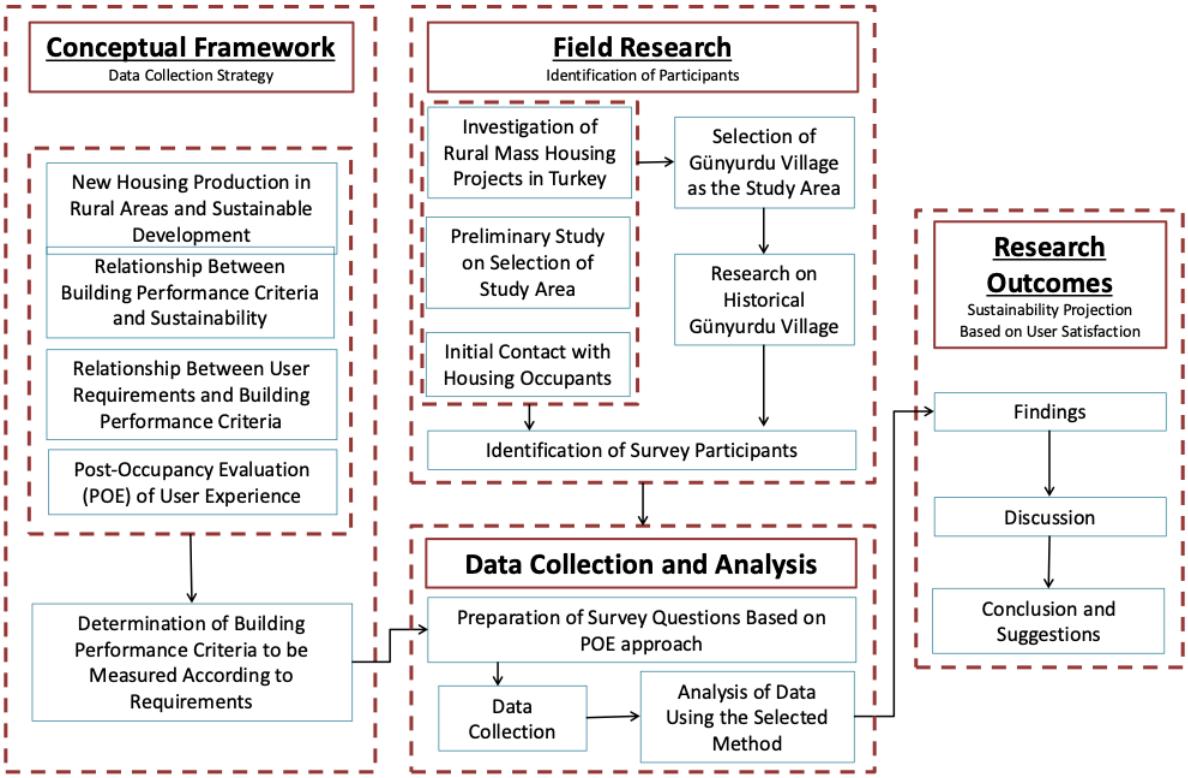

Figure 1. Scope and flow of the research study (Created by Authors)

1.1. Rural Housing Production and Sustainable Development

The historical, cultural, and geographical diversity of rural areas forms a unique identity for these regions. To preserve and enhance this identity, significant steps have been taken worldwide within the framework of rural development plans and strategic policies, as seen in Turkey. International efforts such as the European Union's Rural Development Policy support the sustainable development of rural areas and the preservation of cultural heritage. In Turkey, documents such as the rural development strategy of Ministry of Agriculture and Forestry (2021) and the strategic plan published by Ministry of Environment, Urbanization and Climate Change (2024) emphasize the preservation and enhancement of the distinct identities of rural settlements. In this context, tools such as village design guidelines aim to incorporate local values into the planning and design processes of rural areas (Görgün & Yörür, 2018; Öğdül & Olgun, 2015; Eminağaoğlu & Çevik, 2007). For instance, the character areas approach in the United Kingdom and concepts like pays de cocagne in France present different strategies for preserving and developing rural areas (Öğdül et al., 2018; Baumont, 2009). In Japan, projects focused on revitalizing traditional village houses aim to promote rural tourism and safeguard cultural heritage (Ge & bin Abd Manan, 2025). In Turkey, village design guidelines serve as planning tools developed with the participation of local communities, guiding the future development of rural settlements (Görmüş et al., 2015). Additionally, publications such as the Rural Housing Projects in accordance with local architectural characteristics, prepared by the Ministry of Environment, Urbanization and Climate Change (2024), encourage housing designs that align with the needs and cultural characteristics of rural residents. However, most existing studies have focused on individual housing projects or solutions user-specific. These studies generally emphasize the use of local materials, the adaptation of traditional construction techniques to contemporary conditions, and energy efficiency.

While rural housing production is often linked to private ownership and tailored solutions in literature, rural development policies, disaster management, and demographic shifts can necessitate mass housing projects. Despite offering advantages in terms of financing and construction processes, such mass housing projects may encounter challenges such as the proliferation of standardized designs, incompatibility with local architectural contexts, and negative environmental impacts (Radeloff et al., 2005). These issues highlight the necessity of a careful approach concerning principles of locality and

environmental sustainability. The success of rural mass housing projects is directly related to how well they address the needs of the local population. Methods such as Post-Occupancy Evaluation (POE) can be utilized to assess user experiences after project completion, providing valuable data for future developments. This approach enables planning that is compatible with the cultural and natural environment, sustainable, and socially equitable. Through collaboration among local governments, architects, and other stakeholders, more successful projects can be realized while preserving and enhancing the unique character of rural areas.

Compared to individual rural housing production, studies on mass housing projects are relatively limited but have been receiving increasing attention in recent years (Gkartzios & Scott, 2010). These studies primarily focus on the social, economic, and environmental impacts of projects (Gkartzios & Scott, 2012). Rural housing production is a multidimensional issue influenced by various socio-economic, cultural, and political factors. Recent literature highlights the importance of developing solutions that align with the unique conditions of rural areas while addressing both local needs and external resources and policies. Gkartzios & Scott (2013) argue that such an approach can link housing policy to broader social and economic frameworks, fostering sustainable rural development and promoting inclusivity and diversity in rural housing solutions.

Rural housing production is a complex issue affected by socio-economic, cultural, and political dynamics. This complexity underscores the need for careful planning and implementation, particularly in mass housing projects in rural areas. Literature emphasizes the necessity of creating environmentally sensitive and economically sustainable designs that meet the needs and expectations of local communities by considering building performance criteria and existing socio-economic data. Such an approach can enhance the quality of life for rural residents and secure the future of rural regions.

The sustainability of rural mass housing projects encompasses environmental, economic, and social dimensions. Research indicates that these projects typically focus on environmental impacts, cost-effectiveness, and social outcomes. Wong et al., (2022) highlights the importance of environmental factors such as energy efficiency and water management in rural housing projects, while Aydın (2019) examines their economic sustainability in terms of cost-effectiveness and contributions to the local economy. Scott & Murray (2009) associates' social sustainability with aspects such as community participation and quality of life.

In this regard, the sustainability of rural mass housing projects is not only related to environmental, economic, and social aspects but also closely tied to building performance, which determines how well the structures meet user requirements. Therefore, establishing a clearer connection between building performance criteria and sustainability indicators and supporting analyses from this perspective through methods like Post-Occupancy Evaluation (POE) is crucial. For example, POE studies can assess user satisfaction concerning indoor environmental conditions, energy consumption, and access to social spaces, generating concrete recommendations for improving future projects.

1.2. Relationship Between Building Performance Criteria and Sustainability Indicators

The performance of a building can be defined as its ability to perform optimally throughout its lifecycle (Khalil et al., 2016). To ensure this optimal efficiency, the performance of buildings must be evaluated continuously and systematically using various criteria. Numerous studies in the literature propose diverse criteria for assessing building performance, depending on the building's intended use, location, climatic conditions, and other relevant factors. For instance, Christine Sotsek et al. (2019), through a systematic review, suggested nine distinct categories of building performance criteria: functional, technical, environmental, economic, aesthetic, neighborhood integration, and procedural. Other studies categorize building performance criteria into four main groups: functional, economic, symbolic, and structural (Sanoff, 1977). Based on user expectations and the nature of ongoing functions, some researchers examine criteria under three categories: technical, functional, and behavioral performance (Preiser, 1991). More recent studies have proposed the inclusion of additional elements

the inclusion of additional elements such as physical, service, social, and process performance in performance domains (Preiser &Vischer, 2006; Lützkendorf et al., 2005).

Building performance criteria are metrics that evaluate a building's ability to meet specific objectives and fulfill its intended use (Ibem et al., 2013). These criteria are utilized to assess quality and efficiency at every stage of a building's lifecycle, from design to construction, operation, and maintenance. For instance, during the design phase, these criteria serve as guidelines for designers, helping them shape and optimize design decisions in alignment with project objectives. They are also used to evaluate whether a building meets expectations in areas such as energy and resource efficiency, operational and maintenance planning, and user comfort and satisfaction. Building performance criteria can be continuously reviewed and updated throughout a building's lifecycle to ensure adaptation to evolving needs and standards.

Table 1. User Requirements - Building Performance Criteria Relationship (Created by Authors)

Occupants' Requirements	Related Building Performance Criterion	Explanation	Related Research in the Literature
Spatial Requirements	Functional Performance	Suitability for anthropometric dimensions, suitability for accessibility, suitability for lifestyle and activities, social/privacy context, suitability for main economic activity	(Seshadhri & Topkar, 2017; Baudains et.al., 2014; Fieldson & Sodagar, 2017; Sarran et al., 2020; Astarini & Utomo, 2020)
	Behavioral and Social Performance		(Zhao & Yang, 2022; Fieldson & Sodagar, 2017; Murunga et.al., 2023; Babos et.al., 2023; Sierra et al., 2023)
	Economic Performance		(Astarini & Utomo, 2020; Sarran et.al., 2020; Reeves et.al., 2012; Gülçimen et al., 2021, Kulakov et.al., 2023; Marzouk et.al., 2016)
Thermal Requirements	Technical Performance	Appropriate temperature, humidity, radiation and air movement	(Gil-oulbé et.al., 2020; Lee, 2011; Gür & Sezer, 2018)
	Environmental Performance		(Fieldson & Sodagar, 2017; Zhao & Yang, 2022; Çelebi & Arpacıoğlu,2022)
	Economic Performance		(Sarran et.al., 2020; Oliveira et.al., 2021; Xue et al., 2015; Fieldson & Sodagar, 2017)
Acoustic Requirements	Functional Performance	Acoustic comfort, noise control	(Lee, 2011; Mohamed & Yörükoğlu, 2019; Peck & Stewart, 1985)
	Technical Performance		(Fieldson & Sodagar, 2017; Urban & Máca, 2013; Aburawis & Yörükoğlu, 2018)
Visual Requirements	Functional Performance	Appropriate level of light, view	(Baird & Thompson, 2012; Fakhari et.al., 2022)
	Technical Performance		(Lee, 2011; Sakellaris et al., 2016; Eijkelenboom & Bluyssen, 2019)
	Environmental Performance		(Fieldson & Sodagar, 2017; Hwang & Kim, 2010)
	Economic Performance		(Fakhari et. al., 2022)
Sanitary Requirements	Functional Performance	Clean water, waste disposal, hygiene	(Lee, 2011)
	Technical Performance		(Sarran et al., 2020)
	Environmental Performance		(Lee et al., 2011; Filho et al., 2022; Zhang & Srinivasan, 2020; Nimlyat et al., 2023; Delgado, 2016; El-Salamouny et al., 2019)
Safety and Security Requirements	Functional Performance	Structural strength, material durability, disaster resistance, safety	(Khajavi et al., 2023; Torrecilla-García et al., 2021)
	Technical Performance		(Shirowzhan et al., 2020; Taib & Al-Dabbagh, 2023)

Various studies have demonstrated that a building's ability to meet user requirements directly impacts its environmental, social, and economic sustainability (Jailani et al., 2015). On a global scale, the amount of energy consumed in buildings, especially to provide comfort conditions in the interior,

constitutes a large part of the total amount of energy consumed (Çelebi & Arpacıoğlu, 2022). Furthermore, building performance criteria associated with user requirements can serve as a tool for measuring environmental, social, and economic sustainability. For example, a building that meets thermal requirements contributes to environmental sustainability and reduces users' living costs, thereby supporting economic sustainability. Similarly, the ability of buildings to align with users' lifestyles and the region's economic activities is crucial for functional, behavioral, social, and economic sustainability.

In this study, based on a comprehensive literature review, it was decided to evaluate rural mass housing projects using five building performance criteria: functional, technical, environmental, economic, and behavioral & social performance, as outlined in Table 1.

User requirements were identified through a literature review focusing on rural mass housing, including spatial, thermal, acoustic, visual, health, safety-security, lifestyle-activity continuity, and aesthetic aspects. Table 1 illustrates the correspondence between user spatial requirements and building performance criteria. While these criteria are not strictly separate, multiple user requirements may correspond to more than one performance criterion.

Spatial requirements are associated with functional and behavioral-social performance; thermal requirements with technical, environmental, and economic performance; acoustic requirements with functional and technical performance; visual requirements with functional, technical, environmental, and economic performance; health requirements with functional, technical, and environmental performance; safety-security requirements with functional and technical performance; requirements for lifestyle continuity and activities with functional, behavioral, and economic performance; and aesthetic requirements with environmental and behavioral-social performance (Table 1).

Zagreus et al. (2004) emphasized the critical role of collecting building user feedback in assessing how well buildings meet user needs. Similarly, Fatoye and Odusami (2009) stated that the performance of housing projects determines user satisfaction. However, studies evaluating rural mass housing projects from this perspective are scarce. To fill this gap in the literature, this study aims to conduct a post-occupancy evaluation assessing the relationship between building performance criteria and user requirements through a case study. This will help assess the degree to which rural mass housing projects meet user needs and inform future design processes.

1.3. Hypothesis of the Research

After having the comprehensive literature review, the research questions were identified. According to the research questions the hyphothesis were determined as below:

RQ1. How do the residents of the Günyurdu Project evaluate the extent to which their housing meets their needs, and how do these evaluations affect their overall satisfaction levels?

H1. There is a positive relationship between the housing performance in meeting the user requirements in the Günyurdu Project and the overall satisfaction level.

RQ2. How do the residents of the Günyurdu Project evaluate the various performance features of their homes (e.g., thermal insulation, indoor quality, etc.), and how do these evaluations influence their overall satisfaction levels?

H2. The overall satisfaction level of the residents in the Günyurdu Project varies according to the performance of the housing, depending on user requirements.

RQ3. How do demographic variables, such as gender, influence the level of satisfaction that the residents of the Günyurdu Project experience with their homes?

H3. Demographic variables, such as gender, have different effects on housing satisfaction.

RQ4. How does the increase in the number of people using a residence affect the overall satisfaction levels of the residents of the Günyurdu Project?

H4. There is an inverse relationship between the number of people using a residence and the overall satisfaction level.

RQ5. How do the residents of the Günyurdu Project evaluate the extent to which their homes meet their spatial requirements (e.g., storage, workspace, etc.), and how do these evaluations impact their overall satisfaction levels?

H5. There is a positive relationship between the extent to which a residence meets the spatial requirements of the user and the overall satisfaction level.

2. Material and Method

2.1. Material

The primary focus of this study is the residential units in the new settlement area, built by the Housing Development Administration of Turkey (TOKİ) in 2006 to accommodate the displaced residents of Günyurdu Village in Pazaryeri District, Bilecik Province. This relocation was prompted by the partial submersion of the former settlement following the completion of a dam project in 2006 (Figure 2).

Figure 2. Günyurdu Village new settlement and housing units (Baran Ergül, 2022)

The research area is located at 40.01° N latitude and 29.51° E longitude, situated 36 km from Bilecik City, 8 km from Pazaryeri District, and 2 km from the former settlement. Although Günyurdu Village is geographically located in the Marmara Region, its climate is predominantly continental. Situated at an altitude of 810 meters, the settlement experiences heavy snowfall during winter. Topographical analysis reveals a terrain that gradually decreases in elevation towards the east. The settlement is planned along a northeast-southwest axis.

Formerly known as Bakraz, Günyurdu Village has a documented history dating back to the early Ottoman period, as recorded in the Ottoman archives. The region, chosen as a settlement by members of the Kayi tribe's Karakeçili clan, attained village status in the 1800s (Göker et al., 2019). Until its evacuation, the primary livelihood of historical Günyurdu Village was animal husbandry. The abandoned historical Günyurdu Village retains the characteristics of a traditional rural landscape. The settlement, characterized by traditional dwellings on slopes, hills, rocky outcrops, and dispersed agricultural and pasture lands, maintains a traditional village settlement pattern. The dwellings in the old settlement are modest, small-scale, and typically one or two stories high. The unadorned and human-scale structures emphasize functionality. Although the historical settlement appears densely built, it lacks a structured neighborhood layout. Although a clustering of structures is observed along the village roads, the road's influence on building orientation is minimal, except for parcels adjacent to the road. The positioning of dwellings within parcels varies based on building-road relationships, with the settlement fabric formed by considering topographic data, privacy, and neighborly rights. The parcels forming the rural fabric include single-story service buildings – residential extensions such as barns, haylofts, storage, and toilets, arranged around the main residential structures. However, no boundary walls, fences, or similar features exist between parcels.

Prior to the dam inundation, historical Günyurdu Village housed approximately 120 households. Currently, only 13 households remain in the old settlement. The dam construction led to the flooding of 48 houses, the village school, the old cemetery, and the village mosque. In response to the

inundation threat, TOKİ constructed a new settlement with 123 dwellings approximately 2 km east of the old village. These dwellings were made available to villagers through payment plans extending up to 120 months, while the surplus units were later put up for sale by TOKİ. In addition to the dwellings, the settlement features a school building—now converted into a residence and sold through online listings—a village headman's office, and a communal space for residents (Figure 3).

Figure 3. Günyurdu Village old and new settlements (Baran Ergül, 2022)

2.2. Method

This study aims to evaluate the degree of sustainability of rural mass housing projects in Turkey by assessing building performance, particularly through user experiences and expectations regarding their dwellings. To achieve this, a comprehensive literature review was conducted on rural mass housing, sustainability, and Post-Occupancy Evaluation (POE) concepts. Based on the findings, this study hypothesizes that a sustainable building depends not only on environmental and economic criteria but also on user satisfaction and contentment with their dwellings. In this context, building performance criteria were defined based on users' spatial requirements and expectations. Survey questions were prepared to measure user experiences using the investigation approach within the POE methodology. Inquiry is an approach that aims to understand users' thoughts and experiences regarding their dwellings in depth, allowing for the collection of both quantitative and qualitative data (Jiwane, 2021). Accordingly, a survey consisting of 36 questions, designed according to 6 different expectation categories within the scope of POE, was used as a data collection tool. The survey questions were prepared using a five-point Likert scale, and participants were asked to evaluate their satisfaction levels with their dwellings, compared to their original condition upon delivery, ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, two bipolar questions were included at the end of the survey to measure overall satisfaction with the dwellings. These questions allowed users to make a general evaluation of their dwellings.

The survey was administered to participants through In-person surveys interviews, and a pilot study was conducted to validate the survey and ensure its reliability with necessary adjustments made. Voluntary participation was encouraged during the data collection process, aiming to enhance the reliability of the data. Furthermore, the identities and privacy of the participants were protected, and each dwelling was assigned a unique code. Participants' names, addresses, or other personal information were not collected.

The study was conducted with 76 individuals residing in 44 dwellings constructed by TOKİ in Günyurdu Village, Pazaryeri District, Bilecik Province. The sample was selected from individuals over 18 years of age who continuously reside in the house unit throughout the year.

Günyurdu Village comprises a total of 128 residential structures, 123 of which were constructed by TOKİ in 2006, and 5 of which were built by users between 2019-2020. Among these 128 house units, 15 units built by TOKİ- are not in use. Of the remaining houses, 45 are used year-round, while 63 are utilized as weekend or summer homes. According to 2022 data, 188 people reside in Günyurdu Village. In this study, from the 113 house units built by TOKİ in Günyurdu Village, the opinions of users of

unoccupied or only seasonally used dwellings were excluded, as they may reflect different expectations regarding continuous occupancy. Instead, the focus was placed on the users of the 45 house units continuously occupied throughout the year.

In this study, the simple random sampling method, which is believed to best represent the population, was employed. In this method, each member of the population has an equal chance of being included in the sample. This approach ensures that the sample reflects the characteristics of the population and enhances the generalizability of the results.

To determine the sample size, the confidence interval method was applied. Based on calculations with a 99% confidence level and a 1% margin of error, and assuming a response rate of 50%, it was concluded that a minimum of 150 individuals should be reached. This number is considered sufficient to achieve the objectives of the study and ensure that the results are statistically significant.

The reasons for choosing the simple random sampling method are as follows:

- Representativeness**:** Since each household has an equal chance of being included in the sample, the sample better represents the population.
- Simplicity**:** It is easier to apply compared to other methods.
- Minimizing bias**:** The risk of personal biases influencing the sample is minimized.

The sample size was calculated using the following formula:

n = (Zα/2)^2 * (p*(1-p)) / e^2

Where:

- n: Required sample size
- Zα/2: The z-value corresponding to the confidence level (for 99%, this is 2.58)
- p: Success probability (estimated response rate, in this case, 0.5)
- q: Failure probability (1-p)
- e: Margin of error (0.05)

Based on the calculations using this formula, it was determined that at least 150 individuals should be included in the sample.

Although initially planned to interview users from all continuously occupied house units, one user declined to participate, resulting in the survey being conducted with 76 individuals from 44 housing units (Table 2). The survey included adult participants over 18 years of age from all socioeconomic groups in the village (age, gender, income level, etc.), and this distribution reflects the village's population distribution, ensuring the sample's representativeness.

The data obtained from this sample group allowed for a clearer understanding of how the dwellings are used in daily life, user satisfaction levels, and areas for improvement in the design of the dwellings.

Table 2. Distribution of the Survey Sample (Created by Authors)

Total Number of House Units Surveyed	44 House Units									
House Units Residents by Household Size:	9 House Units with Single-Person Household Member		21 House Units with Two-Person Household Member		14 House Units with Three or More Person Household Member					
Surveyed Individuals	9 House Units with Single household member		18 House Units with Two Household Members	3 House Units with Single Household Member	4 House Units with Three Household Members		6 House Units with Two Household Members		4 House Units with Single Household Member	
Gender Distribution	8 Women	1 Man	21 Women	18 Men	7 Women	5 Men	6 Women	6 Men	3 Women	1 Men
Total Number by Gender	45 Women				31 Men					
Total Number of Survey Participants	76 Person									

The collected data were analyzed using SPSS statistical software. Frequency analyses were initially conducted to examine the distribution of responses for each question. Subsequently, differences in satisfaction levels between different groups were evaluated using statistical analyses, including t-tests and chi-square tests, considering participants' demographic characteristics (gender, household size). Additionally, correlation analyses were performed between responses to questions regarding users' spatial requirements, acoustic comfort, and other needs, to examine the relationships between these requirements.

The survey results, findings related to building performance evaluation and sustainability indicators, are presented in detail in the following findings and discussion section (Table 3).

Table 3. Occupants' requirements and performance criteria relationship (Created by Authors)

OCCUPANTS' REQ.	Q. No	SURVEY QUESTION	TECHNICAL PERFORMANCE	ENVIRONMENTAL PERF.	FUNCTIONAL PERFORMANCE	ECONOMIC PERFORMANCE	BEHAVIORAL & SOCIAL PERF.
SPATIAL	Q01	My home is large enough for my family to live comfortably.			■		
	Q02	I am satisfied with the size of the rooms in my home.			■		
	Q03	I am satisfied with the size of the kitchen in my home.			■		
	Q04	I am satisfied with the size of the bathroom-toilet in my home.			■		
	Q05	My home provides enough storage space.			■	■	■
	Q06	The garden of my home provides the functions I need in the village.				■	■
	Q07	The spaces in my home provide the level of privacy I need. (entrance*)					■
	Q08	My home offers spaces suitable for my ongoing livelihood activities.				■	■
	Q09	The spaces in my home allow me to maintain social relations and neighborhood relationships in the way I am accustomed to.				■	
	Q10	The materials used in the spaces of my home are functionally suitable.			■		
THERMAL	Q11	My home heats up easily and does not cool down quickly.		■		■	
	Q12	I am satisfied with the heating method in my home.		■		■	
	Q13	The heating costs in my home do not strain my budget.				■	
	Q14	The orientation of my home (sun exposure) supports its heating.				■	
	Q15	My home is designed to suit the climate of the village regarding orientation.		■		■	
ACOUSTIC	Q16	I am satisfied with the soundproofing between the spaces in my home.			■		
	Q17	I am not disturbed by street or outdoor noise in my home.	■				
	Q18	I am disturbed by sounds that occur during use in my home (e.g., plumbing, kitchen, flooring sounds, etc.).	■				
	Q19	I am not disturbed by weather-related sounds (wind/rain) in my home.	■				
VISUAL	Q20	I am satisfied with the view from my home.			■		
	Q21	I do not need artificial lighting during the day in my home.	■				
	Q22	All spaces in my home can be illuminated by daylight.	■				
	Q23	The windows in my home are of adequate size.					
	Q24	I am satisfied with the distance between my home and other houses.			■		■
HEALTH	Q25	I am satisfied with the clean water plumbing system in my home.	■				
	Q26	I am satisfied with the hot water plumbing system in my home.			■		
	Q27	I am satisfied with the wastewater plumbing system in my home.			■		
	Q28	All spaces in my home receive fresh air.			■		
	Q29	I do not have any issues with mold in my home.	■				
SAFETY AND SECURITY	Q30	The materials and systems used in my home are suitable in terms of fire safety.	■				
	Q31	The materials and systems used in my home are healthy and safe.			■		
	Q32	I feel safe from unwanted foreigners in my home.			■		
	Q33	The structural elements in my home are designed according to safety standards (e.g., stairs/guardrail heights, etc.).			■		
	Q34	I do not need frequent maintenance or repairs in my home.			■		
GENERAL SATISFACTION	Q35	My old house met my needs better.	■	■	■	■	■
	Q36	My new house is more suitable for my needs.	■	■	■	■	■

3. Findings and Discussion

3.1 Findings

Based on the data obtained from the survey, a general overview has been established regarding which features of the housing units generally create higher satisfaction and which features require improvement (Table 4).

Table 4 presents the satisfaction levels of all participants, regardless of gender and household size, regarding the spatial, thermal, acoustic, visual, health, and safety-security requirements of Günyurdu residential complexes. The data collected using the Likert-type scale are presented along with mean and standard deviation (SD) values.

Table 4. General evaluation of the occupant's satisfaction (Created by Authors)

Occupant's Requirement	Question	Mean	Number	Qtd. Deviation	Qtd. Error Mean
SPATIAL REQUIREMENTS	Q01	3.96	76	0.84625	0.12615
	Q02	3.71	76	0.94112	0.16903
	Q03	4.09	76	0.76871	0.11459
	Q04	4.00	76	0.94193	0.16918
	Q05	3.18	76	0.99344	0.16021
	Q06	2.97	76	0.89202	0.12615
	Q07	2.57	76	0.84625	0.16903
	Q08	2.38	76	0.94112	0.11459
	Q09	2.62	76	0.76871	0.16918
	Q10	1.84	76	0.94193	0.14241
THERMAL REQUIREMENTS	Q11	2.30	76	0.95533	0.14651
	Q12	2.20	76	0.81576	0.13388
	Q13	2.12	76	0.89808	0.17439
	Q14	1.97	76	0.97098	0.12526
	Q15	1.97	76	0.84029	0.13691
ACOUSTIC REQUIREMENTS	Q16	2.55	76	0.76228	0.11043
	Q17	2.96	76	0.74077	0.16637
	Q18	2.37	76	0.79808	0.14188
	Q19	2.51	76	0.84625	0.15439
VISUAL REQUIREMENTS	Q20	3.71	76	0.92632	0.12326
	Q21	3.38	76	0.97098	0.11691
	Q22	2.96	76	0.88625	0.12143
	Q23	3.26	76	0.95098	0.15637
	Q24	2.55	76	0.86029	0.16903
HEALTH REQUIREMENTS	Q25	2.13	76	0.84228	0.11459
	Q26	2.03	76	0.74977	0.16918
	Q27	2.18	76	0.78908	0.14241
	Q28	3.05	76	0.84125	0.14651
	Q29	3.12	76	0.92132	0.13388
SAFETY AND SECURITY REQUIREMENTS	Q30	1.64	76	0.93048	0.17439
	Q31	1.86	76	0.88725	0.11459
	Q32	2.64	76	0.82098	0.16918
	Q33	2.39	76	0.86125	0.14241
	Q34	1.58	76	0.74125	0.14651

Participants generally express satisfaction with the size of their housing units, the adequacy of rooms and kitchens. Particularly high satisfaction levels are noted regarding kitchen and bathroom sizes. For

example, considering the means, 85% of participants stated satisfaction with their kitchen size, and 78% with the spaciousness of their rooms. While the overall satisfaction mean for spatial requirements is high due to space sizes, the satisfaction level regarding the suitability of materials for function within this requirement set is quite low, with a general mean of 1.84.

General satisfaction is also high regarding daylight and views in the housing units. 72% of participants stated that their housing units receive sufficient daylight, and 65% expressed satisfaction with the views. This indicates a positive evaluation of the housing units' location and design.

Participants reported dissatisfaction with the heating methods and thermal insulation of their housing units. Issues such as heating expenses straining their budgets and insufficient solar gain are particularly prominent. For example, 60% of participants stated that heating expenses strain their budgets, and 45% expressed that their housing units are not warm enough. These responses point to substantial deficiencies in the energy efficiency and thermal comfort of the dwellings. The findings underscore the need for targeted improvements in insulation and heating infrastructure to enhance both comfort and affordability, particularly in climates where seasonal heating demands are significant.

While not as prominent as thermal issues, participants also reported discomfort related to acoustic conditions in their housing units. In this context, participants stated the highest discomfort from sounds generated during use in the housing units. This indicates that the housing units' sound insulation is inadequate and fails to provide a quiet living environment.

Participants expressed concerns regarding fire safety, structural safety, and security against intruders in their housing units. Particularly, the satisfaction level regarding the fire safety of the materials used is the lowest, with a mean of 1.64. This suggests that the compliance of the housing units with safety standards needs to be questioned.

Participants' satisfaction levels are also low regarding the housing units' ability to facilitate social interactions and provide suitable spaces for ongoing livelihood activities, with general mean values of 2.62 and 2.38, respectively. These results point to a potential mismatch between housing design and the social and economic practices of residents, particularly in rural contexts. Greater attention to the integration of lifestyle and functional needs into housing design appears necessary.

Participants also expressed dissatisfaction in areas such as water plumbing systems, clean air conditions, and mold. This suggests that necessary improvements need to be made to ensure the housing units can be used in healthy and hygienic conditions.

As shown in Table 4, the survey results reveal a wide variation in participants' satisfaction levels across different dimensions of their housing units. Particularly, satisfaction is lowest in areas such as maintenance and repair needs, fire safety, and the functionality of the materials used. However, participants reported the highest satisfaction with features such as kitchen size, overall size, and view orientation of their housing units. These findings suggest that expectations regarding the physical features of the housing units are generally met, but significant issues exist regarding the long-term usability and safety of the housing units.

After the general table, which was created with the answers given by all participants, regardless of gender and household size, to measure satisfaction levels regarding the housing units, subgroup analyses were conducted based on demographic variables such as gender and household size to examine participants' satisfaction levels regarding different requirements in more detail. These analyses aimed to better understand the expectations and needs of different groups regarding their housing units. Particularly, differences in satisfaction levels of women and men and single-person, two-person, and three-or-more-person households regarding different features of their housing units were examined to develop more detailed approaches for post-occupancy housing evaluation and, consequently, future housing design and policies (Table 5).

Table 5 summarizes the mean values of different spatial, thermal, acoustic, visual, health, and safety requirements according to gender and household size. It includes analyses based on variables obtained from survey data, presents the mean scores of various requirements according to different household

sizes (single, two-person, three or more persons) and gender. Requirements are categorized under six headings: spatial, thermal, acoustic, visual, health, and safety-security.

Table 5. Occupant's requirement group analyses based on different variables (Created by Authors)

Occ. Req. Set	Household Size	Mean	Pearson Correlt.	No	F	Sig.	t	Std. Deviat.	Std. Error Mean
1. SPATIAL REQUIREMENTS									
Women	Single-Person	3.35	0.911**	8	0.491	0.486	-1.075	0.84625	0.12615
	Two-Person	3.10	0.972**	21	0.491	0.486	-1.075		
	Three or More Person	2.82	0.873**	16	0.491	0.486	-1.075		
Men	Single-Person	3.90	0.796**	1	0.491	0.486	-1.054	0.94112	0.16903
	Two-Person	3.68	0.897**	18	0.491	0.486	-1.054		
	Three or More Person	2.59	0.746**	12	0.491	0.486	-1.054		
2. THERMAL REQUIREMENTS									
Women	Single-Person	1.98	0.868**	8	2.414	0.125	-0.765	0.76871	0.11459
	Two-Person	2.24	0.911**	21	2.414	0.125	-0.765		
	Three or More Person	1.86	0.768**	16	2.414	0.125	-0.765		
Men	Single-Person	2.40	0.799**	1	2.414	0.125	-0.737	0.94193	0.16918
	Two-Person	2.18	0.868**	18	2.414	0.125	-0.737		
	Three or More Person	2.20	0.941**	12	2.414	0.125	-0.737		
3. ACOUSTIC REQUIREMENTS									
Women	Single-Person	3.53	0.789**	8	0.444	0.507	1.133	0.99344	0.14809
	Two-Person	2.88	0.822**	21	0.444	0.507	1.133		
	Three or More Person	2.08	0.746**	16	0.444	0.507	1.133		
Men	Single-Person	3.25	0.796**	1	0.444	0.507	1.156	0.89202	0.16021
	Two-Person	2.33	0.892**	18	0.444	0.507	1.156		
	Three or More Person	2.52	0.993**	12	0.444	0.507	1.156		
4. VISUAL REQUIREMENTS									
Women	Single-Person	3.33	0.973**	8	1.441	234	0.295	0.95533	0.14241
	Two-Person	3.11	0.872**	21	1.441	234	0.295		
	Three or More Person	3.06	0.905**	16	1.441	234	0.295		
Men	Single-Person	3.60	0.943**	1	1.441	234	0.304	0.81576	0.14651
	Two-Person	3.42	0.993**	18	1.441	234	0.304		
	Three or More Person	2.92	0.775**	12	1.441	234	0.304		
5.HEALTH REQUIREMENTS									
Women	Single-Person	2.60	0.955**	8	0.020	0.887	-1.088	0.89808	0.13388
	Two-Person	2.57	0.980**	21	0.020	0.887	-1.088		
	Three or More Person	2.26	0.898**	16	0.020	0.887	-1.088		
Men	Single-Person	2.20	0.765**	1	0.020	0.887	-1.072	0.97098	0.17439
	Two-Person	2.57	0.980**	18	0.020	0.887	-1.072		
	Three or More Person	2.57	0.980**	12	0.020	0.887	-1.072		
6. SAFETY AND SECURITY REQUIREMENTS									
Women	Single-Person	2.28	0.762**	8	0.799	0.374	-0.272	0.84029	0.12526
	Two-Person	2.06	0.947**	21	0.799	0.374	-0.272		
	Three or More Person	1.79	0.722**	16	0.799	0.374	-0.272		
Men	Single-Person	2.00	0.892**	1	0.799	0.374	-0.277	0.76228	0.13691
	Two-Person	2.09	0.957**	18	0.799	0.374	-0.277		
	Three or More Person	2.02	0.897**	12	0.799	0.374	-0.277		

The mean value in the table indicates the average satisfaction level for each group. SD (Standard Deviation) is a measure of how much the data are spread from the mean. N indicates the number of observations in each group, while the F statistic is a value obtained from the analysis of variance (ANOVA) and is used to test whether the variances between different groups are equal. Sig. (p-value)

expresses the significance level corresponding to the F statistic. It is usually compared with a threshold value such as 0.05 or 0.01. If the p-value is less than this threshold value, it is concluded that there is a significant difference between the groups. The t-value is a value obtained from the independent samples t-test. It is used to test the significance of the difference between the means of two groups. Df (Degrees of freedom) is a value that determines the reliability of statistical tests. The Std. Error Mean value in the last column of the table indicates the standard error of the mean, i.e., how well the sample represents the population.

The mean scores for each requirement indicate how important that requirement is for the households. For example, while visual and spatial requirements have generally high mean scores of 3.13 and 3.20, respectively, safety-security requirements have the lowest mean score with a general mean of 2.02. It is observed that the spatial requirement, which has the highest mean score in single-person households, slightly decreases as the household size increases. This can be explained by the increase in common areas and the decrease in the need for personal space in larger households. Another requirement set where satisfaction measurement varies according to household size is acoustic requirements. Acoustic requirements, which have the highest mean score in single-person households and the lowest mean score in three or more person households, decrease as the household size increases. This can be associated with increased noise pollution and decreased need for personal quietness in larger households.

However, when the table is examined in general, it is seen that the importance of some requirements decreases as the household size increases, while others remain constant. This is an important indicator of whether household size affects the demand for different requirements. For example, thermal requirements, which have quite similar mean scores in all household sizes, have a general mean satisfaction score of 2.11 and are seen as a basic need. The effect of household size on this requirement appears to be limited. Similarly, satisfaction with visual requirements generally has a high mean score in all household sizes. The effect of household size on this requirement also appears to be limited. Health requirements, which have a mean score of 2.50 in all household sizes, are also seen as a basic need, and it can be said that the effect of household size on this requirement is again limited.

The table also focuses on whether there are differences between genders in terms of some requirements and shows that there are some differences. For example, women generally have a higher thermal requirement than men, while men score higher on acoustic requirements. However, when the F statistic and p-value are examined, it is generally seen that p-values are greater than 0.05. This means that there is no significant difference between the satisfaction levels of groups of different genders. In other words, there is no statistically significant difference between the satisfaction levels of women and men living in single, two, or three or more person households regarding different requirements. In this case, it can be stated that the differences in satisfaction levels are more related to the number of people living in the household than to the gender factor (Table 2).

When the general satisfaction levels of participants regarding their housing units are examined, it is seen that there are significant differences between genders. For the statement "S36: My new home is more suitable for my needs," male participants (mean: 3.03) generally indicated a higher satisfaction level with their housing units compared to female participants (mean: 2.00). However, when the means of the answers given to all questions are examined, this difference is less pronounced. The general satisfaction level is approximately the same for both women (mean: 2.63) and men (mean: 2.72). This suggests that the satisfaction difference between genders may stem from different expectations regarding specific features rather than the general evaluation of the housing unit.

Particularly, the responses to the question "Q35: My old home met my needs better" provide an explanation for this situation. Both female (mean: 4.17) and male (mean: 4.00) participants stated that their old homes met their needs better than their current housing units. This finding indicates that participants have some dissatisfaction with their current housing units and make evaluations by comparing them with their past homes (Figure 4).

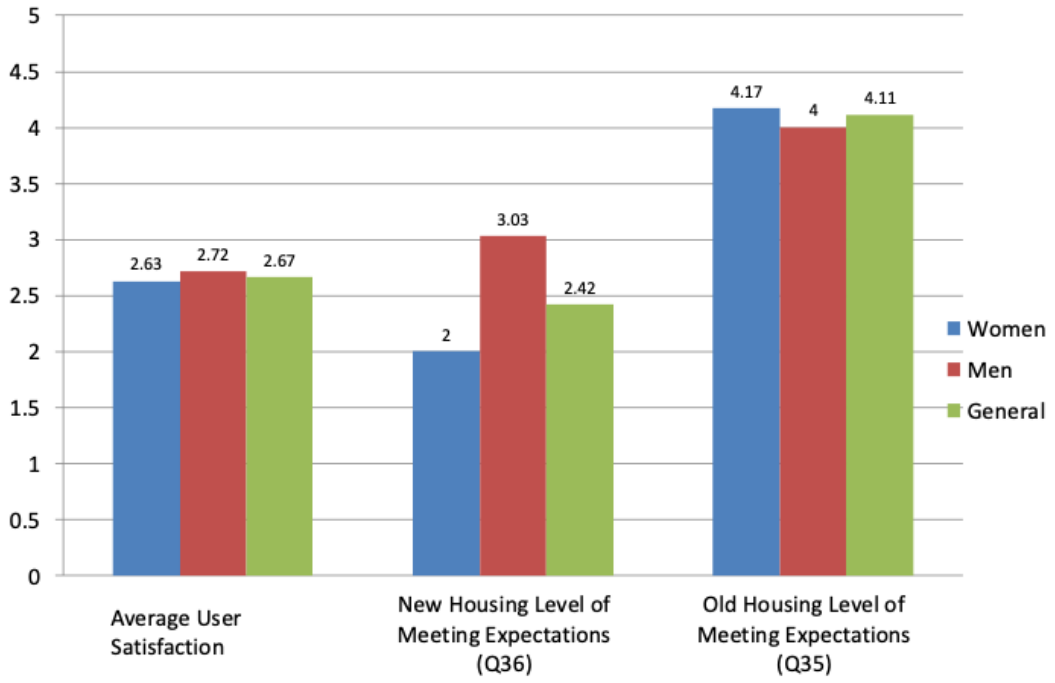

Figure 4. Comparison of expectation fulfillment levels in old and new housing units (Created by Authors)

3.2. Discussion

This study employed a POE approach, a relatively newer research method for rural areas, to assess the satisfaction levels of residents living in 2006 built mass housing in Günyurdu Village. The findings indicate that overall user satisfaction remains below expectations, with significant variations across different aspects of housing quality.

As a result of the literature review, the user requirements were classified under six main headings as spatial, thermal, auditory, visual, sanitary, and safety-security needs. While spatial dimensions such as room and kitchen size received relatively favorable evaluations, critical issues were reported in thermal comfort, acoustic conditions, health-related infrastructure, and safety. These results support previous research suggesting that housing interventions in rural areas often fail to fully align with local needs and living practices (Satsangi et.al., 2010). Moreover, the observation by the authors that some residents expressed reluctance to move into the new housing reinforces the importance of participatory design and context-sensitive housing strategies in rural areas.

Regarding spatial requirements, satisfaction decreases as the number of people living in the household increases, both for female and male residents. Spatial needs influence the performance of all other building performance criteria explored in this study, thus affecting satisfaction in this area. The results show that participants' expectations regarding their personal living space and the fulfillment of their daily needs are largely met by the new homes. However, the authors observed that some village residents had to change their livelihoods due to the new housing or attempted to make modifications to the housing to adapt their living conditions.

Thermal requirements were found to be the least satisfactorily met compared to all other needs. Particularly, women living in households with three or more people are generally dissatisfied with the thermal performance of the homes. This finding aligns with existing literature indicating that larger household sizes can negatively impact thermal comfort due to increased occupancy and associated internal heat gains. For instance, a study by Santin et al. (2009) found that the number of people in a household significantly influences energy consumption patterns, which in turn affects thermal comfort levels. Similarly, research by Wei et al. (2022) highlighted that in rural dwellings, higher occupancy rates can lead to elevated indoor temperatures, exacerbating discomfort during warmer periods.

Auditory needs are met in the housing, with single-person households reporting a satisfactory level for both women and men. However, particularly women in households with three or more people express significant dissatisfaction. This aligns with the research by Bonet-Solà et al. (2023) highlighted that in rural areas, factors such as building materials and construction techniques significantly influence acoustic comfort, leading to diverse occupant experiences.

Visual requirements including adequate natural lighting and visual connection with the surroundings emerged as one of the more positively evaluated aspects of the dwellings, with satisfaction levels above average. However, within this category, residents expressed the lowest satisfaction with the spacing between neighboring units, indicating concerns related to privacy and visual openness.

Health-related requirements—associated with the technical and functional performance of the dwellings—were assessed through indicators such as building materials, indoor air quality, and utility systems. The results indicate that satisfaction with these aspects falls below average for both female and male residents, highlighting deficiencies in ensuring healthy and hygienic living conditions.

Safety and security requirements were evaluated based on satisfaction with the technical and functional performance of the housing. The study focused on material use for technical performance and other aspects for functional performance. Participants expressed notable concerns about fire safety, structural integrity, and protection against intrusions. Particularly fire safety received the lowest satisfaction rating among all categories.

4. Conclusion and Suggestions

This study, which aims to evaluate the level of meeting user requirements in terms of building performance criteria of rural mass housing projects, has carried out a case study for Günyurdu Village in Pazaryeri district of Bilecik province. In 2006, the construction of the Günyurdu Dam for irrigation purposes led to the relocation of all village housing and the development of a mass housing project. The study targets to measure the satisfaction of the village residents with the new housing and address the need for solutions that support sustainable rural living in similar projects.

The findings of the study highlight the necessity of enhancing the quality of life for rural populations, providing continuity of livelihood activities and fostering sustainable development through a pragmatic approach. When developing new mass housing projects in rural areas, moving away from the standardized project approach and adopting a design perspective that considers local values and the needs of rural life can contribute to sustainable development.

This study demonstrates, through a comprehensive literature review, the relationship between different user requirements and specific building performance criteria. For instance, the level at which spatial occupant's requirements are met determines the functional, economic, and behavioral performance of a housing unit, while the fulfillment of thermal requirements shapes the technical, environmental, and economic performance. In designing rural mass housing projects, it is essential to adopt this approach and thoroughly understand user requirements. This will ensure that the building performance of the housing designed to meet these needs is at the desired level, enabling the development of sustainable mass housing projects.

The key practical implications of this study are as follows:

- Field studies based on POE can serve as a feedback mechanism for future planning of rural mass housing projects.
- The importance of incorporating user requirements into sustainable architectural design in rural mass housing, which can ensure technical, functional, environmental, and behavioral sustainability.
- New mass housing projects to be developed in rural areas should consider the socio-economic, functional, technical, and safety-security needs of the rural residents, and architectural solutions should be designed and constructed in line with sustainable development goals. This can provide a resource for relevant governmental institutions and the architecture and construction sectors.

- The study can serve as a guide for institutions and organizations in producing sustainable mass housing projects in rural areas by addressing the need for solutions related to sustainable rural living in similar future projects.

The findings of this study could shed light on the government's efforts to develop appropriate policies and support mechanisms for sustainable housing production in rural areas that align with local identity.

On the other hand, this study has some limitations. Firstly, the sample size is limited to individuals continuously residing in the village. Secondly, the survey questions were not designed to cover all aspects of building performance. Particularly, technical aspects such as structural safety, disaster resistance, and energy efficiency were excluded, as they cannot be measured based on users' subjective evaluations.

As a future direction, there is a need to increase the number of studies employing POE to evaluate occupant satisfaction levels to identify areas with potential for further development in the architectural design and production of rural housing projects that will meet the needs of occupants suitable for rural life considering the sustainable development. Additionally, evaluating the effect of time could be a topic for future studies, and the changing approaches of village residents over time could be examined such as analyzing spatial modifications in time and observations in future studies.

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The article complies with national and international research and publication ethics.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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