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Design, Habits and Perceived Thermal Comfort: A Post-Occupancy Evaluation of the Cerco do Porto Public Housing Estate

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Abstract

This study explores the associations between architectural design solutions, residents' satisfaction, daily habits, and perceived thermal comfort through a post-occupancy evaluation conducted in the Cerco do Porto public housing estate. Built in 1963 in the city of Porto and recently renovated through interventions promoted by the municipal company Domus Social E.M., the neighbourhood offers a suitable setting for examining how different rehabilitation strategies are experienced by residents in ageing housing stock. The research is based on a satisfaction survey conducted among residents in 2024, following renovation works carried out by two distinct design teams according to building typology (gallery and vertical access). This methodological structure enables a comparative assessment of differences in daily practices and perceived comfort across two rehabilitation approaches. These findings suggest that different rehabilitation approaches may be reflected in distinct post-occupancy outcomes and residents' reported perceptions, particularly in contexts where comfort performance is closely tied to building form, envelope interventions, and spatial configuration. This is particularly relevant in contexts of socioeconomic vulnerability. The study contributes to ongoing research on social housing rehabilitation by demonstrating how post-occupancy evaluation can support more socially and environmentally sustainable housing rehabilitation strategies, complementing technical performance assessments with residents' experiences, housing practices, and perceptions of comfort.

Keywords: post-occupancy evaluation; sustainable housing rehabilitation; occupant behaviour; perceived thermal comfort; perceived indoor environmental quality; residents' satisfaction

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1. Introduction

The Cerco do Porto is one of the most representative housing complexes developed under the *Plano de Melhoramentos para a cidade do Porto* [Improvement Plan for the city of Porto] [1]. Building on the directives of the earlier *Plano de Salubrização das Ilhas do Porto* [Sanitisation Plan] [2], prepared by the municipality from the late 1930s onwards, the Improvement Plan envisioned the construction of 6000 dwellings over a ten-year period beginning in 1957. By the end of this timeframe, a total of 6072 homes had been built across Porto, mostly in peripheral urban areas [3].

Located in the eastern part of the city, in the parish of Campanhã, the original 1963 Cerco do Porto development comprises 32 buildings and 804 dwellings designed by Vasco Mendes and Reimão Pinto. This ensemble forms the focus of this study. In 1991, the

estate was expanded with two additional blocks comprising 88 dwellings, designed by José Resende and Rui Paixão [4].

More recently, the local company CMPH—Domus Social—Empresa de Habitação e Manutenção do Município do Porto, E.M. [Housing and Maintenance Company of the Municipality of Porto] has promoted the requalification of both housing developments, focusing on improvements to the building envelopes, shared circulation areas, and the surrounding public space. Buildings organised around multiple vertical access cores followed a proposal by architect Virgínio Moutinho, while those organised around distribution galleries were refurbished according to a proposal by architect José Gigante. Architect José Manuel Soares was responsible for the redesign of the surrounding public space.

Building rehabilitation has become an important strategy for improving energy performance and indoor environmental conditions, as reflected in the European Green Deal and the Renovation Wave initiative [5,6]. The Energy Performance of Buildings Directive (EPBD), in turn, establishes a common framework across European Union Member States, including Portugal [7]. At the national level, some financial programmes, namely the Vale Eficiência [Efficiency Voucher] [8], have also been implemented to support improvements in the energy efficiency of the existing building stock. These objectives acquire particular relevance in contexts of socioeconomic vulnerability, where limited economic resources may restrict residents' ability to actively heat or cool their dwellings, increasing their exposure to energy poverty [9]. However, improvements in building performance do not necessarily translate directly into improved comfort for inhabitants [10]. Thermal comfort depends not only on the physical characteristics of buildings but also on occupant factors, such as clothing, activity levels, and adaptive responses to environmental conditions [11]. In addition, habits, everyday practices and adaptive behaviours can also influence indoor environmental conditions and shape residents' perceptions of comfort [12–15]. These include ventilation routines, heating and cooling behaviours, and the use of different spaces within the dwelling. Architectural design plays an important role in this relationship, as building form, spatial organisation, orientation, envelope characteristics, and ventilation opportunities may affect both environmental performance and the ways in which residents interact with their homes. Understanding these interactions is therefore essential to assessing the outcomes of rehabilitation interventions and residents' post-occupancy experiences.

Rehabilitation strategies, particularly under budget constraints, commonly focus on the building envelope through measures such as the installation of thermal insulation, the replacement of windows, or interventions to façade and roof systems. Depending on the architectural design approach, these measures may involve different degrees of transformation of the existing building and lead to different post-occupancy experiences and patterns of use [16]. While such interventions are frequently analysed in terms of energy efficiency and physical performance, their effectiveness should also be assessed through the experiences and perceptions of residents. Understanding how rehabilitation strategies relate to inhabitants' needs and everyday living conditions is therefore an integral dimension of building performance analysis.

In this context, post-occupancy evaluation (POE) provides a framework for assessing buildings in use and understanding how the built environment is experienced by occupants. Contemporary approaches increasingly emphasise the integration of technical performance indicators with residents' perceptions, behaviours and lived experiences [17–20]. This approach enables the results of rehabilitation interventions to be analysed from the perspective of inhabitants, complementing building performance evaluation with information on satisfaction, comfort, and patterns of use. As such, POE offers an important opportunity to examine how housing environments are experienced, adapted, and appropriated by residents over time. Previous studies have applied POE methodologies to examine the

impacts of housing design and rehabilitation on occupants' satisfaction and thermal comfort [21,22]. However, fewer studies have focused on examining how different architectural solutions and intervention strategies are reflected in post-occupancy outcomes in terms of residents' perceptions, especially within the same housing complex. Such comparisons can contribute to a better understanding of how the physical characteristics of the residential environment relate to housing practices, residents' satisfaction and perceived thermal comfort [23,24]. This gap warrants particular attention in social housing, where design decisions may be associated with important differences in everyday living conditions and residential well-being.

The Cerco do Porto neighbourhood provides a suitable case study for examining this topic. It brings together two distinct architectural approaches carried out within the same timeframe and with common objectives of improving energy efficiency and thermal comfort. The rehabilitation programme involved different building typologies, spatial configurations and intervention strategies, providing an opportunity to compare residents' post-occupancy experiences across contrasting rehabilitation contexts within the same neighbourhood. Moreover, the time elapsed since project completion allows for a post-occupancy analysis based on inhabitants' perceptions and everyday experiences.

This study is part of broader research conducted at FAUP/CENP on housing rehabilitation strategies aimed at improving energy efficiency and thermal comfort, while considering the specificities of local and social contexts. It presents a post-occupancy evaluation of two rehabilitation approaches implemented in the Cerco do Porto public housing estate. More specifically, the study addresses three interrelated questions: (1) How do residents evaluate their residential satisfaction, housing practices, and perceived thermal comfort following rehabilitation? (2) To what extent do these perceptions and practices differ between the two rehabilitation approaches? (3) What insights do these differences provide for the evaluation of rehabilitation strategies in social housing contexts? Rather than assessing measured environmental performance, the study focuses on residents' perceptions and experiences, exploring associations between rehabilitation approaches, housing practices, satisfaction, and perceived thermal comfort. Through a comparative analysis of the two interventions, the research seeks to contribute to ongoing discussions on social housing rehabilitation and user-centred evaluation by identifying patterns emerging from residents' reported experiences and post-occupancy outcomes.

2. Materials and Methods

This study adopts a case study approach centred on the Cerco do Porto neighbourhood, one of the largest housing ensembles built under Porto's Improvement Plan and a representative example of the municipality's recent housing rehabilitation strategies. The research combines an architectural and historical analysis of the neighbourhood and its successive intervention phases with empirical evidence collected through a questionnaire survey conducted among residents following completion of the works.

The methodological framework was designed to examine residents' experiences and perceptions associated with two rehabilitation approaches, focusing on reported satisfaction, perceived thermal comfort, persistent building-related problems and patterns of housing use following the interventions. Given the post-occupancy and perception-based nature of the study, the analysis seeks to identify patterns and associations emerging from residents' accounts rather than establish causal relationships between specific design features and reported outcomes.

Accordingly, the following sections present the case study and its rehabilitation context, the design of the questionnaire survey, the data collection procedures, the methods

adopted for data processing and analysis, and the ethical procedures followed throughout the research.

2.1. Case Study

The study focuses on the original set of 32 buildings constructed at Cerco do Porto in 1963, bounded by Rua Nova de Foz Côa to the north, Rua do Peso da Régua to the west and Rua do Cerco do Porto to the south and east. Following a site plan strategy involving minimal earthworks, the layout of the buildings is independent of the surrounding roads (Figure 1). Generous green areas with footpaths and secondary access points, occasionally connecting to the existing road network, reinforce the relative spatial separation of the ensemble from the surrounding urban fabric. This is a common feature of the Improvement Plan neighbourhoods.



Figure 1. Cerco do Porto neighbourhood under construction, 1966. Source: Reproduced with permission from: Câmara Municipal do Porto [Porto Municipal Council] (CMP. AH. Id. 614685).

This phase follows the dwelling types and distribution schemes of the compact four-storey building typology adopted for the Improvement Plan, as documented in a commemorative catalogue dating back to 1966 [3]. In accordance with principles of rationalisation, rent affordability and the projected number of dwellings to be constructed within the defined timeframe "justified the reduced areas and restraint in construction costs" [25]. Previous research has shown that the original Improvement Plan dwellings were characterised by reduced floor areas and did not comply with the minimum area requirements established by the 1951 Regulamento Geral das Edificações Urbanas–RGEU [General Regulation of Urban Construction] [26], a condition that continues to be relevant when assessing housing quality and residents' perceptions of adequacy [25,27].

In terms of spatial organisation, the Cerco do Porto dwellings follow the standard floor plans, in which the centrally located living room connects the various rooms and also serves as a circulation area. In buildings with gallery access, the living room features a kitchenette and opens directly onto the gallery, while the sanitary installation faces the opposite exterior through a drying room. In buildings with vertical access, the kitchen

offers greater autonomy, the sanitary installation opens directly to the exterior, and the living room includes a balcony [4].

The construction of Cerco do Porto is also closely comparable to that of the other housing ensembles built during the ten-year period, as local tradition-bound construction principles were adopted to meet "rigorous economic conditions to achieve the controlled rent aim" [1] (p. 632). As a result, the buildings were conceived according to a hybrid structural system consisting of a perimeter wall of granite masonry supported by a continuous foundation, combined with interior concrete pillars resting on isolated foundations. The floor slabs were of lightweight reinforced concrete, as were the galleries and the floors of the semi-exterior staircases. The roofs were supported by a timber structure and occasional masonry walls and covered with ceramic tiles (with no underlayment). The most common floor finishes were timber boards laid on battens and cement screed. The simple perimeter walls of granite masonry, above the unclad base, were plastered and painted.

The housing ensembles built under the Improvement Plan [1] and its subsequent five-year extension [28] for social rental housing remain municipal property and continue to be maintained and managed by the municipality to serve the most disadvantaged populations. However, until the 1990s, there were "no conservation and maintenance programmes for the buildings, either in terms of quality or quantity" [29] (p. 18), leading to substantial deterioration of the municipal housing stock. The first interventions in the neighbourhoods of the Improvement Plan occurred in the late 1990s, during the period of the Programa Especial de Realojamento—PER [Special Rehousing Plan] (Decree-Law 163/93) [30]. Since the 2000s, alongside the creation of the local company Domus Social E.M., the municipality has gradually implemented a systematic intervention to requalify these housing ensembles. This process has been supported through the Programa de Financiamento para Acesso à Habitação—PROHABITA [Funding Programme for Access to Housing] (Decree-Law 135/2004) [31] and the subsequent and ongoing programme Reabilitar para Arrendar [Rehabilitate to Rent] [32], following the organic law of the Instituto da Habitação e da Reabilitação Urbana—IHRU [Institute for Housing and Urban Rehabilitation] (Decree-Law 175/2012) [33]. The evolution of these intervention strategies was analysed in previous research by Rocha, Póvoas and Restivo [16].

The first municipal intervention in the Cerco do Porto neighbourhood took place in the late 1990s, addressing the main problems arising from the deterioration of both the housing blocks and the surrounding urban environment. Led by architect Virgínio Moutinho and supported by the European URBAN initiative, in collaboration with the Fundação para o Desenvolvimento do Vale de Campanhã [Foundation for the Development of the Campanhã Valley], the project focused on the rehabilitation of public spaces. This included improvements to the road and pedestrian networks, parking facilities, squares, garden areas, and street furniture, as well as the creation of new collective facilities such as sports areas, playgrounds, leisure spaces, and premises for local businesses [4].

Shortly thereafter, the existing buildings dating from 1963 underwent partial rehabilitation, targeting the building envelope and common circulation areas. This phase included the enclosure of the original entrances to enable access control, the enclosure of drying rooms (laundry areas), and the optimisation of enclosed balcony solutions, while preserving the open galleries. Additional interventions, such as repainting, the replacement of window frames, the application of tiles in the drying areas and roof repairs, contributed to a distinctive use of brighter colours across the buildings. This was further reinforced by the installation of decorative ceramic panels on the side elevations, produced by resident children as part of the Community Tiles Project in collaboration with the artist Elvira Leite [34].

Almost two decades later, by then under the management of the municipal company Domus Social E.M. (established in 2000), the neighbourhood was once again showing evident signs of deterioration in both the buildings and the surrounding public spaces. A new phase brought together several proposals for a comprehensive intervention in the Cerco do Porto, with greater emphasis on reducing energy consumption and improving overall housing quality. Considering the scale of the neighbourhood, with 892 dwellings distributed among 32 buildings dating from 1963 and two additional buildings completed in 1991, the municipal company divided the commission into three projects: buildings with a vertical access core were assigned to architect Virgínio Moutinho (Figure 2); gallery access blocks were addressed by architect José Gigante (Figure 3); and architect José Manuel Soares was responsible for the proposal for the public space. The initial strategy also envisaged the demolition of eight of the original housing blocks. However, when the municipality decided instead to preserve and rehabilitate these eight blocks, the proposal for the public space was discontinued and subsequently reformulated (yet to be implemented), as its design assumptions were no longer compatible with the revised intervention framework. The retained blocks were then incorporated into the rehabilitation programme, following the design principles developed by the teams responsible for the residential buildings. The resulting interventions differed in architectural solutions as well as in construction approaches and implementation periods, providing a relevant basis for comparative post-occupancy analysis. Although these differences do not enable the isolation of individual design variables, they offer an opportunity to examine how residents perceive and experience distinct rehabilitation approaches within the same housing estate context.



Figure 2. Cerco do Porto neighbourhood in a transitional state, showing the simultaneous presence of buildings resulting from the late 1990s intervention and more recently improved buildings, both by architect Virgínio Moutinho. Source: Photograph by J. Restivo, 2019.

The project developed for buildings with multiple vertical access cores, led by architect Virgínio Moutinho and implemented in 2019, followed the rehabilitation model progressively developed for granite-walled housing estates. It combined energy-performance improvements with measures aimed at enhancing durability, access control and indoor environmental conditions. It applied an ETICS system, consisting of a thin synthetic render over expanded polystyrene insulation, across the façades while preserving the granite plinth (and covering the decorative ceramic panels by the artist Elvira Leite installed during the late 1990s refurbishment); replaced exterior windows (new aluminium, double-glazed frames together with new thermal shutter boxes and a built-in ventilation system); enclosed balconies and drying rooms (double-glazed with ventilation grilles), and common staircases (double-glazed aluminium frames and a tubular structure with an aluminium louvre at the top for ventilation), and entrance areas to improve access control and weather

protection; and comprehensively reconfigured the roof with a new galvanised steel sheet finish, polyurethane insulation, and a new supporting structure, as well as applying thermal insulation to the uppermost slab. The project also added tubular metal structures to create outdoor clothesline areas, a functional feature that became distinctive in these municipal interventions [16,35]. However, unlike several contemporary interventions developed under the same programme, no solar panels were incorporated into the roofing solution. The intervention sought to improve energy performance and indoor environmental conditions through multiple complementary measures applied to the building envelope and common areas.



Figure 3. Cerco do Porto neighbourhood following rehabilitation, illustrating the two projects developed by Virgínio Moutinho and José Gigante. Source: Photograph by M. Ghilardi, 2026.

Detailed technical descriptions of both rehabilitation strategies and their architectural and energy-related implications have been presented elsewhere [16]. While previous studies focused primarily on the constructive, architectural and energy-performance dimensions of these interventions, the present study adopts a post-occupancy evaluation perspective, examining how rehabilitated dwellings are experienced by residents in terms of satisfaction, housing practices, and perceived thermal comfort.

The proposal for buildings with a gallery access system, developed by architect José Gigante and executed in 2021–2022, adopted a distinctive approach to the comprehensive intervention on the exterior envelope and common access areas. The works combined the application of external thermal insulation with the construction of a new ceramic brick masonry panel wall. They also formalised ground-floor extensions previously introduced by residents and improved access control through the enclosure of entrances, while preserving the open galleries on the upper floors by means of a new roofing system incorporating a metal structure, a bituminous membrane and fixed glass closures. Additional measures included the installation of aluminium window frames with double glazing and thermal breaks, aluminium blinds and a ventilation system, the enclosure of drying rooms, and the introduction of support structures for clothes racks. Roof interventions comprised the replacement of ceramic tiles, including ventilation tiles, the application of thermal insulation to the uppermost slab and the renewal of external elements such as downpipes. Overall, the project prioritised material durability and minimised future maintenance requirements. Although the introduction of a double wall system altered the architectural language of the buildings, the intervention was intended to enhance the thermal performance of the dwellings and improve overall housing conditions through a comprehensive upgrading of the building envelope.

At the time of the survey, the two rehabilitation approaches had therefore been in use for different periods, an aspect considered in the interpretation of the post-occupancy findings presented in the following sections.

The main constructive solutions adopted in both rehabilitation approaches are summarised in the sectional drawings presented in Figure 4.

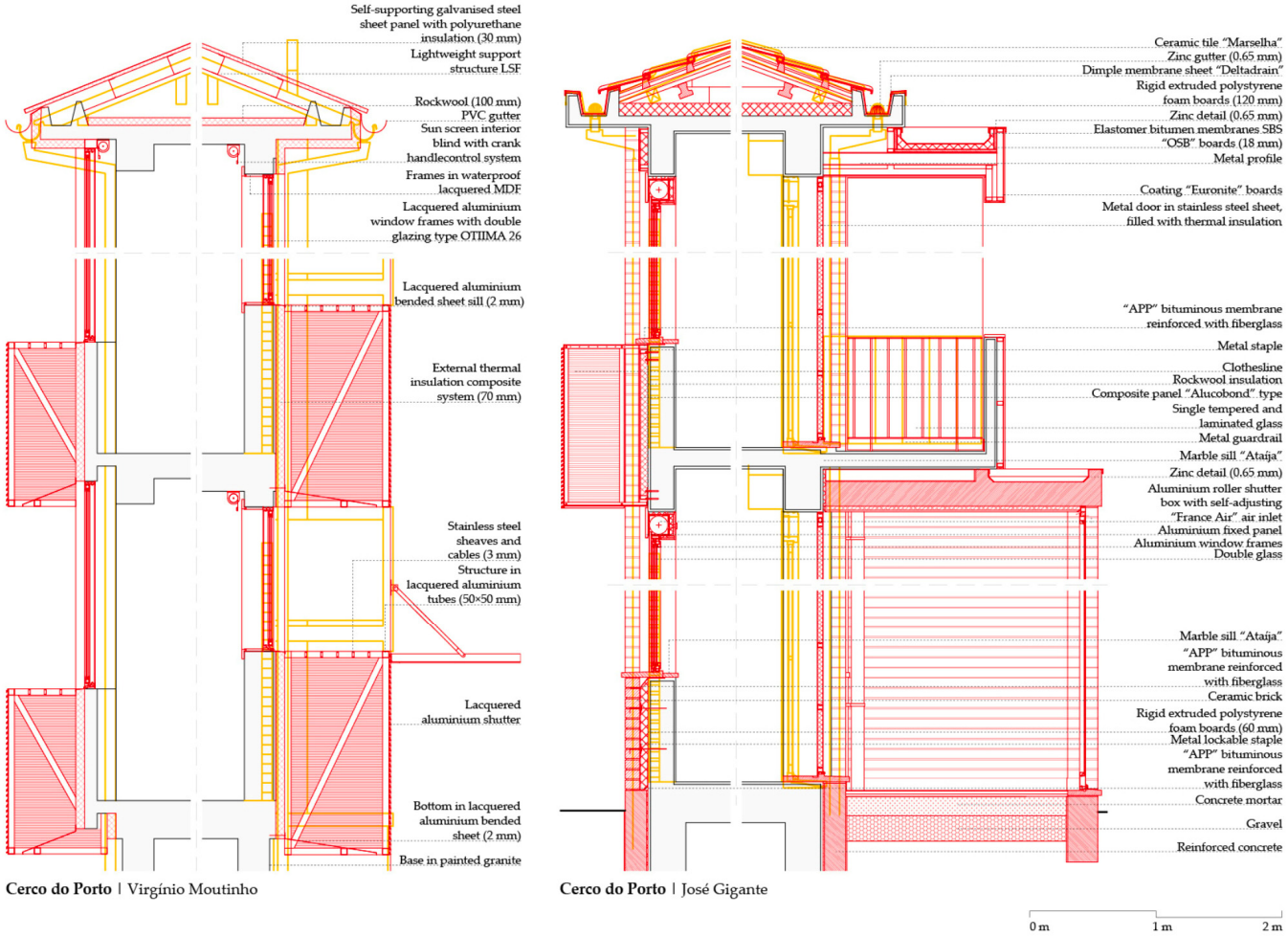


Figure 4. Construction details of interventions in the Cerco do Porto neighbourhood by Virgínio Moutinho (**left**) and by José Gigante (**right**). Additions in red and demolitions in yellow. Source: Adapted from Rocha et al. (2023) [16].

Concurrently with the implementation of subsequent major interventions to the building envelope, the municipal company, following a long-standing established internal practice, carried out refurbishment works in vacant dwellings during tenant turnover. These works were intended to restore and improve housing conditions while preserving the original dwelling typologies and internal layouts.

2.2. Research Design

The development of the questionnaire—Residents' Satisfaction Survey on Cerco do Porto Rehabilitation (RSS-CPR)—drew on prior participation in a study aimed at characterising and diagnosing a neighbourhood built immediately before the Improvement Plan, with a view to the preliminary identification and quantification of ex-ante intervention scenarios [36]. It was also informed by a subsequent questionnaire developed within the scope of a doctoral research project designed to assess post-occupancy user satisfaction following renovation works in another municipal neighbourhood, where the merging of

dwelling typologies enabled compliance with regulatory floor area standards [27]. In both cases, the *CTT—Pereiró* (1956) and *Rainha D. Leonor* (1953) neighbourhoods, as in the Improvement Plan neighbourhoods themselves, shared a common limitation: constrained interior space. Nevertheless, this study has a distinct focus, aiming to understand residents' post-renovation opinions and habits, assess their overall satisfaction and, in particular, examine their perceptions of thermal comfort.

Following the recommendations of Ghiglione and Matalon [37], and the established principles of questionnaire construction and survey design of Bryman [38] (pp. 246–267), the present questionnaire was designed to capture both quantitative and qualitative ex-post indicators, enabling a comprehensive understanding of the Cerco do Porto inhabitants' perceptions of the intervention measures implemented in the buildings. Priority was given to closed-ended questions, complemented by a limited number of open-ended items. These were introduced to allow for greater diversity in responses while facilitating the aggregation and comparability of results. All questions were pre-formulated, and interviewers were instructed to administer them exactly as written, without adaptation or additional clarification. Particular attention was given to ensuring that the wording of the questions was appropriate for the target population. A preliminary pilot test with a resident was undertaken to assess the clarity, comprehensibility and sequencing of the questions and to support refinements to the wording and questionnaire structure. Given the exploratory nature of the study, no formal psychometric validation procedures were undertaken. Instead, content validity was supported through the adaptation of instruments previously used in studies of municipal housing neighbourhoods in Porto and through expert review by the multidisciplinary research team. Non-response categories were not included among the predefined options for the closed-ended questions. However, interviewers systematically recorded such occurrences whenever respondents indicated that they "did not know", preferred "not to answer", or when a question was not applicable, among other similar situations.

The document was organised into six main sections. The first section introduces the study and collects basic information regarding the duration of residence in the neighbourhood. The second focuses on the evaluation of the rehabilitation work, addressing overall satisfaction and specific aspects of the dwellings, including spatial adequacy, natural lighting, thermal comfort (in summer and winter), acoustic comfort and the security of common areas. The third section identifies persistent building problems, such as moisture, odour, condensation and mould. It also records residents' assessments of the extent to which the interventions have contributed to mitigating these problems. Subsequent sections examine habits and patterns of use, involving ventilation practices, heating and cooling strategies, and changes in usage routines following the interventions. They also address perceptions of the enhancement of the dwellings and quality of life, allowing residents to express both positive and critical assessments of the interventions. The final section gathers sociodemographic information to support the interpretation of the results.

Beyond its thematic structure, the questionnaire also incorporated strategic design choices to support the complexity of the cross-analysis. For example, the identification of the building block and dwelling typologies was systematically included to enable comparative analysis across different spatial configurations. Furthermore, a key evaluative question concerning the perceived enhancement of the dwellings was intentionally placed at the end of the questionnaire to assess potential variations in responses over the course of the survey. This design decision resulted in two related but distinct evaluative measures: an assessment of dwelling conditions following the intervention and a final overall evaluation recorded at the end of the questionnaire.

One limitation encountered during the research process was that the municipal company did not provide the necessary sociodemographic data. Access to information on

dwelling occupancy and household composition would have enabled not only a more accurate assessment of occupancy patterns but also a preliminary categorisation of residents by age group, educational level, and employment status, thereby allowing the development of a shorter questionnaire. Such information would also have made it possible to determine the current occupancy status of the dwellings, which would have been highly relevant to the analysis conducted.

2.3. Data Collection

The data collection process unfolded in two consecutive stages. An initial pilot test was conducted in September 2024 to assess the structure of the questionnaire and the feasibility of its application on site. This preliminary stage informed minor adjustments before the full data collection, carried out between October and December 2024.

The questionnaire was developed by a multidisciplinary team from the Centre for Studies in Architecture and Urbanism (CEAU), recently renamed the Nuno Portas Centre for Studies (CENP), at the Faculty of Architecture of the University of Porto (FAUP) and the Institute of Sociology (IS) of the Faculty of Arts and Humanities of the University of Porto (FLUP). The fieldwork was undertaken by two members of these institutions, ensuring methodological consistency throughout the process.

A total of 100 surveys were collected from the 804 dwellings of the Cerco do Porto neighbourhood (1963), corresponding to approximately 12%. Questionnaires were administered through face-to-face interviews with residents approached on site. Participation was voluntary and interviews were conducted with residents who agreed to take part in the survey. Consequently, the sample should not be interpreted as statistically representative of the entire resident population but rather as providing an indicative picture of residents' perceptions and experiences following rehabilitation.

Moreover, the sample was intentionally balanced across the two building typologies according to their access system: 51 surveys from buildings with gallery access and 49 from buildings with vertical access. This sampling strategy was adopted to facilitate comparison between the two rehabilitation approaches rather than to reproduce the exact distribution of dwellings within the neighbourhood. Of the 32 buildings dating from 1963, 11 were not included in the survey either because intervention works were still ongoing or the buildings were awaiting intervention (8 buildings) or because fieldwork access was not feasible during the survey period (3 buildings). The final sample was therefore drawn from 21 rehabilitated blocks, comprising 9 gallery access buildings and 12 vertical access buildings. This study specifically aims to assess inhabitants' perceptions of housing performance following the implementation of the retrofit measures.

2.4. Data Processing and Analysis

The questionnaire was conducted through face-to-face interviews, with responses recorded directly on paper forms. Following the fieldwork, all responses were manually encoded and transferred to a digital database.

Data processing was carried out using IBM SPSS Statistics (version 28.0.1) software, while data processing and statistical analysis were undertaken by the sociology team. This process included the structuring of variables and the anonymisation of personal identifiers.

The statistical analysis was primarily descriptive and comparative in nature. Frequency distributions were calculated for the main survey variables and cross-tabulations were used to compare responses across the two intervention types. Measures of association, including Cramér's V and Lambda, were used to explore relationships between selected variables. Chi-square tests were performed to assess the statistical significance of observed differences between groups, after verification of expected cell frequencies within contingency tables;

where sparse cell frequencies were present, Fisher's Exact Test was additionally calculated and reported. Significance was considered at $p < 0.05$.

Open-ended answers were reviewed by the sociology team and grouped into recurring themes through an inductive coding process. These themes were subsequently used to support the interpretation of quantitative findings.

2.5. Ethical Considerations

The processing of personal data followed the principles of fairness, transparency, responsibility, and confidentiality, ensuring full compliance with the ethical standards applicable to research involving human subjects. All survey responses were collected anonymously and handled confidentially throughout the research process.

Participants received clear and comprehensive explanations of the research procedures and the voluntary nature of their involvement. They were also informed that they could withdraw at any time without consequence. Written informed consent was obtained and countersigned by a member of the research team.

Particular care was taken to ensure that participation did not interfere with residents' daily routines and that all responses were used for research purposes.

3. Results

This section presents the general results of the survey, organised into three main parts: sociodemographic characterisation, analysis of the main problems and habits, and evaluation of residents' satisfaction.

3.1. Sociodemographic Characterisation

As shown in Tables 1–3, the population surveyed in the Cerco do Porto neighbourhood has clearly defined social characteristics. In terms of duration of residence, respondents have lived in the neighbourhood for a long time, with an average of 32 years. However, the predominantly female resident population is changing, with a quarter having lived in the neighbourhood for ten years or less. In terms of age, the respondents reflect an ageing population: the average age is over 57 years, and those aged 65 or over account for 36% of the surveyed population. On average, households consist of 2.72 individuals, with single-person households accounting for 22%.

Table 1. Data on the social composition of the Cerco do Porto neighbourhood in 2024.

Households that have lived locally for ten years or less (%)	25
Average duration of residence among respondents (years)	32.34
Residents who have always lived in the neighbourhood (%)	41
Resident population surveyed (number of individuals)	100
Female population (%)	79
Average age of surveyed residents (years)	57.51
Surveyed population aged 65 or over (%)	36
Average size of respondents' households	2.72
Respondents living in single-person households (%)	22

Source: Authors, based on RSS-CPR, 2024.

Table 2. Employment status of surveyed residents (%).

Employment Status	(%)
Active	31.0
Unemployed	19.0
Homemaker	5.0
Retired or pensioner	38.0
Unfit for work	7.0
Total	100.0

Source: Authors, based on RSS-CPR, 2024.

Table 3. Social class distribution of surveyed residents (%).

Social Class	(%)
Intellectuals	1.0
Self-employed	6.0
Routine employees	22.0
Industrial workers	7.0
Agricultural workers	1.0
Did not answer	63.0
Total	100.0

Residents were classified by social class based on an adaptation of the framework developed by Almeida, Costa and Machado (1988) for social class analysis [39]. Source: Authors, based on RSS-CPR, 2024.

Regarding economic activity, as shown in Table 2, the largest category among the surveyed population is retired people or pensioners (38%), which is consistent with the ageing profile identified above, followed by those in employment (31%). The proportion of unemployed individuals is also substantial (19%), as is that of people who declare themselves unfit for work (7%). Thus, in addition to its ageing profile, the surveyed population is vulnerable to social problems such as unemployment.

As shown in Table 3, a substantial proportion of respondents did not provide sufficient information to enable their social class to be determined. Among those who did respond, the predominant social class is that of routine employees (22%), followed by industrial workers (7%) and the self-employed (6%). Table 4 indicates that respondents' level of education is relatively low. In addition to the 7% of respondents who cannot read or write, 49% have four or fewer years of schooling. Although they are in the minority, some respondents have higher levels of education: 19% have completed more than four years of schooling but fewer than nine years, while 11% have completed secondary education, the highest level of education among the respondents.

Finally, it should be noted that the distribution of respondents by housing type (according to the number of bedrooms) is relatively diverse (Table 5). The most common category is type 3 (36%), followed by type 2 (34%). The least common type is 1 (9%).

In summary, the population surveyed in the Cerco do Porto neighbourhood has lived there for a relatively long time, although the neighbourhood's population has changed over time. The surveyed population shows signs of ageing and feminisation and lives in relatively small households, with a substantial proportion consisting of single-person households. It is also characterised by the proportion of retired people and high levels of unemployment. The local population is marked by the prevalence of routine employees and limited variation in levels of education. Respondents are distributed across different types of

accommodation in a municipal neighbourhood structured around collective housing. These characteristics provide important contextual information for understanding the surveyed population and the post-occupancy experiences discussed in the following sections. A review of the sociodemographic characteristics according to building typology did not reveal substantial differences in age, gender distribution, household composition, or socio-professional profile between respondents from gallery-access and vertical-access buildings. Consequently, the two groups may be regarded as broadly comparable for the purposes of the comparative analyses presented in Section 4.

Table 4. Educational attainment of surveyed residents (%).

Level of Education	(%)
Cannot read or write	7.0
Year 4 or below	49.0
Up to Year 9	19.0
Year 9	13.0
Incomplete secondary education	1.0
Secondary education	11.0
Total	100.0

Source: Authors, based on RSS-CPR, 2024.

Table 5. Housing type of surveyed residents (%).

Type of Accommodation	(%)
One-bedroom	9
Two-bedroom	34
Three-bedroom	36
Four-bedroom	21
Total	100

Source: Authors, based on RSS-CPR, 2024.

3.2. Analysis of Problems and Habits

The analysis of the results, as shown in the row totals of Tables 6–9, reveals the persistence of several problems across the dwelling spaces, namely dampness, condensation on glazing, odours and mould. Dampness and mould were most commonly identified in bedrooms (47% and 36%, respectively), while odours were predominantly associated with kitchens (26%) and bathrooms (26%). Although less frequently reported, condensation on glazing was identified at similar levels across different rooms, suggesting a more widespread occurrence.

Table 6. Dampness problems following interventions, by building access.

Access	Moisture						
	None	Living Room	Kitchen	Bedroom(s)	Bathroom	Encl. Balcony	Total
Vertical	18 (36.7%)	8 (16.3%)	11 (22.4%)	27 (55.1%)	12 (24.5%)	1 (2.0%)	49 (100.0%)
Gallery	27 (52.9%)	14 (27.5%)	3 (5.9%)	20 (39.2%)	6 (11.8%)	1 (2.0%)	51 (100.0%)
Total	45	22	14	47	18	2	100

Source: Authors, based on RSS-CPR, 2024. Note: Multiple responses were permitted, as residents could report problems in more than one room. The category "None" was exclusive of the identification of problems in individual rooms.

Table 7. Condensation on glazing following interventions, by building access.

Access	Condensation on Glazing						
	None	Living Room	Kitchen	Bedroom(s)	Bathroom	Encl. Balcony	Total
Vertical	24 (49.0%)	15 (30.6%)	9 (18.4%)	16 (32.7%)	13 (26.5%)	3 (6.1%)	49 (100.0%)
Gallery	30 (58.8%)	11 (21.6%)	8 (15.7%)	12 (23.5%)	9 (17.6%)	5 (9.8%)	51 (100.0%)
Total	54	26	17	28	22	8	100

Source: Authors, based on RSS-CPR, 2024. Note: Multiple responses were permitted, as residents could report problems in more than one room. The category "None" was exclusive of the identification of problems in individual rooms.

Table 8. Odour problems following interventions, by building access.

Access	Odours						
	None	Living Room	Kitchen	Bedroom(s)	Bathroom	Encl. Balcony	Total
Vertical	21 (42.9%)	3 (6.1%)	15 (30.6%)	9 (18.4%)	16 (32.7%)	1 (2.0%)	49 (100.0%)
Gallery	29 (56.9%)	1 (2.0%)	11 (21.6%)	7 (13.7%)	10 (19.6%)	1 (2.0%)	51 (100.0%)
Total	50	4	26	16	26	2	100

Source: Authors, based on RSS-CPR, 2024. Note: Multiple responses were permitted, as residents could report problems in more than one room. The category "None" was exclusive of the identification of problems in individual rooms.

Table 9. Mould problems following interventions, by building access.

Access	Mould						
	None	Living Room	Kitchen	Bedroom(s)	Bathroom	Encl. Balcony	Total
Vertical	21 (42.9%)	7 (14.3%)	9 (18.4%)	19 (38.8%)	8 (16.3%)	3 (6.1%)	49 (100.0%)
Gallery	32 (62.7%)	8 (15.7%)	4 (7.8%)	17 (33.3%)	4 (7.8%)	0 (0.0%)	51 (100.0%)
Total	53	15	13	36	12	3	100

Source: Authors, based on RSS-CPR, 2024. Note: Multiple responses were permitted, as residents could report problems in more than one room. The category "None" was exclusive of the identification of problems in individual rooms.

Residents' assessment of the contribution of the interventions points mainly to the stability of the problems. Dampness, however, is an exception, presenting the most positive outcome, with 38% of responses reporting an improvement following the intervention. The remaining responses indicate the persistence of the problems, namely condensation on glazing (58%), odours (68%), and mould (49%). The results suggest that these problems continue to be reported by a substantial proportion of residents following rehabilitation.

The analysis of domestic habits shows that the living area, including the kitchen, is the most frequently used space during the day, according to 90% of the responses. With regard to ventilation practices, all residents report opening windows to air the dwelling, with 58% keeping them open throughout the day and 30% opening them several times a day. The results also suggest a uniform distribution of ventilation practices across interior spaces, with bedrooms being the most frequently ventilated (96%), followed by bathrooms (93%) and the living/kitchen area (92%). Residents most frequently refer to the need "to air the house" (25.1%), "to get fresh air" (25.1%), or "to avoid odours" (17.2%). Furthermore, a considerable number of residents do not answer the question concerning the most appropriate time to ventilate the dwelling ($n = 33$). Among those who do answer, 38.8% identify the morning as the most suitable period, while 25.4% indicate that the windows should remain open at all times.

3.3. Satisfaction Evaluation

Overall, residents report positive evaluations of most interior spaces. A total of 87% of resident respondents report being satisfied (65%) or very satisfied (22%) with the number of bedrooms; 78% are satisfied (74%) or very satisfied (4%) with the size of the bedrooms; 72% are satisfied (67%) or very satisfied (5%) with the size of the living room; 56% are satisfied (53%) or very satisfied (3%) with the size of the kitchen (or kitchenette, depending on the typology); 88% are satisfied (78%) or very satisfied (10%) with the size of the bathroom; and 65% are satisfied (62%) or very satisfied (3%) with the laundry facilities. However, only 42% report being satisfied (38%) or very satisfied (4%) with the storage areas, while 22% are somewhat satisfied and 36% are not satisfied at all.

The results also show that 94% of respondents are satisfied (49%) or very satisfied (45%) with natural lighting; 72% are satisfied (50%) or very satisfied (22%) with thermal comfort in summer; 90% are satisfied (48%) or very satisfied (42%) with thermal comfort in winter; and 80% are satisfied (62%) or very satisfied (18%) with acoustic comfort.

Regarding the surrounding exterior spaces, 68% of surveyed residents are satisfied (57%) or very satisfied (11%) with access to the dwelling entrance, while 70% are satisfied (54%) or very satisfied (16%) with their sense of safety.

4. Comparative Analysis of the Two Interventions

Following the general analysis of the results, a comparative reading of the two interventions based on their access systems, vertical access and gallery access buildings, reveals variations in the incidence of reported problems, main domestic habits and levels of satisfaction.

4.1. Main Problems

The comparison between the two intervention strategies associated with the different access systems, gallery access and vertical access buildings, reveals similar patterns in the problems reported by residents. Dampness (Table 6), condensation on glazing (Table 7), odours (Table 8), and mould (Table 9) are reported in both cases, albeit with variations in frequency and spatial distribution.

Overall, higher frequencies are reported in vertical access buildings across most problem categories. In the case of dampness, bedrooms emerge as the most affected space in both typologies, reported by 55.1% of residents in vertical access buildings and 39.2% in gallery access buildings. Higher frequencies are also observed in kitchens (22.4% in vertical access compared with 5.9% in gallery access) and bathrooms (24.5% compared to 11.8%).

Condensation on glazing is distributed across several domestic spaces, affecting mainly living rooms, bedrooms, and bathrooms in both typologies. Higher frequencies are again observed in vertical access buildings, with 32.7% in bedrooms (compared with 23.5% in gallery buildings), 30.6% in living rooms (compared with 21.6%) and 26.5% in bathrooms (compared with 17.6%).

Similar patterns are observed for odours and mould. Regarding odours, higher frequencies are reported in kitchens (30.6% in vertical access and 21.6% in gallery access) and bathrooms (32.7% in vertical access and 19.6% in gallery access), while lower values are recorded in the remaining spaces. In the case of mould, bedrooms are the most affected space in both typologies, with reports of 38.8% in vertical access and 33.3% in gallery access buildings. Differences in the remaining spaces are less marked.

It should be noted that, in gallery access buildings, the living room and kitchen form an integrated space, whereas in vertical access buildings they are generally separated rooms. This spatial distinction should be considered when comparing the distribution of reported problems between the two typologies.

Overall, moisture-related problems, condensation and mould remain among the most frequently reported issues in both intervention types, although prevalence differs between the two rehabilitation approaches.

4.2. Main Habits

In relation to domestic habits, the comparison between the two building typologies also reveals similar patterns, with some variations in ventilation practices (Table 10) and in the use of heating and cooling equipment (Table 11). In both cases, ventilation emerges as a common domestic practice. However, this tendency is more evident in gallery access buildings, where 70.6% of residents report keeping windows open throughout the day, compared with 44.9% in vertical access buildings. Among the 93 residents who answered this question, the most frequent reasons reported for opening windows are "to air the house" (25.1%) and "to get fresh air" (25.1%), while 17.2% refer to avoiding odours and 10.8% mention dampness. The latter percentages refer only to respondents who provided a valid answer to the open-ended question concerning the reasons for window opening ($n = 93$).

Table 10. Ventilation frequency following interventions, by building access.

Access	Ventilation Frequency			
	Once a Day or Less	**Several Times a Day**	**All Day**	**Total**
Vertical	9 (18.4%)	18 (36.7%)	22 (44.9%)	49
Gallery	3 (5.9%)	12 (23.5%)	36 (70.6%)	51
Total	12	30	58	100

Pearson's χ^2 (2, $N = 100$) = 7.542, $p = 0.023$|Cramér's $V = 0.275$. Note: All expected cell frequencies exceeded 5 (minimum expected frequency = 5.88). Therefore, the conventional assumptions for Pearson's chi-square test were satisfied. Source: Authors, based on RSS-CPR, 2024.

Table 11. Use of equipment following interventions, by building access.

Access	Heating|Winter			Cooling|Summer		
	Yes	**No**	**Total**	**Yes**	**No**	**Total**
Vertical	6 (12.2%)	43 (87.8%)	49 (100.0%)	23 (46.9%)	26 (53.1%)	49 (100.0%)
Gallery	7 (13.7%)	44 (86.3%)	51 (100.0%)	36 (70.6%)	15 (29.4%)	51 (100.0%)
Total	13	87	100	59	41	100

Heating: Pearson's χ^2 (1, $N = 100$) = 0.048, $p = 0.826$|Cramér's $V = 0.022$. Cooling: Pearson's χ^2 (1, $N = 100$) = 5.778, $p = 0.016$|Cramér's $V = 0.240$. Note: The assumptions underlying Pearson's chi-square tests were verified for both comparisons. All expected cell frequencies exceeded 5 (minimum expected frequency = 6.37 for Heating|Winter and 20.09 for Cooling|Summer). Source: Authors, based on RSS-CPR, 2024.

Regarding heating practices during winter, responses are very similar across both typologies, with a clear predominance of residents reporting that they do not use heating equipment (87.8% in vertical access buildings and 86.3% in gallery access buildings). Overall, the reported use of heating equipment remains limited in both intervention types.

In contrast, greater variation is observed in relation to cooling practices during summer. In gallery access buildings, 70.6% of residents report using cooling equipment, whereas in vertical access buildings, responses are more evenly distributed, with 46.9% reporting its use and 53.1% indicating that they do not use such equipment.

These results reveal similarities in reported domestic habits across both intervention types, while differences can be observed in ventilation and cooling practices. These findings reflect residents' reported behaviours and experiences and should not be interpreted as direct evidence of the effectiveness of these practices or of indoor environmental conditions.

4.3. Evaluation

Given the central role of residential satisfaction and perceived thermal comfort in the study objectives, these indicators were also compared according to building access type. The analysis considered residents' assessments of natural lighting (Table 12), thermal comfort in summer (Table 13) and in winter (Table 14), and acoustic comfort (Table 15).

Table 12. Satisfaction with natural lighting following interventions, by building access.

Access	Natural Lighting			
	Slightly Satisfied	**Satisfied**	**Very Satisfied**	**Total**
Vertical	6 (12.2%)	28 (57.1%)	15 (30.6%)	49 (100.0%)
Gallery	0 (0.0%)	21 (41.2%)	30 (58.8%)	51 (100.0%)
Total	6 (6.0%)	49 (49.0%)	45 (45.0%)	100 (100.0%)

Fisher–Freeman–Halton Exact Test (two-sided), $p = 0.0013$ | Cramér's $V = 0.346$. Note: Two cells (33.3%) had expected frequencies below 5 (minimum expected frequency = 2.94). The Fisher–Freeman–Halton exact test was therefore used. Source: Authors, based on RSS-CPR, 2024.

Table 13. Satisfaction with thermal comfort (summer) following interventions, by building access.

Access	Thermal Comfort (Summer)				
	Not Satisfied	**Slightly Satisfied**	**Satisfied**	**Very Satisfied**	**Total**
Vertical	1 (2.0%)	10 (20.4%)	27 (55.1%)	11 (22.4%)	49 (100.0%)
Gallery	1 (2.0%)	16 (31.4%)	23 (45.1%)	11 (21.6%)	51 (100.0%)
Total	2 (2.0%)	26 (26.0%)	50 (50.0%)	22 (22.0%)	100 (100.0%)

Fisher–Freeman–Halton Exact Test (two-sided), $p = 0.661$|Pearson's χ^2 (3, $N = 100$) = 1.665, $p = 0.645$|Cramér's $V = 0.129$. Note: Two cells (25.0%) had expected frequencies below 5 (minimum expected frequency = 0.98). The Fisher–Freeman–Halton exact test was used in place of the asymptotic Pearson chi-square test. Source: Authors, based on RSS-CPR, 2024.

Table 14. Satisfaction with thermal comfort (winter) following interventions, by building access.

Access	Thermal Comfort (Winter)			
	Slightly Satisfied	**Satisfied**	**Very Satisfied**	**Total**
Vertical	6 (12.2%)	25 (51.0%)	18 (36.7%)	49 (100.0%)
Gallery	4 (7.8%)	23 (45.1%)	24 (47.1%)	51 (100.0%)
Total	10 (10.0%)	48 (48.0%)	42 (42.0%)	100 (100.0%)

Pearson's $\chi^2(2, N = 100) = 1.301$, $p = 0.522$|Cramér's $V = 0.114$. Note: One cell (16.7%) had an expected frequency below 5 (minimum expected frequency = 4.90). No expected cell frequency was below 1. The conventional assumptions for the application of Pearson's chi-square test were satisfied. Source: Authors, based on RSS-CPR, 2024.

Table 15. Satisfaction with acoustic comfort following interventions, by building access.

Access	Acoustic Comfort				
	Not satisfied	**Slightly Satisfied**	**Satisfied**	**Very Satisfied**	**Total**
Vertical	1 (2.0%)	8 (16.3%)	32 (65.3%)	8 (16.3%)	49 (100.0%)
Gallery	1 (2.0%)	10 (19.6%)	30 (58.8%)	10 (19.6%)	51 (100.0%)
Total	2 (2.0%)	18 (18.0%)	62 (62.0%)	18 (18.0%)	100 (100.0%)

Fisher–Freeman–Halton Exact Test (two-sided), $p = 0.9048$|Pearson's $\chi^2(3, N = 100) = 0.469$, $p = 0.926$|Cramér's $V = 0.068$. Note: Two cells (25.0%) had expected frequencies below 5 (minimum expected frequency = 0.98). The Fisher–Freeman–Halton exact test was used in place of the asymptotic Pearson chi-square test. Source: Authors, based on RSS-CPR, 2024.

The results reveal a statistically significant association between apartment access type and satisfaction with natural lighting (Fisher-Freeman-Halton exact test, $p \approx 0.0013$; Cramér's $V = 0.346$) (Table 12). Residents living in gallery-access apartments reported higher levels of satisfaction, with 58.8% declaring themselves very satisfied, compared with 30.6% of residents in vertically accessed apartments. Furthermore, low satisfaction with natural lighting was reported exclusively among residents of the latter group. By contrast, no statistically significant association was found between apartment access type and satisfaction with either summer thermal comfort (Fisher-Freeman-Halton exact test, $p = 0.661$; Cramér's $V = 0.129$) (Table 13) or winter thermal comfort (Pearson's $\chi^2(2, N = 100) = 1.301$, $p = 0.522$; Cramér's $V = 0.114$) (Table 14). Although some variation was observed in the distribution of responses, the overall patterns of satisfaction were broadly similar across the two rehabilitation typologies.

A similar situation was observed regarding acoustic comfort (Table 15). No statistically significant association was identified between apartment access type and residents' evaluations (Fisher-Freeman-Halton exact test, $p = 0.9048$; Cramér's $V = 0.068$). In both groups, most respondents reported being satisfied with indoor acoustic conditions, while dissatisfied responses remained residual. Overall, these findings suggest that apartment access configuration is not a significant differentiating factor in residents' assessments of thermal or acoustic comfort. Natural lighting constitutes the only dimension for which statistically significant differences emerge between the two rehabilitation approaches.

The first evaluative measure, focusing specifically on perceived changes in dwelling conditions following the intervention works (Table 16), indicates a generally positive assessment across both building typologies. In both cases, the majority of residents report an improvement in dwelling conditions, with similar percentages in vertical access buildings (61.2%) and gallery access buildings (60.8%). A further 12.2% of residents in vertical access buildings and 19.6% in gallery access buildings indicate that conditions improved considerably. Some residents report no noticeable change in dwelling conditions (20.4% and 13.7%, respectively).

Table 16. Evaluation of dwellings following interventions, by building access.

Access	Following Intervention				
	Worsened	**Unchanged**	**Improved**	**Improved Greatly**	**Total**
Vertical	3 (6.1%)	10 (20.4%)	30 (61.2%)	6 (12.2%)	49 (100%)
Gallery	3 (5.9%)	7 (13.7%)	31 (60.8%)	10 (19.6%)	51 (100%)
Total	6	17	61	16	100

Pearson's χ^2 $(3, N = 100) = 1.506$, $p = 0.681$|Fisher–Freeman–Halton exact test, $p = 0.682$|Cramér's $V = 0.123$. Source: Authors, based on RSS-CPR, 2024.

A second and broader evaluative measure, conducted at the end of the questionnaire and capturing respondents' overall assessment of the intervention (Table 17), shows a similar pattern, although responses tend to be more favourable. In vertical access buildings, a larger proportion of residents report that conditions improved considerably (46.9%). In gallery access buildings, responses remain concentrated in the improved category (52.9%), while 41.2% report that conditions improved considerably. Reports of worsening conditions are limited in both typologies, accounting for only 2% of responses.

Overall, the results indicate positive evaluations of the rehabilitation works across both intervention types, with most residents reporting improvements in their housing conditions following the interventions.

Table 17. Satisfaction with dwellings following interventions, by building access.

Access	Following Intervention				
	Worsened	**Unchanged**	**Improved**	**Improved Greatly**	**Total**
Vertical	1 (2.0%)	8 (16.3%)	17 (34.7%)	23 (46.9%)	49 (100%)
Gallery	1 (2.0%)	2 (3.9%)	27 (52.9%)	21 (41.2%)	51 (100%)
Total	2	10	44	44	100

Pearson's χ^2 (3, $N = 100$) = 5.926, $p = 0.115$|Fisher–Freeman–Halton exact test, $p = 0.080$|Cramér's $V = 0.243$. Source: Authors, based on RSS-CPR, 2024.

5. Discussion: How Do the Two Interventions Differ in Post-Occupancy Outcomes?

Residents' opinions indicate that both vertical access and gallery access units tend to present similar results within each group, with the former generally reporting a higher incidence of problems than the latter, even though some exceptions are observed in both cases. The survey also allows a number of broader observations to be made.

Housing units from buildings organised around vertical access cores do not appear to have been in a more favourable condition prior to the intervention, despite offering slightly larger floor areas, although these remained below the minimum area requirements established in legislation. Conversely, although units accessed through distribution galleries have slightly smaller floor areas, they generally present lower frequencies of reported problems. These findings suggest differences in the way residents experience the two rehabilitation approaches over time. Furthermore, gallery access buildings tend to have a slightly reduced depth, a characteristic that may favour cross-ventilation and contribute to the differences reported by residents. However, the present study does not allow the relative influence of these factors to be assessed independently.

Regarding heating habits, no substantial differences are observed between the two building types or interventions, with both showing low levels of heating equipment use. By contrast, cooling practices reveal some variation, with residents of gallery access units reporting greater use of cooling equipment.

5.1. Size (Building Size, Dwelling Size, Room Size)

When asked about the number and size of rooms, residents expressed a very high level of overall satisfaction. These results are consistent with other studies carried out in comparable neighbourhoods from the same period in Porto [27,36]. This apparent contrast between the small size of the dwellings, below current regulatory standards, and the positive evaluations reported by residents highlights the complexity of housing satisfaction and its relationship with dwelling size, a relationship that has been found to depend on multiple housing, household and contextual factors rather than on floor area alone [40,41].

High satisfaction levels may also reflect processes of adaptation to long-term housing conditions, as documented in studies on adaptive preferences, residential attachment, and housing satisfaction. Residents' evaluations are shaped by the physical characteristics of dwellings, but also by previous housing experiences, household expectations, and the perceived improvements brought about by rehabilitation interventions.

This issue warrants particular attention when considered alongside the problems identified by residents. The limited floor areas of these dwellings may contribute to challenges associated with everyday housing use, particularly in relation to ventilation practices and the management of moisture-related problems. Although the present study does not allow direct relationships between dwelling size and indoor environmental conditions to be established, the coexistence of high satisfaction levels and persistent environmental concerns

highlights the need for further investigation into how residents experience and adapt to constrained housing environments. Moreover, while the present study does not allow the effectiveness of specific design interventions to be assessed, the limited dimension of several rooms suggests that some of the environmental and functional problems identified may be difficult to resolve through maintenance and upgrading measures alone, potentially requiring more comprehensive rehabilitation interventions, including the spatial reconfiguration of dwelling layouts. This issue should also be interpreted in light of the current occupation of dwellings, as changes in household composition over time may have contributed to a growing mismatch between the original dwelling typologies and current household needs.

5.2. Awareness and Housing Practices

All respondents report ventilating their homes, with a high proportion (58%) stating that they air them "throughout the day". However, when asked about their reasons for doing so, most residents refer to broad motivations such as airing the house, obtaining fresh air, avoiding odours, or addressing dampness. These responses suggest that ventilation is primarily understood as part of everyday domestic routines rather than being explicitly associated with indoor environmental quality or moisture control.

This issue warrants closer attention when considering specific spaces within the dwelling. The bedroom, for instance, is typically the smallest habitable room and one in which a substantial amount of time is spent, making ventilation practices and indoor environmental conditions particularly relevant. Bathrooms, by contrast, are often small and humid spaces characterised by limited openings to the exterior. The recurrence of moisture-related problems in these spaces highlights the importance of understanding how everyday ventilation practices interact with the physical characteristics of dwellings.

At the same time, residents' ventilation behaviours should not be interpreted solely in technical terms. Research on window opening in dwellings has identified physiological, psychological, social, physical environmental and contextual drivers of occupant behaviour [42]. In this case, decisions regarding window opening and ventilation may also be influenced by factors such as weather conditions, energy costs, outdoor noise, security concerns, household routines, and previous housing experiences. These considerations suggest that domestic practices emerge from a complex interaction between residents' needs, habits, and spatial characteristics of their homes.

A further consideration arises from some residents' desire to transform the access galleries into enclosed shared circulation spaces. Indeed, the formal adoption of such solutions in previous interventions promoted by the municipal company in other neighbourhoods followed the gradual informal enclosure of drying areas, balconies, and access galleries by residents over time. While such transformations may respond to residents' aspirations for increased enclosure, privacy, or weather protection, they may also have implications for ventilation, habitability, and building safety. The enclosure of galleries also reduces direct connections between habitable rooms and the exterior, potentially conflicting with regulatory provisions [27].

These findings highlight the importance of considering residents' everyday practices when assessing rehabilitation outcomes. They also suggest the value of further investigation into how occupants understand and manage indoor environmental conditions, and how such practices relate to the spatial and architectural characteristics of rehabilitated housing.

5.3. Thermal Comfort Perception

The interpretation of results concerning perceived thermal comfort should take into account the socioeconomic context of the resident population. In this respect, the limited use of heating systems may reflect not only patterns of use, but also financial constraints

associated with energy poverty [43–45]. This is consistent with evidence that Portuguese households consume substantially less energy than would be required to achieve thermal comfort, resulting in a marked gap between theoretical and actual energy use across the national dwelling stock [46].

This becomes more apparent when comparing winter and summer practices. Residents report limited use of heating systems, while cooling devices are more commonly used, particularly in gallery access buildings. Differences in cost, accessibility and ease of use may partly contribute to this contrast, as cooling solutions such as portable fans are generally more affordable and widespread than electric heating equipment. In addition, colder indoor conditions may often be addressed through individual adaptive strategies, such as the use of additional clothing or bedding, whereas high temperatures can be more difficult to mitigate without some form of environmental control.

These findings suggest that perceptions of thermal comfort are shaped by physical characteristics of dwellings and by residents' economic circumstances and everyday practices. This interpretation is reinforced by the comparative analysis, which revealed no statistically significant differences in perceived summer or winter thermal comfort between the two building typologies despite differences in architectural configuration and reported building-related problems. In contexts of social vulnerability, positive evaluation of housing and residential satisfaction may coexist with constraints affecting indoor comfort and environmental conditions. Research on energy poverty in Portugal has shown that households may come to regard feeling cold or hot at home as normal and acceptable [47], which may partly explain the high levels of satisfaction with winter thermal comfort reported by residents, despite the limited use of heating equipment. From this perspective, the results highlight the importance of understanding housing experiences through the interaction of physical, social, and behavioural factors rather than through technical considerations alone.

Although residents generally report positive evaluations of the rehabilitation works, moisture-related problems, condensation and mould continue to be identified in both intervention types. These findings reinforce the value of post-occupancy evaluation in identifying aspects of the lived housing environments that may not be fully captured through technical assessments alone. Continued monitoring of rehabilitated housing, combining residents' perceptions with objective environmental measurements, could contribute to a more comprehensive understanding of post-occupancy outcomes and support future rehabilitation strategies.

6. Conclusions

Following the analysis and discussion of the results, some additional considerations are relevant to support a broader understanding of the present analysis.

6.1. Main Findings

This study explored residents' satisfaction, housing practices, and perceived thermal comfort following two rehabilitation approaches implemented in the Cerco do Porto public housing estate. Through a post-occupancy evaluation centred on residents' experiences, it sought to examine how these interventions are perceived and experienced in everyday domestic environments.

Overall, the findings reveal positive levels of satisfaction across both intervention types, suggesting that the rehabilitation works were generally well received by residents. At the same time, differences emerged in reported building-related issues, ventilation practices, and perceived thermal comfort, with residents of gallery access buildings generally reporting fewer problems and more favourable overall assessments of the rehabilitation works. While satisfaction with natural lighting differed significantly between the two building typologies,

no statistically significant differences were observed regarding perceived thermal comfort in summer or winter, nor regarding acoustic comfort. These findings should be interpreted as descriptive patterns emerging from residents' reported experiences rather than as evidence of causal relationships, but they nevertheless highlight variations in specific post-occupancy outcomes across the two rehabilitation approaches.

The results also suggest that residents' evaluations of their homes cannot be fully understood through physical or environmental characteristics alone. The coexistence of high levels of satisfaction with concerns related to moisture, perceived thermal comfort, or spatial constraints highlights the complex relationship between housing conditions, everyday practices, and residents' expectations. Housing satisfaction appears to be influenced by the dwelling itself as well as by processes of adaptation, comparison with previous housing conditions, and the broader experience of residential stability associated with rehabilitation.

From a design perspective, the study reinforces the importance of considering patterns of use and residents' experiences alongside architectural and environmental objectives. Residents' accounts illustrate how perceptions of comfort and housing quality emerge through the interaction between built space and everyday domestic routines. The fact that significant differences were detected primarily in relation to satisfaction with natural lighting, rather than thermal or acoustic comfort, further highlights the multidimensional nature of post-occupancy experience and the need to consider specific environmental dimensions separately. In this sense, post-occupancy evaluation can provide valuable insights that complement technical assessments and help identify aspects of the lived environment that may otherwise remain overlooked.

More broadly, the findings support the integration of residents' perspectives into the planning, design, and assessment of social housing rehabilitation projects. The study also highlights the contribution of post-occupancy evaluation to sustainability-oriented housing policies, demonstrating how social and environmental dimensions of sustainability can be more effectively integrated into the design, implementation, and assessment of rehabilitation programmes. By combining architectural analysis with post-occupancy evaluation, it becomes possible to develop a more comprehensive understanding of how rehabilitated housing is experienced over time and to inform future interventions aimed at improving housing quality and residential well-being.

6.2. Limitations

This study presents several limitations that should be considered when interpreting its findings. First, the analysis is based primarily on residents' self-reported perceptions and experiences. While these provide valuable insights into post-occupancy conditions and everyday housing practices, they do not constitute direct measurements of environmental performance. Consequently, the findings related to perceived thermal comfort should be understood as residents' reported experiences rather than as indicators of actual thermal performance.

Second, the study adopts a cross-sectional design, capturing residents' evaluations at a single point in time. As such, the findings do not allow causal relationships to be established between specific design characteristics and reported outcomes. Rather, they identify descriptive patterns emerging from the comparison of residents' reported experiences across two rehabilitation approaches within the same housing estate.

The number of responses constitutes an additional limitation. Although care was taken to ensure a balanced representation of the two intervention types within the sample, participation remained voluntary, raising the possibility of self-selection bias and limiting the extent to which the findings can be generalised to the wider resident population. Fur-

thermore, while the questionnaire was reviewed and refined prior to implementation, some dimensions of residents' experiences may not have been fully captured.

Another important consideration relates to the timing of the interventions. The rehabilitation works associated with the two housing typologies were completed during relatively close but distinct periods, resulting in unequal lengths of occupancy at the time of the survey. Consequently, differences observed between groups may reflect not only characteristics associated with the rehabilitation approaches themselves, but also varying periods of use, ageing processes, maintenance conditions, and patterns of adaptation over time.

Finally, the study did not incorporate objective environmental monitoring data or detailed socioeconomic information, both of which may influence residents' perceptions of housing quality, comfort and everyday housing practices. These limitations should therefore be considered when interpreting the findings and their broader applicability.

6.3. Future Research

The findings of this study highlight several directions for future research. A priority would be to combine residents' perceptions with objective measurements of indoor environmental conditions, including temperature, relative humidity, air quality, and energy use. Such an approach would allow a more comprehensive understanding of the relationships between rehabilitation strategies, indoor environmental conditions, and perceived thermal comfort.

Longitudinal studies could also provide further insight into how perceptions of comfort, satisfaction, and housing quality evolve over time. Given the slightly different periods elapsed since rehabilitation in the two intervention types studied, future work may benefit from examining post-occupancy experiences at multiple stages following intervention, allowing changes associated with building ageing, maintenance, and patterns of use to be better understood.

Further investigation into residents' everyday practices, particularly those related to ventilation and environmental control, would also be valuable. Combining quantitative surveys with qualitative methods, such as interviews or household observations, could help clarify how occupants adapt their homes to seasonal conditions and how these practices interact with the spatial and architectural features of dwellings. Such approaches may contribute to a more comprehensive understanding of post-occupancy outcomes in rehabilitated social housing and support the development of future interventions that are more responsive to residents' everyday experiences and expectations. The findings presented here contribute to an ongoing research agenda on housing rehabilitation.

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