

Comparative analysis of the state of conservation of social housing facades in

Pelotas/RS

Análise comparativa do estado de conservação das fachadas de habitações de interesse social em

Pelotas/RS

Análisis comparativo del estado de conservación de fachadas de viviendas de interés social en

Pelotas/RS

Received: 04/20/2022 | Reviewed: 04/29/2022 | Accept: 05/03/2022 | Published: 05/05/2022

Vitória Silveira da Costa

ORCID: <https://orcid.org/0000-0003-4898-9850>
Universidade Federal de Pelotas, Brazil
E-mail: vitoriascosta@yahoo.com.br

Tais Marini Brandelli

ORCID: <https://orcid.org/0000-0002-4745-3141>
Universidade Federal de Pelotas, Brazil
E-mail: taisbrandelli@hotmail.com

Vívian Michele Bandeira da Silva

ORCID: <https://orcid.org/0000-0001-5786-4780>
Universidade Federal de Pelotas, Brazil
E-mail: viviansilva@ifsul.edu.br

Charlei Marcelo Paliga

ORCID: <https://orcid.org/0000-0003-0521-4764>
Universidade Federal de Pelotas, Brazil
E-mail: charleipaliga@gmail.com

Ariela da Silva Torres

ORCID: <https://orcid.org/0000-0003-4686-9759>
Universidade Federal de Pelotas, Brazil
E-mail: arielatorres@gmail.com

Abstract

The housing projects is the way most used by the Brazilian federal government to attend the housing demand of the low-income population. The low quality in the production process leads to a greater need for maintenance, which becomes critical due to the limited availability of resources for residents, influencing user satisfaction. In this context, this study aimed to compare the survey of data obtained in 2010 in the INQUALHIS project on pathological manifestations in newly built housing projects with the surveys of pathological manifestations carried out in 2016 and 2019 of the same housing projects, analyzing the evolution of the state of conservation of the facades. The housing complexes presented problems related to use and lack of maintenance. This study, in addition to serving to detect the pathological manifestations of the objects of study, verified the post-occupancy evaluation - higher incidences of pathological manifestations, led to greater dissatisfaction of residents with the facades of buildings due to their bad appearance. In addition, observing the types of manifestations incident on the facades of both surveys, it was possible to perceive that the survey carried out in the newly built projects already revealed a predisposition of the most incident types in each set.

Keywords: Pathological manifestations; Social housing; Architectural technology; Conservation; Facades.

Resumo

Os conjuntos habitacionais são a forma mais utilizada pelo governo federal brasileiro para atender a demanda habitacional da população de baixa renda. A baixa qualidade no processo produtivo leva a uma maior necessidade de manutenção, que se torna crítica devido à limitada disponibilidade de recursos para os moradores, influenciando na satisfação dos usuários. Nesse contexto, este estudo teve como objetivo comparar o levantamento de dados obtidos em 2010 no projeto INQUALHIS sobre manifestações patológicas em conjuntos habitacionais recém-construídos com os levantamentos de manifestações patológicas realizados em 2016 e 2019 dos mesmos conjuntos habitacionais analisando a evolução do estado de conservação das fachadas. Os conjuntos habitacionais apresentavam problemas de uso e falta de manutenção. Este estudo, além de servir para detectar as manifestações patológicas dos objetos de estudo, verificou a avaliação pós-ocupação - maiores incidências de manifestações patológicas, levaram a uma maior insatisfação dos moradores com as fachadas dos edifícios devido à sua má aparência. Além disso, observando os tipos de manifestações

incidentes nas fachadas de ambos os levantamentos, foi possível perceber que o levantamento realizado nos projetos recém-construídos já revelava uma predisposição dos tipos mais incidentes em cada conjunto.

Palavras-chave: Manifestações patológicas; Habitação de interesse social; Tecnologia da arquitetura; Conservação; Fachadas.

Resumen

Los proyectos habitacionales son la forma más utilizada por el gobierno federal brasileño para atender la demanda habitacional de la población de bajos ingresos. La baja calidad en el proceso de producción conduce a una mayor necesidad de mantenimiento, que se vuelve crítico debido a la limitada disponibilidad de recursos para los habitantes. En este contexto, este estudio tuvo como objetivo comparar la encuesta de datos obtenidos en 2010 en el proyecto INQUALHIS sobre manifestaciones patológicas en proyectos de vivienda de nueva construcción con las encuestas de manifestaciones patológicas realizadas en 2016 y 2019 de los mismos proyectos de vivienda, analizando la evolución del estado de conservación de las fachadas. Los conjuntos habitacionales presentaban problemas de uso y falta de mantenimiento. Este estudio, además de servir para detectar las manifestaciones patológicas de los objetos de estudio, verificó la evaluación post-ocupación - mayor incidencia de manifestaciones patológicas, condujo a una mayor insatisfacción de los residentes con las fachadas de los edificios debido a su mala apariencia. Además, al observar los tipos de manifestaciones en las fachadas de ambos levantamientos, se pudo percibir que el levantamiento realizado en los proyectos de nueva construcción ya revelaba una predisposición a ciertos daños.

Palabras clave: Manifestaciones patológicas; Vivienda social; Tecnología Arquitectónica; Conservación; Fachadas.

1. Introduction

In a building, the facades, in addition to defining the appearance, function simultaneously as a barrier to external aggressions and an element of communication between the interior and the exterior. Humidity, radiation, extreme temperatures, dirt, salts, plants, birds, and deformation, for example, can significantly affect the performance of facades. Therefore, the facade of a building requires periodic maintenance, as do other systems (Madureira *et al.*, 2017). The pathological manifestations can originate for several reasons, among them, the main ones are: failure in execution, design errors, misuse of the building and the use of low quality materials (Aleixo *et al.*, 2019).

According to NBR 5674 (ABNT, 2012), to ensure a longer useful life, maintenance services must be carried out from the beginning of the use of a building, whether of a routine, corrective, or preventive nature, and that, despite the cost relevant in the use phase, should be understood as an investment in its preservation. The deterioration of buildings due to lack of preventive maintenance is a constant, regardless of the type of construction system adopted. Corrective maintenance prolongs the durability of materials and systems, thus ensuring the durability of the building during its useful life (Correa *et al.*, 2022). Therefore, periodic evaluation and planning of preventive maintenance provide greater comfort, safety and durability of buildings (Cirino, *et al.*, 2020). However, in Brazil, building maintenance actions are culturally seen as inconvenient expenses. Actions are usually carried out only to correct faults or anomalies, ignoring the need for periodicity of preventive maintenance activities, significantly contributing to the premature depreciation of buildings (Vieira, 2015). In addition, the minimization of construction costs and deadlines give rise to problems regarding the performance and durability of the projects (Stuckert; Sobrinho Junior, 2016). Over the years, the useful life of buildings can suffer a natural or influential degradation of human actions. These degradations, in a way, can affect the safety, aesthetics, usability and durability of buildings. Pathological manifestations bring inconvenience not only to the client, but also to the builder, as the costs of an eventual intervention after a work delivery are higher compared to the costs of a well-done execution (Cordeiro *et al.*, 2021).

After a history of attempts to meet the great demand for housing for the low-income population in Brazil, through public housing policies, in 1999 the Brazilian Government created the Programa de Arrendamento Residencial (Residential Lease Program - PAR), a housing financing program (Law no. 10,188, of February 12, 2001), which proposed granting ownership of the property to the lessee upon payment of monthly fees, offering, through the Anticipated Purchase Law, the option to purchase after a period of five years. However, until the property is paid off, Caixa Econômica Federal remains the owner and allocates condominium management to outsourced companies (Chiarelli, 2014).

In the city of Pelotas, in Rio Grande do Sul, 21 housing projects were implemented by PAR between 2002 and 2008 of two different types, being two-story townhouses and four- or five-story apartment buildings. Until 2004, PAR was classified only in the Normal modality, serving residents in the range between three and six minimum wages. Regarding the developments of this level, the private usable area is 37m² and the buildings would be constructed with up to 04 floors without an elevator. However, with the aim of serving a lower income bracket, from two to four minimum wages, the PAR was created in the Special modality, reducing the minimum design and execution specifications. In addition, the private usable area increased to 33m², allowing the construction of buildings of up to five floors without elevators. In addition, the specifications of the finishes were made more flexible. As for roofs, the use of fiber cement roofing tiles began to be admitted, which until 2004 specified the use of ceramic tiles (CHIARELLI, 2014).

With the objective of evaluating the social interest housing developments in PAR, the INQUALHIS Project Report (Generation of Quality Indicators for Collective Spaces in Social Housing Developments) was published (Medvedovski, 2010). INQUALHIS covered three major areas of study: condominium management, pathological manifestations, and collective spaces, and used Post-Occupation Assessment (POA) strategies, prioritizing aspects related to user satisfaction, especially in the condominium space. Regarding pathological manifestations, quantitative and qualitative surveys were carried out in the condominium areas of the buildings (facades, internal circulation, and party hall), to be used as indicators of the quality of the projects.

The INQUALHIS Project was financed by FINEP (Financier of Studies and Projects) and investigated eleven housing projects built between 2005 and 2008 in Pelotas, aiming to improve the quality of future housing through the feedback of the design, construction, management process I just. Among the eleven housing estates analyzed by the research, six are of semi-detached houses typology and five of buildings, being two of the Normal modalities and three of the Special modalities. The evaluated projects are listed in Table 1.

Table 1: PAR projects analyzed in INQUALHIS.

Residential name	Typology	Modality	Year of Delivery
Regente	Buildings with 4 floors	Normal	19/01/2006
Jardins da Baronesa	Buildings with 4 floors	Normal	09/12/2005
Querência 1	Townhouses		02/10/2006
Querência 2	Townhouses		02/10/2006
Querência 3	Townhouses		13/06/2008
Charqueada 1	Townhouses		02/10/2006
Charqueada 2	Townhouses		13/06/2008
Charqueada 3	Townhouses		02/10/2006
Solar das palmeiras	Buildings with 5 floors	Special	19/09/2006
Paraíso	Buildings with 5 floors	Special	15/08/2007
Estrela Gaúcha	Buildings with 5 floors	Special	01/03/2007

Source: Medvedovski (2010) adapted by the authors.

Through the diagnosis carried out at INQUALHIS, whose surveys were carried out in the newly built projects, within a maximum period of two years between the date of delivery of the housing complex and the date of the survey, Medvedovski (2010) found that the incidence of pathological manifestations observed was of constructive failures, caused mainly by the lack of detailing of the projects and of quality control during the execution of the work. Silva (2016) and Brandelli (2019) carried out a survey of pathological manifestations in the Residencial Solar das Palmeiras, Residencial Paraíso, Residencial Regente, Residencial Jardins da Baronesa and Residencial Estrela Gaúcha between the years 2016 and 2019.

In this context, this study aimed to compare the survey of data obtained in the INQUALHIS project (MEDVEDOVSKI, 2010) about pathological manifestations in newly built housing projects with the surveys of pathological manifestations carried out by Silva (2016) and Brandelli (2019) of the same housing complexes analyzing the evolution of the facades' state of conservation. The relationship between the different types of projects – special or normal – with the emergence of pathological manifestations was analyzed. Finally, post-occupancy assessments were examined in view of the state of conservation.

2. Method

Considering the objective of this study, technical inspections were carried out to characterize the incidence of pathological manifestations on the facades of housing projects and interviews about user satisfaction in relation to the facades, applying methodological procedures of APO. According to Gil (2002), the case study is the in-depth study of one or a few objects. For Yin (2010), the case study is a research strategy chosen when you want to examine contemporary events, aiming to explain the events. However, despite the fragility for generalization caused by the analysis of one or a few cases, the case study can provide a global view of the problem, identifying the possible factors that influence it (GIL, 2002).

The methodology was based on technical inspections through direct observation of the sets that form the object of study, adopting as a reference the methodology of Lichtenstein (1986), with the purpose of carrying out surveys and recording of information, through files, photographs, and graphic representations. of the elements. Since the analyzes are restricted to the facades of the buildings, due to the importance of these constructive elements for the buildings, and considering also, a greater ease of access in the accomplishment of the visits. The dates of the surveys carried out in the projects are listed in Table 2. Initially, the survey of pathological manifestations was carried out by Medvedovski (2010) in the INQUALHIS Project. Between 2016 and 2019, subsequent surveys were carried out by Silva (2016) and Brandelli (2019).

Table 2: Date of surveys in the analyzed projects.

Residential name	Modality	Year of Delivery	Year of 1st inspection (INQUALIS, 2010)	Year of 2nd inspection (Silva, 2016 and Brandelli, 2019)
Regente	Normal	19/01/2006	2007	2019
Jardins da Baronesa	Normal	09/12/2005	2007	2019
Solar das palmeiras	Special	19/09/2006	2008	2016
Paraíso	Special	15/08/2007	2008	2016
Estrela Gaúcha	Special	01/03/2007	2008	2019

Source: Authors.

The classification of pathological manifestations in this research followed the indications of Azevedo and Guerra (2008). The authors classified the pathological manifestations into four types. In addition to the three traditionally established in the literature: moisture, coating detachment and fissures/cracks, they added to the irregularity of the finish. For this analysis, the three items of the traditional classification were adopted, adding dirt, since the facades observed present significant changes related to this pathological manifestation.

For the analysis of the study objectives, the data were manipulated in the Excel application. Initially, the number of incidences of each type of pathological manifestation on each floor of each set was quantified, allowing the comparison of the number of incidences on each floor of the building. To compare incidences between the housing projects in this study, the number of incidences on the facades was divided by the areas of the corresponding facades, as they have different sizes, allowing the creation of a comparison factor, defined by the number of incidences of pathological manifestations per meter facade area square.

As a method of evaluating user satisfaction, forms were applied to residents (owners or tenants) by Silva (2016) and Brandelli (2019). The form includes only thirteen questions, the first six referring to the resident and the following about the

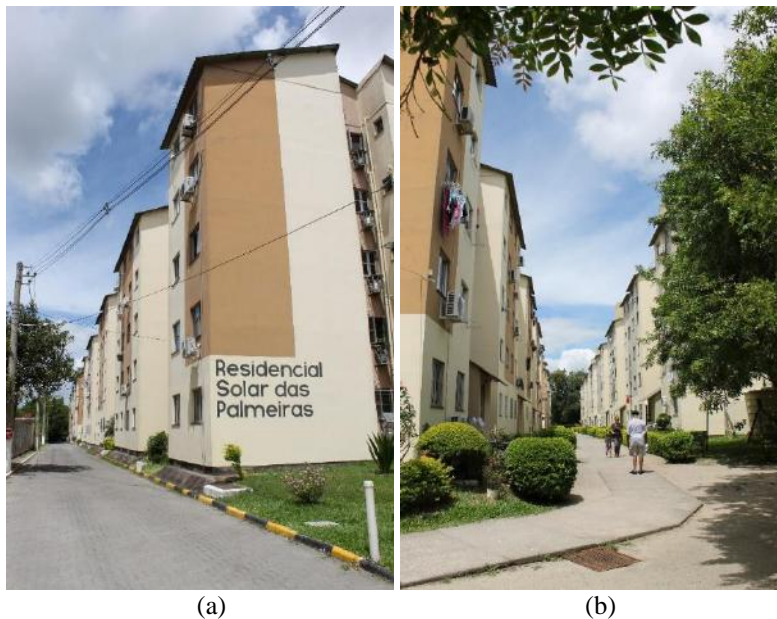
current situation of the facades, maintenance activities and condominium administration. 30 questionnaires were randomly applied to each housing project. After tabulating the data from the forms in Excel, the results were crossed, performing a comparative analysis between the user's perception and the survey of pathological manifestations. According to Roméro and Ornstein (2003), APO uses a series of methods and techniques that diagnose positive and negative factors of the environment during use, considering the point of view of technical evaluators as well as users.

2.1 Objects of study: PAR Residences

Residencial Solar das Palmeiras was delivered to the tenants in September 2006, in the PAR SPECIAL modality, where adaptations were introduced, to reduce the cost of the works and facilitate the payment method, aiming to serve families with lower monthly income (up to four minimum wages).

Vehicle and pedestrian access to the complex takes place along the public road, with two gates, a guardhouse, and a gate. The bike rack has no cover and is located next to the guardhouse, along with the mailboxes and waste collectors. The parking lot is located at the end of the plot, with spaces for 152 cars. The space for motorcycles is attached to that for vehicles, but closer to the blocks. Figure 1a and 1b show views of the residential from the vehicle and pedestrian access roads, respectively.

Figure 1: Residencial Solar das Palmeiras.



Source: Authors.

This housing complex was built in structural masonry of ceramic blocks with dimensions of 14x19x29 cm. The thickness of the laying mortar was 1 cm. The external walls have 2.5 cm thick plaster coating on the outside and finishing paint, receiving only paint internally, totaling 16.5 cm thick. The internal walls have no coating, the blocks received only paint (texture). The roof is made of fiber cement tiles with an 8 cm thick prefabricated concrete slab. The external frames are all in aluminum with a sliding opening system in the bedrooms and living room, maxi-air in the bathroom and opening in the service area (Curcio, 2011). The internal doors are in wood. The apartments were delivered to the residents with only the top face of the polished slab to finish the floors of the bedrooms and living room, with ceramic tiles being applied only in the wet areas of the bathroom, kitchen, and service area.

Residencial Paraíso was delivered to residents in August 2007, under the PAR SPECIAL modality. Figures 2a and 2b contain general views of the blocks, access roads, green areas, and spaces for parking vehicles. According to Azevedo and Guerra

(2008), the construction system used in the set consists of external and internal vertical seals of structural ceramic blocks with dimensions of 14x19x29 cm, and the external finish consists of roughcast, plaster, sealer, and acrylic paint. In the internal finish, only sealer and pigmented texture were used. The external frames are in aluminum and the internal ones in wood. The floors were built in pre-molded slabs, with the upper face (floor) of the bedrooms being simply polished, while ceramic tiles were applied in the other rooms. The underside of the slabs (ceiling) was not coated, thus remaining in exposed concrete. As for the foundations, excavated concrete piles were adopted. The roof consists of a wooden structure and fiber cement tiles.

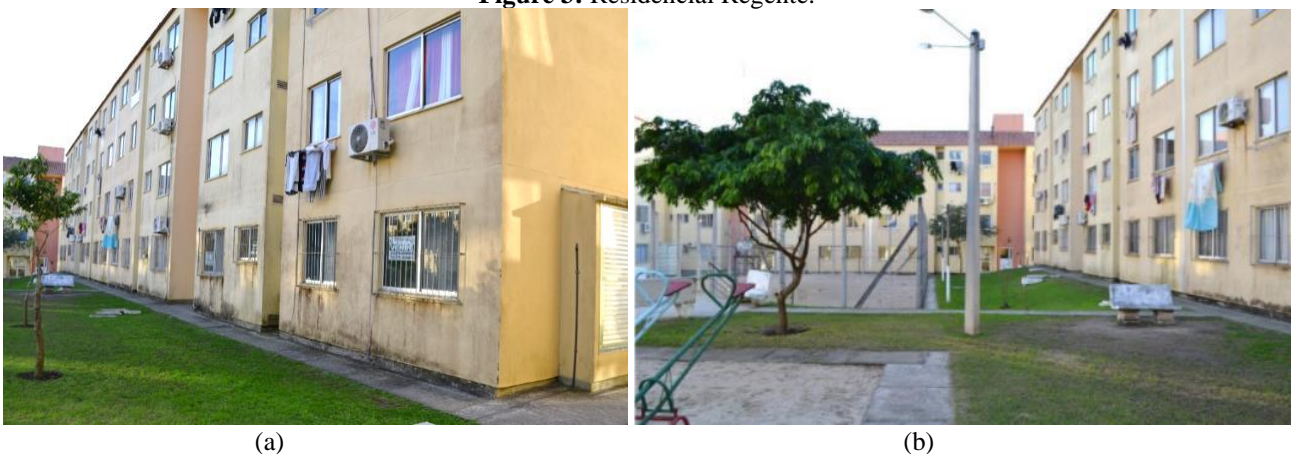
Figure 2: Residencial Paraíso.



Source: Authors.

The Residencial Regente are four-story housing projects belonging to the PAR Normal modality and were delivered to the tenants in January 2006. Figures 3a and 3b contain general views of the blocks. The construction system of the set consists of structural masonry of ceramic blocks with mortar coating. The floors were built on pre-molded slabs supported on the mooring belt made with a channel-type ceramic block filled with grout and the foundations are excavated concrete piles. The roof is composed of ceramic tiles on a wooden structure supported by masonry props on the roof slab. The set has a 15cm eaves and does not have a gutter for collecting rainwater. The external frames are made of aluminum, which are closed with transparent glass framed in the aluminum profiles. The windows do not have opaque closures. The drip trays were made of concrete and painted with the same paint as the masonry.

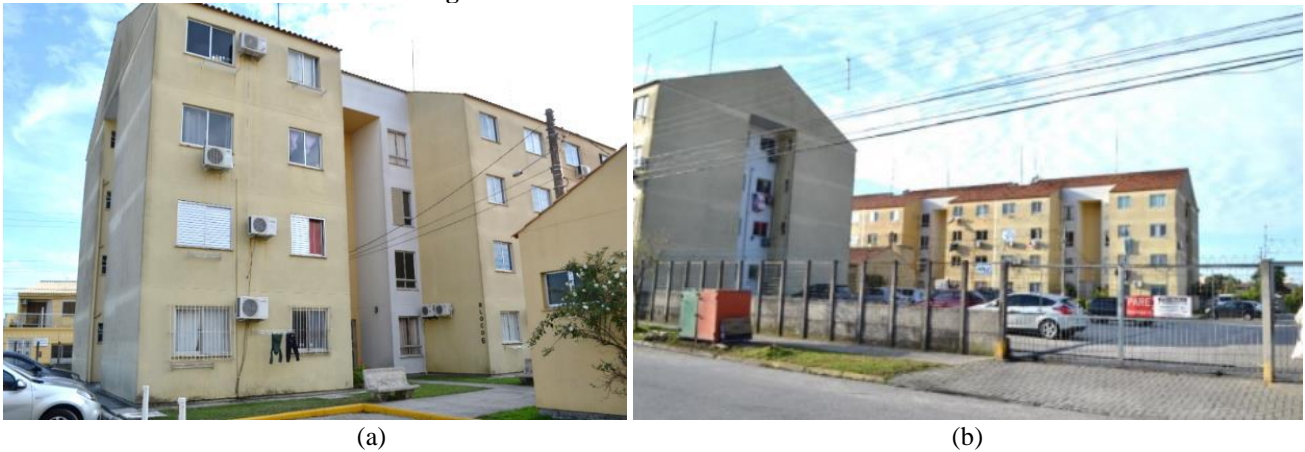
Figure 3: Residencial Regente.



Source: Authors.

Residencial Jardins da Baronesa consists of four-story buildings delivered to tenants in December 2005, belonging to the PAR Normal modality, shown in Figures 4a and 4b. The residential was built in structural masonry of ceramic blocks coated with mortar. The floors were built on pre-molded slabs supported on the mooring belt made with a channel-type ceramic block filled with grout and the foundations are excavated concrete piles. The roof is composed of ceramic tiles on a wooden structure supported by masonry props on the roof slab. The set has a 15cm eaves without a gutter to collect rainwater. The external frames are made of aluminum, with closure made with transparent glass, without opaque closure. The drip trays were also made of concrete and painted in the same color as the masonry.

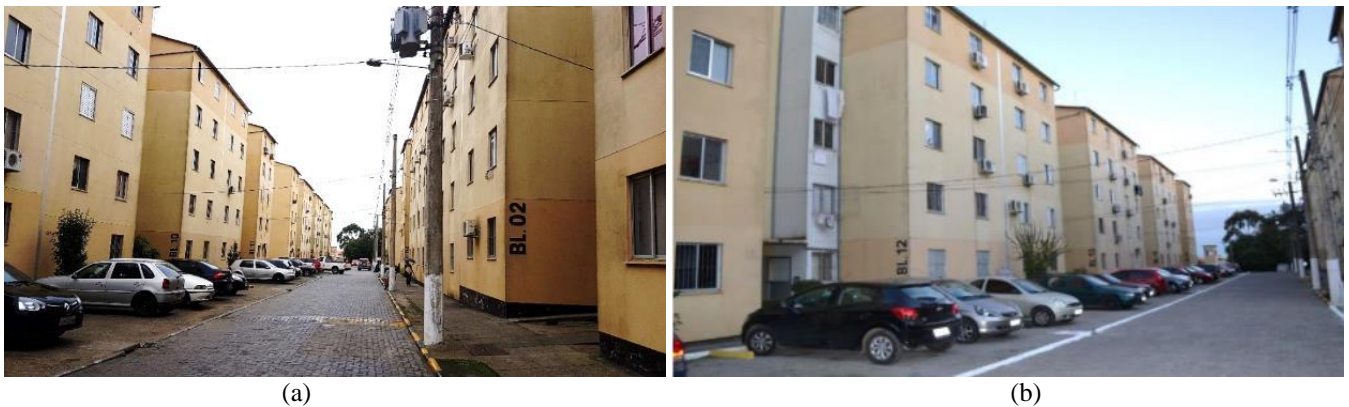
Figure 4: Residencial Jardins da Baronesa.



Source: Authors.

The Residencial Estrela Gaúcha, with five floors, belongs to the PAR Especial modality and is shown in Figures 5a and 5b. Like the other sets, this residential was also built-in structural masonry of ceramic blocks with floors executed in pre-molded slabs, supported on the mooring belt made with a channel-type ceramic block filled with grout and the foundations are excavated concrete piles. However, unlike the two previous sets, the Residencial Estrela Gaúcha has a roof with fiber cement tiles and gutters to collect rainwater. As in the other sets, the external frames are made of aluminum, with closure made with transparent glass, without opaque closure. The drip trays were also made of concrete and painted in the same color as the masonry.

Figure 5: Residencial Estrela Gaúcha.



Source: Authors.

Before starting the evaluations, authorizations were obtained from the landlords and condominium managers to carry out the research. During reconnaissance visits, it was found that the sets did not undergo recent maintenance actions.

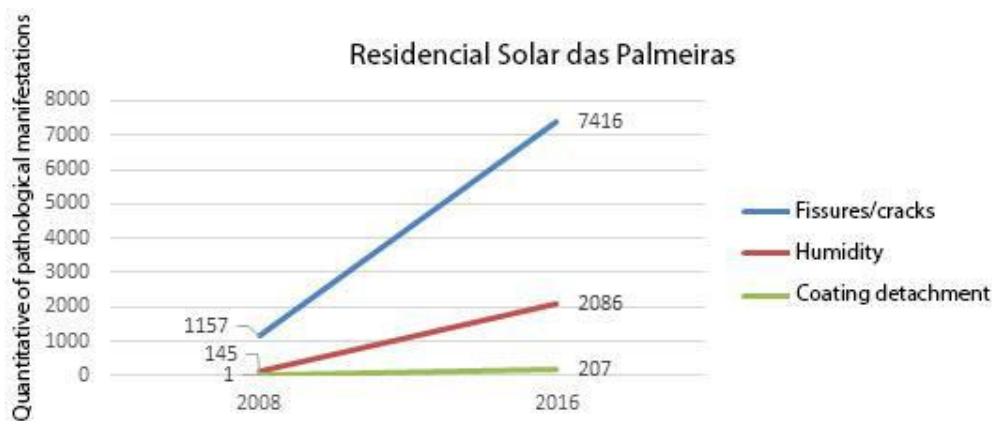
3. Results and Discussion

In The problem of finishing irregularities, which basically includes imperfections in the render resulting from inadequate execution, is an anomaly that manifests itself from the moment of construction, so the time elapsed between the end of the work and the completion of the survey has no influence on the number of observed occurrences. In the study of the INQUALHIS project, this data was significant to point out flaws in the construction period that affect the general quality of the finishing of the buildings. However, a new survey for quantification and comparison is irrelevant, as the problem does not change over time.

In Residencial Solar das Palmeiras, considering the same area of observation of facades and only the three groups of pathological manifestations: fissures/cracks, humidity, and coating detachment, in the INQUALHIS survey 1303 incidences were obtained and in the current survey 9709 incidences. There was an increase of approximately 745% in the number of incidences in a period of seven years and eight months.

Figure 6 was generated to visualize the differences in the incidence of diagnosed pathological manifestations. It is observed that the representation of fissures and cracks showed a decrease of 12.4% in relation to the previous survey. In terms of humidity, there was an increase of 10.4% in relation to the previous survey. Coating detachment, which previously had only 1 record, now represents 2.1% of the anomalies. The predominance of the cracking problem remains evident. This pathological manifestation represents 76.4% of the problems in the current survey and 88.8% in the previous one.

Figure 6: Comparison of the incidence of pathological manifestations from the survey with the INQUALHIS survey of Residencial Solar das Palmeiras.



Source: Authors.

In Residencial Paraíso, considering the same area of observation of facades and only the three main groups of pathological manifestations: fissures/cracks, humidity, and coating detachment, in the INQUALHIS survey only 82 incidences were obtained and in the current survey 9106 incidences. There was an impressive increase of approximately 11105% in the number of incidences over a period of eight years and three months.

Figure 7 was generated to visualize the differences in the incidence of diagnosed pathological manifestations. It is observed that the representation of fissures and cracks presented an increase of 6% in relation to the previous survey. In terms of humidity, there was a decrease of 6% in relation to the previous survey, the coating detachment continues to represent 9% of the anomalies. The predominance of the cracking problem remains evident. This pathological manifestation represents 67% of the problems in the current survey and 61% in the previous one.

Figure 7: Comparison of the incidence of pathological manifestations from the survey with the INQUALHIS survey of Residencial Paraíso.



Source: Authors.

The following graph, shown in Figure 8, shows the incidence of each group of pathological manifestations in the INQUALHIS survey and in the current survey of Residencial Regente. In the INQUALHIS survey, 954 pathological manifestations were diagnosed and in the current survey 9549 incidences, an increase of 1000.94% in the number of incidences in a period of 11 years and 3 months.

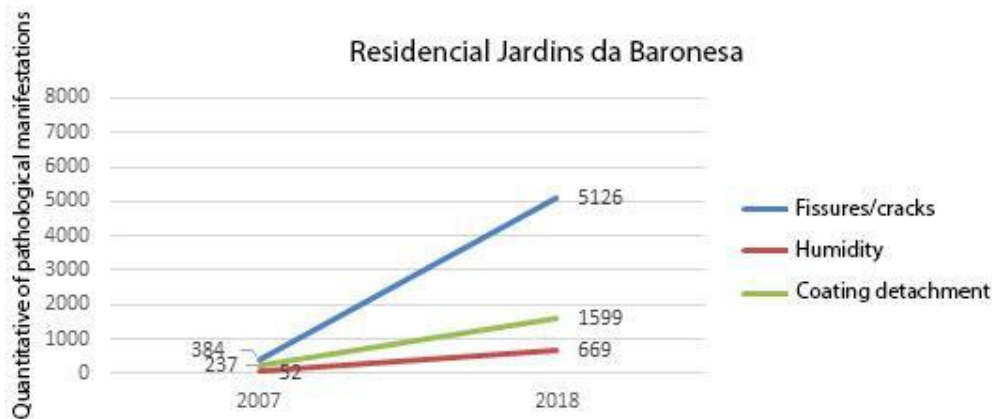
Figure 8: Comparison of the incidence of pathological manifestations from the survey with the INQUALHIS survey of Residencial Regente.



Source: Authors.

Figure 9 shows the incidence of each group of pathological manifestations in the INQUALHIS survey and in the current survey of Residencial Jardins da Baronesa. In the INQUALHIS survey, 673 manifestations were recorded while in the current survey 7861 occurrences, resulting in an increase of 1168.05% in 11 years and 3 months.

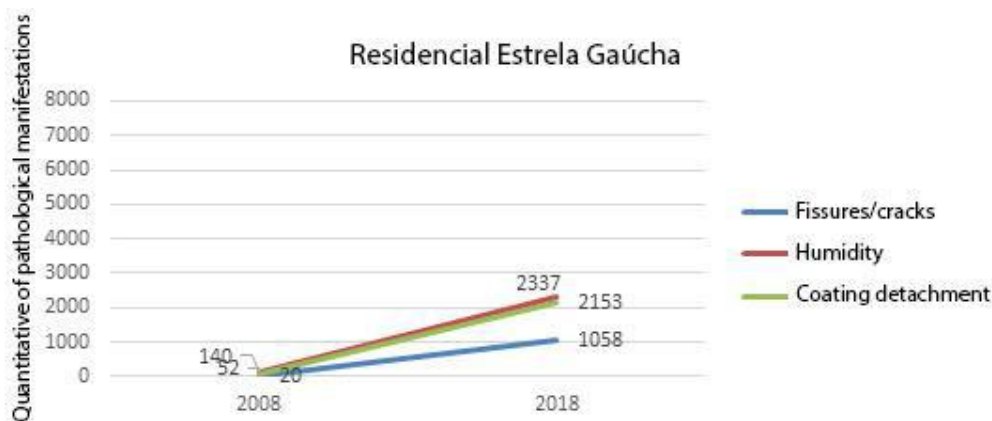
Figure 9: Comparison of the incidence of pathological manifestations from the survey with the INQUALHIS survey of Residencial Jardins da Baronesa.



Source: Authors.

In Residencial Estrela Gaúcha, considering the incidence of pathological manifestations in the two surveys is shown in Figure 10. There was an increase between the two surveys of 3450.94%, increasing from 212 manifestations to 7316 in a period of 11 years and 4 months.

Figure 10: Comparison of the incidence of pathological manifestations from the survey with the INQUALHIS survey of Residencial Estrela Gaúcha.

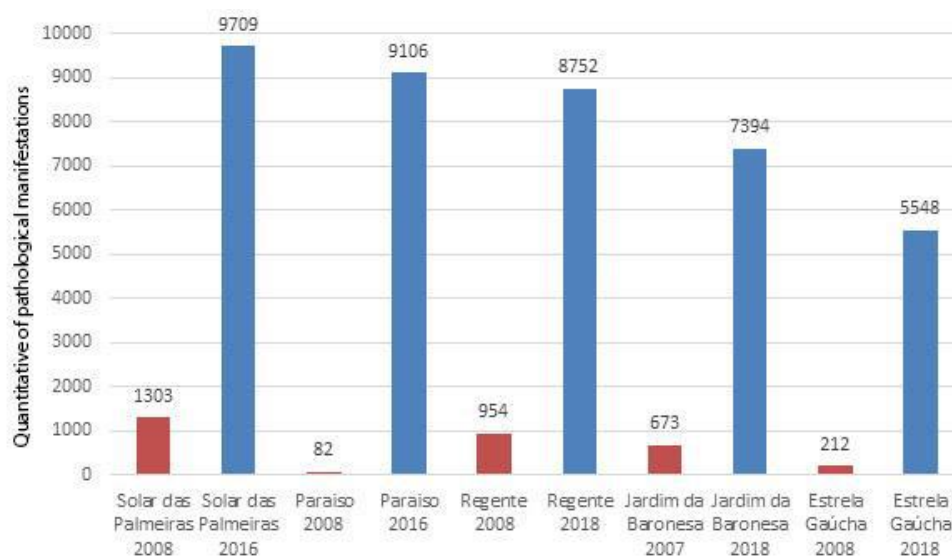


Source: Authors.

Thus, from the surveys carried out, Figure 11 presents the comparison of the quantity of pathological manifestations of the INQUALHIS survey with the current survey of the condominiums studied in this work. From the INQUALHIS survey carried out between 2007 and 2008 - carried out shortly after the construction of the housing projects - compared to surveys carried out between 2016 and 2018, it was possible to observe that all projects had significant increases in the number of incidences of pathological manifestations in the external facades of the complexes, showing that most of the damage incidents on the facades of the housing complexes in this study are problems related to maintenance. Therefore, there is a need for improvement in the use phase, with the management of maintenance activities. Comparing the survey (2016 and 2019) and the INQUALHIS survey (2007 and 2008), it was possible to observe that the Normal or Special modality did not influence the emergence of pathological manifestations. The residential complexes of the PAR Normal modality intended for a higher income bracket, do not have superior constructive quality in relation to the incidence of pathological manifestations, considering the Residencial Regente and

Residencial Jardins da Baronesa (PAR Normal) had a higher incidence of pathological manifestations than the Residencial Estrela Gaúcha of the Special modality. In addition, the housing complexes that had the highest incidence of pathological manifestations in INQUALHIS maintained the highest incidence in the current survey, with the greatest degradation in the facades: Residencial Solar das Palmeiras, followed by Residencial Regente. When comparing the enterprises of the Normal PAR type, no significant difference was observed between them. However, it was possible to observe a significant difference between the buildings of the special modality, in view of the projects Residencial Solar das Palmeiras and Residencial Paraíso have the highest number of damages and the Residencial Estrela Gaúcha the lowest number of damages in this research.

Figure 11: Comparison of the quantity of pathological manifestations of the INQUALHIS survey with the survey of pathological manifestations.

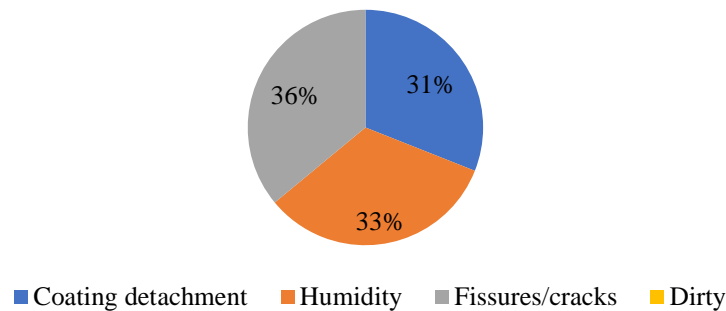


Source: Authors.

To obtain the results of the evaluation of user satisfaction, after carrying out the surveys of incidences of pathological manifestations, thirty structured interviews were carried out with the users. In Residencial Solar das Palmeiras, it was found that 67% of respondents own and 33% rent the property, so there were no interviews with tenants. Most respondents are female, making up 73% of participants. The age group of 47% of the participants is from 40 to 59 years old, 23% from 25 to 39 years old, 23% over 60 years old and 7% up to 24 years old. Questions were asked about which floor the user lived on. Most participants (37%) live on the ground floor, with the remaining percentage distributed as follows: 23% on the 4th floor, 20% on the 3rd, 13% on the 5th and 7% on the 2nd. As for the number of residents per housing unit, it was found that most of the respondents' apartments are inhabited by three people (47%) or two people (36%), 10% by one person and 7% by four or more people.

About the user's perception in relation to pathological manifestations, 90% of the interviewees have already noticed the existing damages on the facades of the residential and 60% feel uncomfortable with these problems. However, only 30% of users made a complaint to the real estate administrator in relation to these problems on the facades. With this information, it is noted that there is a considerable distance between perceiving a problem and intervening in some way to reach a solution, in this case, claiming actions from the condominium administrator. The pathological manifestation that most attracts the attention of the users interviewed is cracking, followed by recurring problems of moisture and detachment of the coating, as shown in Figure 12. The order of relevance shown by the interviewees about existing anomalies coincides with the technical survey carried out, which verified the highest number of incidents related to cracks, followed by problems of moisture and coating detachment.

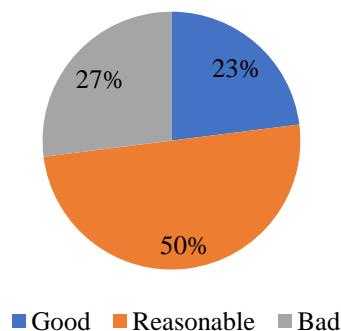
Figure 12: Percentage of pathological manifestations, according to the relevance given by the user of Residencial Solar das Palmeiras.



Source: Authors.

Most of the interviewees consider the situation of the facades to be reasonable (50%), with 27% considering it to be bad and 23% considering it to be in good condition (Figure 13). Regarding the need for maintenance on the facades, 90% of respondents consider it necessary and 10% believe that maintenance on the residential facades is not necessary. Although 23% of the residents consider that the facades are in good condition and 50% assess the situation as reasonable, almost all (90%) of the respondents declared that maintenance interventions were necessary.

Figure 13: Percentage of user perception regarding the situation of the facades in Residencial Solar das Palmeiras.



Source: Authors.

And, in relation to the maintenance priorities to be performed on the facades, the interviewees arranged the repairs in the coatings in order of priority, for later washing, followed by the painting of the facades. Although the survey did not contain any requirement regarding knowledge of the civil construction area on the part of the interviewees, their perception regarding the priority of maintenance is quite appropriate, since the application of a good and durable paint film is preceded, first, by the recovery of damaged areas of the coating and then by the cleaning and preparation of the surfaces that will receive the final finish.

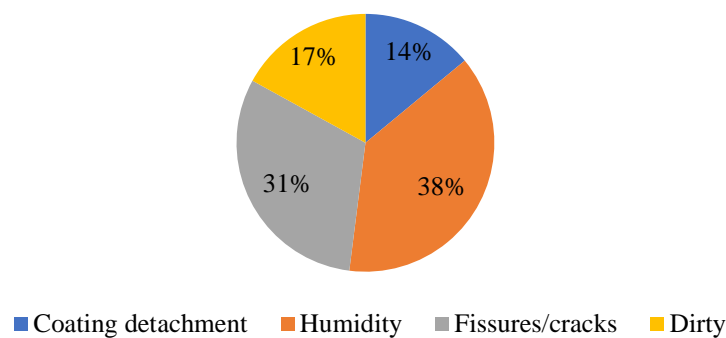
In Residencial Paraíso, it was found that 57% of respondents are owners and 33% are tenants of the property, and 10% are tenants. Most respondents are female, making up 53% of participants. The age group of 47% of the participants is 25 to 39 years old, 40% from 40 to 59 years old, 10% up to 24 years old and 3% over 60 years old.

As for the number of residents per housing unit, it was found that most apartments of respondents are inhabited by two people (50%) or three people (30%), 13% by four or more people and 7% by one person.

About the user's perception of pathological manifestations, 70% of respondents have already noticed the damage to the residential facades and 57% feel uncomfortable with these problems. However, only 33% of users made a complaint to the real estate administrator in relation to these problems on the facades. Evidencing the distance between the perception of a problem and the search for a solution by the residents.

According to Figure 14, the pathological manifestation that most attracts the attention of the users interviewed is humidity, followed by problems of cracking, dirtiness, and detachment of the coating. The order of relevance shown by the interviewees about existing anomalies does not coincide with the technical survey carried out, as it verified the highest number of incidences related to cracks, followed by problems of moisture, coating detachment and dirt.

Figure 14: Percentage of pathological manifestations, according to the relevance given by the user of Residencial Paraíso.

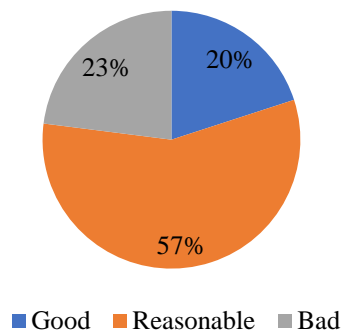


Source: Authors.

And, in relation to the maintenance priorities to be performed on the facades, the answers arranged in order of priority the washing, for later repairs in the coatings, followed by the painting of the facades. The priority given to washing by the interviewees is explained by the appearance of the facades, which, in general, are significantly impaired by the presence of fungi. Repairing the coatings, appearing before painting in the order of priority of the residents, is adequate, since the execution of a good and durable finishing painting is preceded, first, by the recovery of areas with cracks and detachments, in addition to cleaning the surface.

Most of the interviewees consider the situation of the facades to be reasonable (57%), with 23% considering it to be bad and 20% considering it to be in good condition (Figure 15). Regarding the need for maintenance on the facades, 83% of respondents consider it necessary and 17% believe that maintenance on the residential facades is not necessary. Although 20% of residents consider the facades to be in good condition and 57% assess the situation as reasonable, the majority (83%) of respondents declared that maintenance interventions are necessary. This appreciation of maintenance activities by the residents is essential, both for motivation in the search for intervention services with the administrator, as well as in the care with the conservation of the facades by the users themselves.

Figure 15: Percentage of user perception regarding the situation of the facades in Residencial Paraíso.

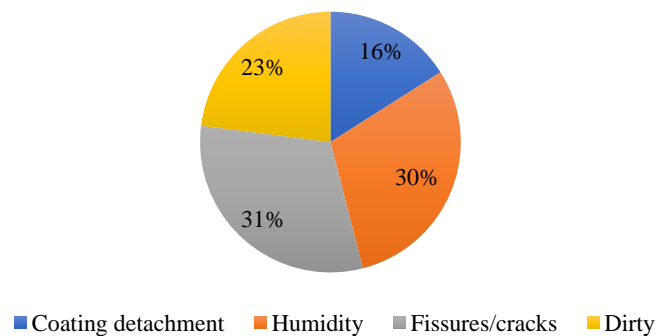


Source: Authors.

In Residencial Regente, most respondents were female (80%) between 25 and 39 years old (40%) and 40 to 59 years old (30%). Most respondents, 67%, are tenants of the apartment, another 27% are owners and 6% are tenants. As for the number of residents per housing unit, 40% of the respondent residents' apartments are inhabited by two people, followed by 20% by four or more people, 20% by three people and 20% by one person.

As for user satisfaction in relation to pathological manifestations, residents were asked if they had already noticed the problems on the facades of buildings, and most respondents said yes (90%), and when asked if these problems bothered them, 90% of residents answered yes. As shown in Figure 16, the pathological manifestations that most call the attention of residents are fissures and cracks (31%) and humidity (30%), followed by dirt (23%), with coating detachment being the pathological manifestation that draws attention. less attention (16%). The manifestation that most attracts the attention of the residents coincides with the most frequent pathological manifestation, fissures, and cracks.

Figure 16: Percentage of pathological manifestations, according to the relevance given by the user of Residencial Regente.

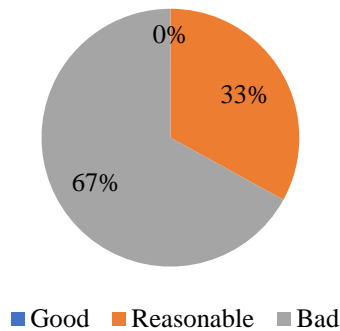


Source: Authors.

Regarding the maintenance of the facades, all respondents considered maintenance activities necessary, including those who had not noticed the problems. However, 77% never made any type of complaint with the real estate company about the problems with the facades.

Finally, residents were asked to assess the current situation of the buildings. The responses are shown in Figure 17. According to the graph, 67% of the respondents consider the current situation of the facades of buildings to be bad, against 33% who consider it as reasonable. None of the respondents qualified the facades as good.

Figure 17: Percentage of user perception regarding the situation of the facades in Residencial Regente.

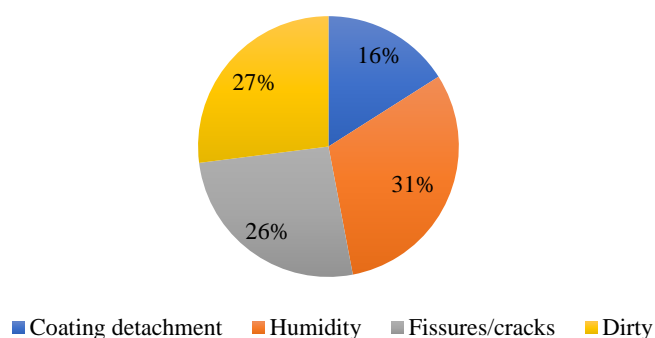


Source: Authors.

In Residencial Jardins da Baronesa, most respondents were female (63%), 50% between 25 and 39 years old and 27% between 40 and 59 years old. Most respondents (50%) own the apartment, followed by tenants, who represent 47% of residents, the rest are tenants (3%). As for the number of residents per housing unit, 47% of the respondent residents' apartments are inhabited by two people, followed by 23% by four or more people, 20% by one person, and 10% by three people.

As for user satisfaction in relation to pathological manifestations, residents were asked if they had already noticed the problems existing on the facades of buildings. Most respondents said yes (93%), and when asked if these problems bothered them, 90% of residents answered yes. As shown in Figure 18, the pathological manifestations that most call the attention of the residents are humidity (31%), followed by dirt (27%), fissures and cracks (26%) and coating detachment (16%). Despite the high incidence of fissures and cracks in the residential, most of it is on the back facade of Building A, so it is not seen by most residents.

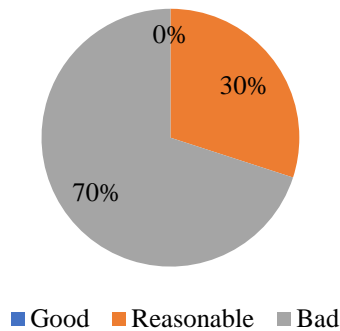
Figure 18: Percentage of pathological manifestations, according to the relevance given by the user of Residencial Jardins da Baronesa.



Source: Authors.

Regarding the maintenance of the facades, all respondents considered necessary maintenance actions, including those who had not noticed the problems. However, 70% never made any kind of complaint with the real estate company about the problems with the facades. Finally, residents were asked to assess the current situation of the buildings. As shown in Figure 19, 70% of respondents consider the current situation of the facades of buildings to be bad, against 30% who consider it to be reasonable. None of the respondents qualified the facades as good.

Figure 19: Percentage of user perception regarding the situation of the facades in Residencial Jardins da Baronesa.



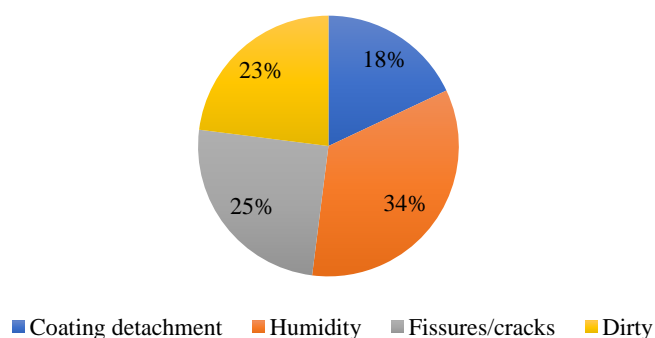
Source: Authors.

At Residencial Estrela Gaúcha, most respondents were female (73%) between 10 and 59 years old (33%) and up to 24 years old (30%). Most respondents (57%) are tenants of the apartment, followed by owners (30%), with the remainder being tenants (13%). As for the number of residents per housing unit, 43% of the respondent residents' apartments are inhabited by three people, followed by 27% by one person, 17% by four or more people, and 13% by two people.

As for user satisfaction in relation to pathological manifestations, residents were asked if they had already noticed the problems existing on the facades of buildings. Most respondents said yes (80%), and when asked if these problems bothered them, 73% of residents answered yes.

As shown in Figure 20, the pathological manifestations that most call the attention of residents are humidity (34%), followed by dirt (23%), fissures and cracks (25%) and coating detachment (18%). At Residencial Estrela Gaúcha, the most common pathological manifestation is humidity, so residents can observe this fact.

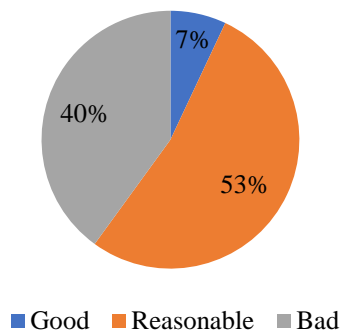
Figure 20: Percentage of pathological manifestations, according to the relevance given by the user of Residencial Estrela Gaúcha.



Source: Authors.

Regarding the maintenance of the facades, all respondents considered maintenance activities necessary, including those who had not noticed the problems. However, 70% never made any kind of complaint with the real estate company about the problems with the facades. Finally, residents were asked to assess the current situation of the buildings, with the answers shown in Figure 21. 53% of the respondents consider the situation of the facades of the buildings as reasonable, 40% that they consider it as bad and only 7% consider the situation good.

Figure 21: Percentage of user perception regarding the situation of the facades in Residencial Estrela Gaúcha.



Source: Authors.

4. Conclusion

The method used to inspect the facade coverings was effective in diagnosing pathological manifestations and can be replicated in PAR social housing in other cities and other architectural and constructive typologies and other housing programs.

The residential ones presented problems that could have been avoided with the adoption of more rigorous quality standards, since the design flaws, work execution and quality of materials contribute to the degradation of buildings. The anomalies incident on the facades of the housing projects in this study are also problems related to use and lack of maintenance. This study, in addition to helping to detect the problems of the objects of study, allows for a better understanding of the process of production and management of social housing in Brazil.

With the comparison between the current survey and INQUALHIS, it was possible to verify that the survey carried out in the newly built sets showed a tendency of degradation of the buildings, where the sets that showed a higher incidence of pathological manifestations in INQUALHIS maintained a higher incidence in the current survey, Residencial Solar das Palmeiras, followed by Residencial Regente, had greater degradation on the facades. The exception was found in Residencial Paraíso, which had the lowest incidence of damage in the INQUALIS survey and an increase of 11105% in the number of incidents in a period of eight years and three months. In addition, observing the types of manifestations incident on the facades of both surveys, it was possible to perceive that the survey carried out in the newly built projects already revealed a predisposition of the most incident types in each set.

The problems encountered, in addition to reducing performance and useful life, impair the habitability of buildings. Contrary to expectations, the residential complexes of the PAR Normal modality intended for a higher income range do not have superior constructive quality, in relation to the incidence of pathological manifestations of the mortar coatings, since the Residencial Regente and the Residencial Jardins da Baronesa, of this modality, had a higher incidence than the Residencial Estrela Gaúcha, of the Special modality.

The inspection carried out in the housing projects should serve as a basis for the elaboration of a maintenance plan, but the implementation of the plan is conditioned to the availability of resources of the residents, which, in the case of housing of social interest, are limited. In this way, it is confirmed the fact that the availability of resources of the residents for the maintenance of the buildings must be considered, in the design and execution of housing of social interest, looking for alternatives for lower costs of operation, maintenance and repair of the buildings during its lifespan.

Most of the interviewees perceive the existing damages on the facades of the residential and feel uncomfortable with them. However, the minority of users made some type of complaint with the real estate administrator in relation to these problems. Evidencing a considerable distance between perceiving a problem and intervening in some way to reach the solution.

Residents' satisfaction with the housing complex is totally related to the appearance of the buildings. The appreciation of maintenance activities by residents is essential to obtain positive results in the conservation of this element, which is not only exposed to various agents of degradation but is also deeply associated with the aesthetics and protection of the building. After all, interest, concerns, and efforts related to maintenance interventions can result in a series of programmed activities, which are crucial to solve existing problems and avoid the emergence of new pathological manifestations, prolonging the useful life of facades at a rewarding cost.

Acknowledgments

The authors appreciate the financial assistance provided by CAPES (Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) —Finance Code 001— and the support of NEPAMAT (Núcleo de Estudos em Patologias e Materiais), PROGRAU (Programa de Pós-Graduação em Arquitetura e Urbanismo), and UFPel (Universidade Federal de Pelotas).

References

- ABNT. NBR 5674 (2012). *Manutenção de edificações: Requisitos para o sistema de gestão de manutenção*. Associação Brasileira de Normas Técnicas.
- Aleixo, H. S. P.; Eloy, G. R.; & Silva Junior, L. A. (2019). Pathological problems - Case study of the Antônio Papini Public School in João Monlevade. *Research, Society and Development*, 8(6).
- Azevedo, S. L. & Guerra, F. L. (2008). Análise comparativa do levantamento das manifestações patológicas em conjuntos habitacionais para população de baixa renda. *Anais do XVII Congresso de Iniciação Científica e X Encontro de Pós-Graduação*. Pelotas, RS, Brasil.
- Cirino, M. A. G.; Oliveira, B. B. De; Pereira, S. L. De O.; Cordeiro, S. B.; Morais, J. M. P. De; Silva, E. M. Da; & Barboza, E. N. (2020). Evaluation of the pathological manifestations of the buildings of the department of food engineering of the Federal University of Ceará. *Research, Society and Development*, 9(7).
- Cordeiro, J. T. De L.; Barbosa, V. M.; & Vilas Boas, D. C. C. (2021). Survey of pathological manifestations of civil construction: a study in home residence in the City of São Luís, Maranhão. *Research, Society and Development*, 10(12).
- Correa, T. dos S.; Pacheco, F.; Ehrenbring, H. Z.; Christ, R. & Simonetti, C. (2022). Analysis of pathological manifestations in two municipal schools in Canoas/RS: comparative case study between innovative and conventional systems. *Research, Society and Development*, 11(6).
- Chiarelli, L. M. Á. (2014). *Habitação Social em Pelotas (1987 – 2010). Influências das políticas públicas na promoção de conjuntos habitacionais. [Social Housing in Pelotas (1987 – 2010) (Tese de Doutorado)*. Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, Brasil.
- Curcio, D.R. (2011). *Desempenho termo-energético de Habitações de Interesse Social produzidas pelo Programa de Arrendamento Residencial – PAR na cidade de Pelotas/RS* (Dissertação de Mestrado). Universidade Federal de Pelotas, Pelotas, RS, Brasil.
- GIL, A. C. (2002). *Como elaborar projetos de pesquisa*. Atlas.
- Madureira, S.; Flores-Colen, I.; De Brito, J. & Pereira, C. (2017). Maintenance planning of facades in current buildings. *Construction and Building Materials*, 147.
- Medvedovski, N. S. (2010). *Geração de indicadores de qualidade dos espaços coletivos em EHS – INQUALHIS. Relatório final de conclusão de Pesquisa do Núcleo de Pesquisa em Arquitetura e Urbanismo*. FINEP/HABITARE.
- Silva, V. M. B. (2016). *Manifestações Patológicas em Fachadas de Empreendimentos do Programa de Arrendamento Residencial na Cidade de Pelotas/RS: Residenciais Solar das Palmeiras e Paraíso*. (Dissertação de Mestrado). Universidade Federal de Pelotas, Pelotas, RS, Brasil
- Stuckert, T. C. & Sobrinho Júnior, A. (2016). Patologias em habitações de interesse social. *Revista InterScientia*, 4(2).
- Vieira, F. N. (2015). *Proposta de elaboração de plano de manutenção para edificações a partir da obrigatoriedade legal da inspeção predial no contexto urbano das Cidades*. (Dissertação de Mestrado). Universidade Federal do Rio de Janeiro., Rio de Janeiro, RJ, Brasil
- Yin, R. K. (2001). O estudo de caso. Bookman.