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REHABILITATION IN SOCIAL HOUSING: A CASE STUDY ON TECHNICAL ASSISTANCE THROUGH UNIVERSITY EXTENSION IN BRAZIL

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Abstract: In a context marked by precarious conditions of social housing, the fragility of public housing policies, and the limited involvement of construction professionals in this realm, this article aims to present data on how academic extension practices in *Technical Assistance for Housing of Social Interest (TAHSI)* contribute to the rehabilitation of houses and to improve life quality for socially vulnerable families, focusing on civil engineers' participation. As a case study, the ATHOS Extension Project – *Technical Assistance for Social Housing* was analyzed. It has been implemented by the Faculty of Architecture and Urbanism at the University of Brasília since 2018, and the investigation focus on housing improvement actions in Dorothy Stang settlement, in Sobradinho, Federal District, Brazil, in 2024. The analysis was carried out using the participant observation method. Guiding principles of architectural and complementary projects developed within the technical assistance framework were observed, specifically in house rehabilitation: in this case, the renovation/expansion of a pre-existing and inhabited housing unit. The premise is that the involvement of civil engineers can help prevent construction pathologies and the lack of structural elements, both common outcomes of self-built housing practices. The phased execution proposal within the design concept allows beneficiaries to gradually obtain financial resources needed for the construction. Through the observation of civil engineers' contribution, the article highlights its potential to effectively integrate technical knowledge with social demands, thus expanding their professional scope within TAHSI.

Keywords: Social housing; Civil Engineering; Technical Assistance; House Rehabilitation.

1. Introduction

The precarious conditions of houses in vulnerable territories represent a critical issue in Brazil. Despite public policies developed over the years and the significant social housing¹ production throughout the 20th century, there is still an estimated housing deficit of approximately 6 million house units (FJP, 2022). According to a study by the *Fundação João Pinheiro* - FJP (2022), nearly 27.1% of households within housing deficit are classified as precarious. This precariousness extends beyond housing shortages, encompassing issues such as poor construction performance, inadequate materials, and a lack of basic infrastructure, including sanitation,

¹ The term "Social Housing" is used here to describe nonmarket private housing produced either in the context of public policies or by self-construction processes.



public lighting, and accessibility. Addressing these demands requires recognizing the role of civil engineers in improving social housing, particularly when integrated into professional training through extension activities. The Brazilian Federal Law No. 11.888/2008 (BRASIL, 2008), which establishes free public technical assistance for the design and construction of Social Housing, underscores the importance of specialized professionals assisting low-income families, promoting housing dignity and strengthening citizenship. The involvement of these professionals in Social Housing projects enables a shift from an emergency-based model to housing planning: it prioritizes the construction of houses, community empowerment and access to fundamental rights.

The Brazilian Council of Architecture and Urbanism (CAU/BR, in Portuguese) and the Federal Council of Engineering and Agronomy (CONFEA, in Portuguese) emphasize the importance of integrating civil engineers and architects into multidisciplinary teams to address housing challenges. Through their Regional Councils, these entities have supported the inclusion of what they call “Public Engineering and Architecture” in the implementation of Law No. 11.888/2008 (BRASIL, 2008). According to a Technical Assistance Report (CAU/BR, 2023), investments in technical assistance directly improve living conditions, reduce risks of urban disasters, and foster social inclusion. This approach highlights the important role of construction professionals in combating housing inequality and enhancing life quality for families in vulnerable living conditions.

In this context, the main objective of this article is to demonstrate how academic extension practices in Technical Assistance for Social Housing (TAHSI) can contribute to the rehabilitation of houses, promoting better living conditions for socially vulnerable families. This practice is also essential for the professional development of future civil engineers, as it fosters technical skills and strengthens their social engagement. By participating in projects aimed at improving social housing conditions, students apply acquired knowledge while gaining a broader understanding of social and environmental demands.

To achieve this goal, we adopted an exploratory methodological approach based on a qualitative focus, the participant observation method (THIOLLENT, 1987). The study case is the action of the “Technical Assistance for Social Housing” (ATHOS, in Portuguese) academic extension project, developed by the Faculty of Architecture and Urbanism at the University of Brasília in 2024. In that year, ATHOS project proposed housing rehabilitation at Dorothy Stang settlement, located in Sobradinho, Federal District, Brazil. Once the case study was defined, we surveyed the adopted guiding principles of architectural and complementary projects linked to technical assistance. The action included a proposal for the renovation and expansion of a self-built house with reinforced masonry. It was defined that the construction process should take place in stages, allowing the beneficiary to gradually obtain the financial resources required to complete the work.

The article outlines the investigative path adopted to acquire both theoretical and practical knowledge and its contribution to the improvement of civil engineering education. It aims to highlight the importance of integrating TAHSI oriented extension practices into academic training. It emphasizes their role in applying technical knowledge to contexts of socio-spatial vulnerability to prevent construction deficiencies and to enhance social impact of the profession.

2. Case study: The ATHOS Project in Dorothy Stang settlement (2024)

The ATHOS Project began in 2018 with the goal of improving life quality for socially vulnerable families through technical assistance for housing improvements. Its focus includes architecture design, building safety, accessibility, sanitation, construction training, and urban development, and also assisting organized community groups. Its actions aim to address families’ housing needs through continuous and participatory dialogue, aligning specific demands with technically and socially adequate solutions. The work team includes architecture and civil engineering professors and students.

In 2024, ATHOS Project collaborated with the Lato Sensu Postgraduate Program in Residency in Science, Technology, and Society (Residencia CTS, in Portuguese) – Habitat, Agroecology, Solidarity Economy, and Ecosystem Health, focusing on Dorothy Stang settlement, in Sobradinho/DF, together with Periferia Viva

Program, from the Ministry of Cities. This initiative reinforced ATHOS's role in the TAHSI field and expanded its social impact. The extension project provided TAHSI services to families previously selected in partnership with the "Residents, Fighters, and Supporters Association of the Dorothy Stang Residential" (AMREDS, in Portuguese), through a working process that integrates undergraduate and graduate students with faculty members. It strengthened knowledge exchange between university and community. The involvement of these diverse actors enables an interdisciplinary and multigenerational approach through a practical, collaborative learning experience.

According to Costa (2019), the occupation of Dorothy Stang territory (Figures 1a and 1b) began in 2015, driven by the social movement "*Frente Nacional de Luta*"² (FNL). The urban design was established gradually, with streets formed by the division of land among families, resulting in a spontaneous urban configuration. Today, AMREDS represents and defends residents' interests, playing a key role in articulating local demands and advocating for housing and infrastructure improvements. The settlement has grown, and the territory's boundaries have been consolidated, as shown by Geoportal³ data (see Figure 1b). This growth has attracted public attention to land property and increased infrastructure investment.



Figure 1 – Location of Dorothy Stang settlement, Sobradinho, Federal District, Brazil

Figure 2 illustrates the built environment in the region, highlighting the precarious housing conditions houses, mostly built through self-built housing processes. Some dwellings were even constructed with inadequate and improvised materials, such as plywood. In addition to the structural weaknesses, there is a noticeable lack of basic infrastructure.

Within the framework of the ATHOS Project Case study in Dorothy Stang settlement, the outputs developed are assessed based on the analysis of the product of the technical assistance provided to one family.

² A Brazilian Land and Housing Rights Community based Movement

³ Federal District Spatial Data Infrastructure (IDE/DF/ in portuguese). <https://www.ide.df.gov.br/geoportal/>



(a) Dorothy Stang Settlement in 2017



(b) Dorothy Stang Settlement in 2024

Figure 2 – Existing houses in Dorothy Stang settlement in different years.
Source: ATHOS Project Archive (2024)

Figure 3 illustrates the stages of the technical assistance process, which begins with the selection of beneficiaries and culminates in the delivery of final documents developed for each family. The first stage involved selecting families through a public call, conducted in partnership with the CTS Residency and AMREDS. The selection criteria focused on families facing significant socio-economic vulnerability and those living in precarious housing conditions. However, to proceed, families needed to demonstrate the availability of financial resources for both materials and labor to construct at least one room based on the technical assistance provided. The selection process employed a points system that took into account factors such as the availability of family members or collaborators to participate in construction, the length of engagement in community work, the status of being a mother or head of the household, and the presence of individuals with disabilities and/or elderly family members.

1. FAMILY SELECTION	2. SITE INSPECTION	3. PRELIMINARY ARCHITECTURE DESIGN	4. CONSTRUCTION DOCUMENTS
The ATHOS Project team, in partnership with Residência CTS, the Periferia Viva program, and AMREDS, prepares the call for applications and the family selection process. This phase involves data collection and contact with interested families. Additionally, it includes structuring the activity schedule, as well as the selection and training of undergraduate extension students.	The team conducts a physical and photographic survey of the lot, building, and furniture, as well as interviews with the beneficiary family. Resulting documents: - Survey documentation; - Technical diagnostic report.	The survey data and family needs are consolidated; proposals are developed and presented to the family, subject to revision. Resulting documents: - Preliminary Architecture Design.	The team develops and finalizes the budget and construction documents (architecture, structure, and plumbing/electrical systems); models and 3D-prints the scale model; and presents it to the family. Resulting documents: - Construction Design Set; - Budget Spreadsheet; - Physical Scale Model; - Descriptive Memorial; - Training Workshop.

Figure 3 – Stages and outputs developed during technical assistance processes for Social Housing improvements

The second stage involved conducting interviews with the selected families to understand their specific needs, expectations, and previous experiences with construction processes. This approach allowed for the mapping of demands and the planning of tailored solutions that were appropriate to the context of each household. It is worth highlighting that the ATHOS Project employs a participatory methodology, engaging families in decision-making process and ensuring that the architectural project reflects their values, cultures, and realities. This exchange of knowledge between the university and the community fosters a dynamic learning experience, enabling students to develop skills that go beyond technical abilities, such as active listening, negotiation, and adaptation to challenging adverse contexts.

At this stage, a survey of the physical conditions of the dwellings is conducted through observation visits and detailed photographic documentation. This allows for a comprehensive analysis of the structural and

functional state of the house. The information collected in the field aids in preparing technical diagnoses that consider the specific needs of the families. During this process, any construction and design flaws that compromise the safety, accessibility, and salubrity of the dwellings are identified.

Based on this data, the third stage begins, in which undergraduate students—guided by faculty and postgraduate students — develop proposals for the improvement of the houses, in line with the extensionist principle of valuing student protagonism. During this phase, preliminary studies are prepared and presented to the families in an intermediate session so they may evaluate the proposals, either approving them in full or requesting changes based on their needs and expectations. This intermediate and responsive delivery reinforces the participatory nature of the extension activity, ensuring that the technical solutions are aligned with the reality of the beneficiaries.

The fourth stage corresponds to the delivery of the complete material for construction. This includes the architectural executive project and the complementary projects (structural, electrical, and hydrosanitary installations), detailed according to the established guidelines, in addition to a preliminary budget. This budget uses information from the National System of Costs Survey and Indexes of Civil Construction - SINAPI, in Portuguese – that is a public database managed by the Brazilian federal government. SINAPI offers standardized cost references for materials and labor in civil construction throughout Brazil, which helps ensure that cost estimations are transparent and reliable. To facilitate understanding of the proposal, a physical 3D-printed model of the dwelling (Figure 4) is also presented to the family. These models are produced by the Laboratory of Prototyping, Innovation, and Systems Laboratory (LAPIS, in Portuguese), allowing for a concrete and accessible visualization of the developed project.

The ATHOS Project also aims to complement the technical assistance provided by offering families, potential builders, and other interested residents a Construction Process Training Workshop, detailed in section 3.4 of this article.



(a) Preliminary study



(b) Executive Project

Figure 4 – Presentation of the preliminary study and the executive project to the beneficiary.

Source: ATHOS Project Archive (2024)

3. The technical assistance provided

In 2024, the ATHOS project provided TAHSI to nine families, focusing on the rehabilitation of houses. Among these, six involved the design of new housing units, and three focused on housing improvements through renovations and extensions of pre-existing structures in precarious conditions. For this case study, one social housing unit was selected for analysis, which involved the evaluation and proposal of interventions in an

existing dwelling. The aim of this selection was to highlight the procedures necessary for this type of technical assistance in previously built structures, where the proposed solutions need to be adapted to the pre-existing conditions of the building and its immediate surroundings.

3.1 Characteristics of the social housing unit

The chosen social housing unit for this study is located in a mid-block plot. It is the residence for two individuals: the beneficiary APS, and his mother. The existing house, located at the rear of the lot, is built using conventional masonry and features reinforced concrete beams and columns. Its layout is quite simple, consisting of an integrated living room and kitchen, two bedrooms, and a bathroom. The walls and floors are unfinished, and only the front entrance of the house has a door, while the other areas are either closed off with curtains or left open. The bathroom lacks a window, and the bedrooms have incomplete openings without frames or glass. The roof is single-pitched, supported by a wooden structure covered with fiber-cement tiles (Figure 5).

The surroundings of the house are enclosed with improvised materials such as wooden boards, roof tiles, and metal sheets. At the front of the lot, there is vegetation, and an isolated room constructed from plywood, which was previously used as a bedroom and is currently used for storage. The electrical installations within the residence are precarious and insufficient, necessitating the use of extension cords to supply power to essential appliances. The lack of a proper sewage system further compounds sanitary risks, as kitchen wastewater is discharged directly into the backyard, while bathroom sewage is released into a hole dug in the ground, devoid of proper structure of drainage.



(a) Beams are not supported by columns (b) Misaligned beams (c) Misaligned beams and lack of ventilation

Figure 5 – Failures in the connection between structural elements observed in the pre-existing house

Source: ATHOS Project Archive (2024)

Given these conditions, the primary request from the residents pertains to the expansion of the house, with the objective of achieving more comfortable, healthy, and safe living conditions. They also emphasized the necessity of completing the interior finishes, particularly in the bathroom, which requires ceramic coating and waterproofing.

The resulting list of spatial requirements included a living room, kitchen, two bedrooms (one for APS and one for his mother), a bathroom, a service area, and a veranda. The architectural design proposal⁴ involved both

⁴ The Design and Construction Documents Set was developed by professors Architect Cristiane Guinancio, Civil Engineer Andrea Lizerre, postgraduate student Civil Engineer Lohany Costa and Architect Mariana Azevedo, and undergraduate student Viviane Araújo.

improvements and expansions, resulting in a total built area of 88.17 m² (Figure 6). During the presentation of the Preliminary Study, the family requested specific modifications, such as enlarging the kitchen and reorganizing the placement of doors and windows.



Figure 6 – The analyzed house (pre-existing and TAHSI proposal)
Source: ATHOS Project Archive (2024)

The expansion of the residence was designed using reinforced concrete structures and hollow ceramic brick masonry. In areas subject to moisture, waterproofing mortar along with ceramic floor and wall coverings, has been specified. The existing roof will undergo a revision, reusing roof tiles wherever feasible. In alignment with the existing tiles, the new roof —covering the kitchen, service area, and veranda— will incorporate fiber cement tiles supported by a wooden framework. Additionally, flashing and a waterproof membrane will be installed to mitigate the risk of leakage. The veranda's flooring will be finished with smooth cement, while the indoor areas will feature ceramic tile flooring.

The proposed interventions prioritized not only the expansion of the facilities but also the rehabilitation of various reinforced concrete elements and includes the installation of lintels above and below the openings of windows and doors, as well as the improvement of plumbing and electrical systems. The demolition and construction drawings for each phase detail the strategic reuse of existing components, such as the kitchen sink, bathroom fixtures, and the entrance door. The construction has been planned in phases (Figure 7) as a strategy to enhance the project's financial feasibility for the family, with the timeline established in collaboration with the beneficiary.

The first phase will involve demolishing the plywood room and constructing a new kitchen, service area, and veranda. This will be done initially without waterproofing or wall coverings. Additionally, a portion of the lateral wall will be installed along with the water and sewage systems, which will include a septic tank and water reservoir. The second phase will focus on reinforcing the existing building's structure. This phase will also include applying finishes in wet areas, installing bathroom fixtures and taps, and making adjustments to the internal electrical and plumbing systems. Finally, the third phase will concentrate on completing the front wall, enhancing security, and establishing the definitive boundary of the lot.

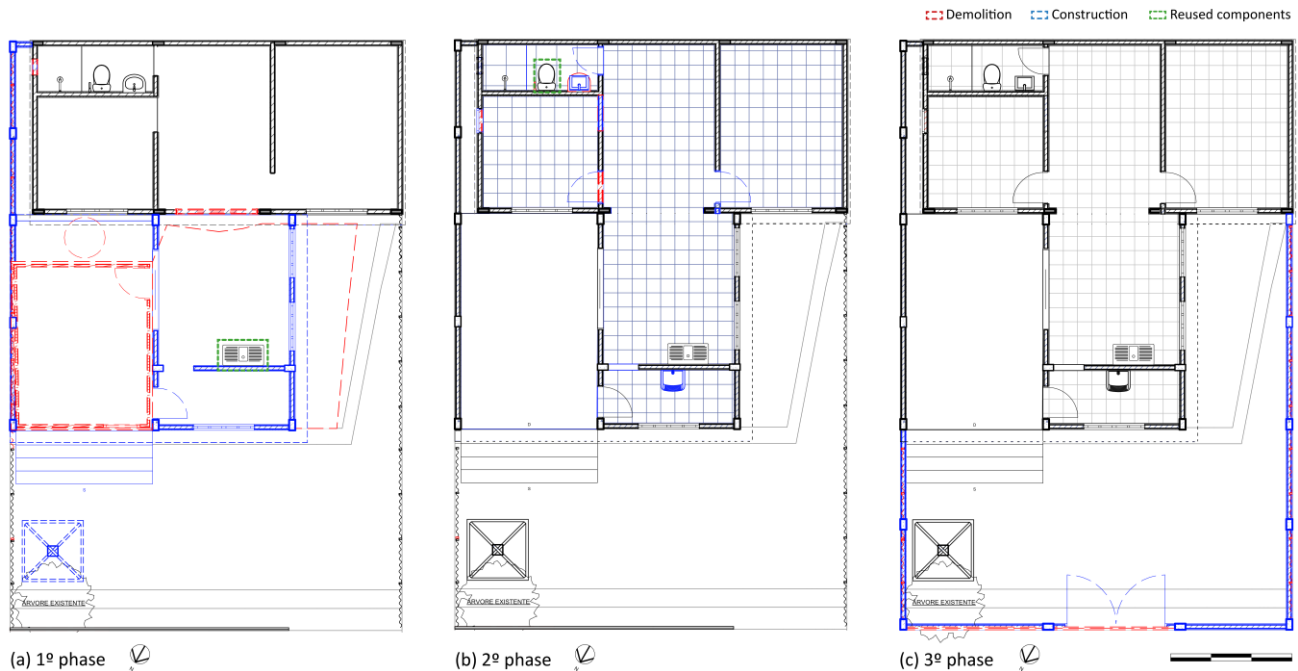


Figure 7 – Construction stages proposed in TAHSI intervention
Source: ATHOS Project Archive (2024)

The civil engineer played a crucial role in addressing the structural challenges of the pre-existing building. One major issue identified was the absence of a proper sanitation system. This problem was resolved by installing a septic tank and correctly positioning a water reservoir, which helped to mitigate environmental and health risks.

Structurally, the house exhibited misalignment between the beams and columns, necessitating corrections such as the addition of new columns and the adjustment of tie beams to ensure the stability of the walls. The engineer's intervention involved integrating the new structure with the existing one, ensuring safety while preserving the integrity of the original construction.

Another important aspect was the reconfiguration of the previously inadequate electrical system. This included installing a distribution panel, planning the circuit layout, isolating the shower circuit, and adding new power outlets. The arrangement of the energy points was modified to safely meet demand, preventing overloads and short circuits.

Additionally, ceramic coatings and waterproofing were applied to wet areas, enhancing the durability of the construction. The engineer's work effectively balanced the residents' needs with the technical constraints of the structure, proposing solutions that transformed the space into a more functional, safe, and accommodating environment for the family.

At the conclusion of the technical assistance process, the beneficiary receives a comprehensive set of project documentation, along with a 3D-printed physical model of the house. This resource provides the beneficiary with a clear and thorough understanding of the architectural proposal, facilitating the project's execution according to the established plan. The documentation also emphasizes cost-reduction strategies, such as consolidating wet areas into a single section of the house to minimize expenses related to plumbing and hydraulic infrastructure.

3.2 Development of Complementary Projects (Structural, Electrical, and Plumbing Systems)

The main section of the pre-existing house was preserved, including its original reinforced concrete structure. However, uncertainties about the strength and dimensions of existing beams and columns posed risks to safely integrating old and new structural elements.



To address this, the expansion was designed with a new, independent structure, reducing the risk of overloading a potentially compromised foundation. Local reinforcements were also recommended to improve the safety of the existing structure.

Since the expansion would occur in phases, structural components were carefully calculated to support loads at each stage. Two alternatives were considered: continuous beams and simply supported beams. The use of continuous beams depended on the timeline of future phases, as changes in load distribution could affect structural performance.

Electrical and plumbing continuity also required careful planning to ensure coordinated progress. To avoid long-term exposure and corrosion of reinforcement bars—common in future expansions—the team recommended avoiding exposed dowel bars for beam extensions.

Instead, two safer alternatives were proposed: (a) treating beams as independent simply supported spans; or (b) implementing reinforcement continuity only during the corresponding construction phase. This strategy aimed to preserve structural integrity, ensure safety, and respect the family's real conditions and the principles of TAHSI.

3.3 Criteria for Developing the Budget

Preparing and presenting a detailed budget is crucial for assessing the feasibility of the housing proposal. It helps the beneficiaries understand the costs associated with each stage of construction as well as the total investment required. The budget spreadsheet facilitates decision-making and allows the plan to be developed in line with the family's financial limitations. This approach ensures that the proposed solutions are economically viable and consistent with the realities of the families being assisted.

Table 1 presents the preliminary budget for each construction phase of the assisted residences. It is important to note that this budget reflects a base value prepared using the SINAPI Table. This base value already includes indirect costs, profit margins, and labor charges, which means it tends to be higher than the actual investment needed. The beneficiary may be able to complete the construction at significantly lower costs, particularly through self-built housing and the use of locally available materials.

Table 1: Preliminary budget by construction phase for the technical assistance case, based on the SINAPI Table (2024)

Technical Assistance	Social Housing Analyzed
Total built area	88,17 (m ²)
Stage 1	R\$ 46.008,48
Stage 2	R\$ 16.762,58
Stage 3	R\$ 31.308,71
Total cost:	R\$ 94.079,77
Cost per m²:	R\$ 1.067,03

By analyzing the estimated costs, it becomes possible to plan and adjust the construction process based on the availability of financial resources, materials, and labor. This allows for strategic substitutions that can reduce expenses without compromising quality or safety. Such flexibility gives the beneficiary greater control over expenditures and encourages the exploration of alternatives that align more closely with their circumstances, thereby enhancing the project's feasibility throughout all phases.

3.4 Orientation Workshop on the Construction Process

Civil engineering professionals played a key role in guiding the construction process and building community capacity through workshops on construction techniques and the installation of water, sewage, and electrical systems. In parallel, communication channels were established with residents to answer questions about the

building process, encourage knowledge exchange, and strengthen the beneficiaries' autonomy in carrying out their housing improvements.

To support this effort, instructional booklets (see Figure 8) were delivered along with the project documents. These materials included clear guidance on interpreting architectural plans and executing different construction stages, such as foundations, reinforced concrete structures, masonry, roofing, and finishes. The goal was to make each construction phase more accessible, especially for families choosing self-built housing processes.

To further improve the usability of the technical materials, the extension team worked on enhancing the visual and textual presentation of the ATHOS Project's outputs. The aim was to deliver technical guidelines in a clear and practical format, increasing the likelihood of safe and high-quality construction.

This review process led to the creation of standardized templates for key components, initially focusing on architectural, structural, and foundation plans. The team also selected and applied updated Brazilian Technical Standards to help bridge regulatory guidelines with real-world application, aligning project solutions with both the social context and technical feasibility.



Figure 8 – Instructional booklets developed by the ATHOS Project team
Source: ATHOS Project Archive (2024)

4. Results and Discussions

The complexity and diversity of project situations and construction techniques encountered throughout the advisory process provided by the ATHOS Project team highlight the value and necessity of involving civil engineering professionals. For the students, the learning acquired during technical assistance processes significantly contribute to their professional training, bridging theoretical knowledge with practical application and creating meaningful impacts on both pedagogical and social levels.

Extension experiences offer insights into housing vulnerable contexts, fostering skill development beyond technical expertise. Professionals enhance competencies such as active listening and community dialogue practices. Technical diagnosis plays a central role in evaluating pre-existing buildings, allowing for the



identification of structural issues, assessment of safety conditions, and the proposal of appropriate technical and economic solutions.

While traditional academic civil engineering training emphasizes the design and sizing of new structures based on ideal conditions and established norms, the context of Social Housing presents specific challenges, such as: (a) how to assess the resistance of existing structures without reference projects, and (b) how to ensure safe expansions when integrating new structures into existing constructions.

These challenges demand a differentiated technical approach, urging civil engineers to develop solutions within existing limitations. This includes selecting accessible materials, adapting construction techniques to the reality of self-built housing, and designing structural, electrical, and sanitary solutions compatible with pre-existing elements, provided they are in suitable technical condition.

In construction technologies for Social Housing realm, the need for research that combines technological innovation with low-cost solutions is evident. For instance, the drywall partitioning system, which receives little attention in undergraduate courses, is increasingly utilized in civil construction and may serve as a viable option for internal walls in Social Housing.

The reflective and design processes in civil engineering account for necessary technical interventions, ensuring that the proposed solutions align with local conditions and the needs of beneficiary families. This approach aims not only to improve immediate or planned housing conditions but also to secure a key aspect: creating a safe, healthy, and sustainable environment in the long term.

In addition to designing projects adapted to the local context, contributions also include the preparation of accessible educational materials and participation in training workshops. These activities empower residents in the construction and maintenance of their homes while contributing to broader community education, preparing members to engage in the civil construction sector. Simultaneously, students become knowledge multipliers, promoting the dissemination of technical and innovative practices within their communities.

4. Conclusions

The ATHOS Project experience demonstrates that academic extension activities combined with TAHSI offers a powerful educational platform for the training of civil engineers. This model allows students to connect academic knowledge with the realities of social housing and to propose viable, context-specific solutions.

By engaging with communities, students develop a critical, socially engaged approach to engineering. The experience enhances their ability to work under real-world constraints, fosters interdisciplinary thinking, and strengthens their ethical and civic responsibility.

Ultimately, the project confirms the transformative role of academic extension practices in civil engineering education, reaffirming the need to integrate these experiences into the academic curriculum as a means of preparing professionals who are not only technically proficient but also committed to social transformation.

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