

Article

A SWOT Analysis of AWH Project Implementation in the Brazilian Amazon as Perceived by Affordable Housing Stakeholders

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Abstract: In Brazil, affordable housing programs aimed at low-income populations reach a limited number of people. In the northern region, conventional bricklaying is the preferred method of building affordable single-family houses, which are essentially sets of tiny houses on the outskirts of cities. Conventional bricklaying can damage the environment. This study, started in July 2019, aimed to understand the perception of using timber to build affordable houses by housing program stakeholders and determine why the beneficiaries of housing programs prefer brick houses to wooden houses in locations with building permits. We applied a SWOT analysis to a group of 60 individuals comprising government agents and wooden and brick house residents of cities located in the northern region of Brazil. Subsequently, we devised relevant strategies, validated by stakeholders involved in public policy, for the provision of wooden housing for low-income populations. We used R software to analyze the data, and the results showed that the beneficiaries of affordable housing programs were unaware of wooden architectural projects and their durability, despite the regional abundance of wood and its environmental benefits. We suggest using strategies based on the SWOT analysis and validated by a group of experts to include the Affordable Wooden Housing (AWH) Project in the National Rural Housing Program (PNHR) and Harvest Plan.

Keywords: public housing policy; affordable houses; Brazil northern region; wooden buildings

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1. Introduction

Housing is a basic human need related to private space (1) that provides shelter, psychological comfort, and familiarity. From this perspective, decent housing is an achievement for Brazilian citizens, and the right to a sustainable city is a part of the City Statute—a basic norm for Brazilian urban master plans [2]. Affordable housing requires changes in the space, such as city expansion, insertion of houses into the urban structure, new businesses, and more urban equipment [3]. Additionally, houses are commercial products and have economic value, especially for those who invest money to build their own homes (4); therefore, construction materials have immense economic significance (4) and timber has considerable commercial value (5).

Wood is an abundant natural resource used for various purposes, from manufacturing kitchen utensils to building houses and transport equipment (6,7); therefore, it has been a valuable material for human wellbeing throughout history (8). Thus, it stands out as a versatile and renewable material (9–11). Technology and wood science have evolved to create multi-story wooden buildings worldwide, demonstrating the versatility of the material (12–14). Moreover, timber provides thermal comfort and contributes to urban sustainability by reducing energy consumption in the climatization of internal environments of wooden buildings (15).

The Brazilian housing deficit predominantly affects low-income populations. Therefore, the AWH Project relies on scientific knowledge about wooden houses and considers simplifying construction using structural modules (multiples of 90 cm) and achieving environmental comfort using different solutions for each region, for example, roof vents, raised floors, and ceramic roof tiles [16]. The AWH Project has been available for two decades but has never been part of a housing program subsidized or financed by the Brazilian government. The National Council of Extractivist Populations (CNS) officially demanded that the Federal Government include wooden houses in financing programs or subsidize them through the NRHP (17). Interministerial Ordinance No. 318/2014 authorized AWHs (18). The southern and southeastern regions already have affordable wooden houses built using the wood frame method and financed by the government (19).

Although legal norms exist, affordable wooden houses are controversial (20). Environmentalists argue that increasing the demand for biological construction materials, such as wood, exerts increasing pressure on natural resources and may eventually cause their depletion (20,21), which is the reason for building brick houses through the *Minha Casa, Minha Vida* (MCMV) Program. However, the literature shows that the environmental benefits of wooden houses outweigh those of brick houses (22). Nonetheless, the construction industry can develop and adopt alternative ecological technologies to bricklaying based on international concerns about environmental damage and material sustainability [23]; thus, AWH is an alternative.

Before proposing the insertion of AWH into public policies, it is necessary to convince beneficiaries to accept wooden houses. Thus, we sought to identify the reasons behind the empirical knowledge that low-income, rural beneficiaries of housing policies in the northern region of Brazil prefer brick houses to wooden houses. Therefore, this study aimed to understand why beneficiaries of affordable housing programs prefer brick houses in the northern region of Brazil, despite wood being abundant and promoting thermal comfort in a tropical climate, and suggest strategies validated by experts to enable the inclusion of the AWH Project in large-scale affordable housing public programs.

2. Materials and Methods

We applied a SWOT matrix to four groups comprising beneficiaries of housing programs and government agents. The SWOT analysis enabled the elaboration of strategies submitted to a group of experts from the forest sector for validation.

2.1. Location and Characterization of the Studied Areas

We administered part of the SWOT matrix questionnaire in loco to cities of the northern region of Brazil: Mucajaí, located in mid-western Roraima, 51 km from its capital city Boa Vista and accessible through the BR 174 highway (02° 26' 22" N, 60° 54' 36" W) (24); Porto Velho, the capital city of Rondônia, located 85 m above sea level with an area of 34,209.5 km² (08° 45' 43" S, 63° 54' 14" W) (25); Rio Branco, the capital city of Acre, located at the banks of the Acre River, with an estimated population of 413,000 inhabitants and an area of 8836 km² (09° 58' 29" S, 67° 48' 36" W) (26); and the Extractive Reserve Chico Mendes, located in Xapuri, Acre (10° 39' 06" S, 68° 30' 16" W) (27).

Government agents received the SWOT matrix questionnaires via e-mail. Figure 1 shows the area where the SWOT matrix survey occurred.

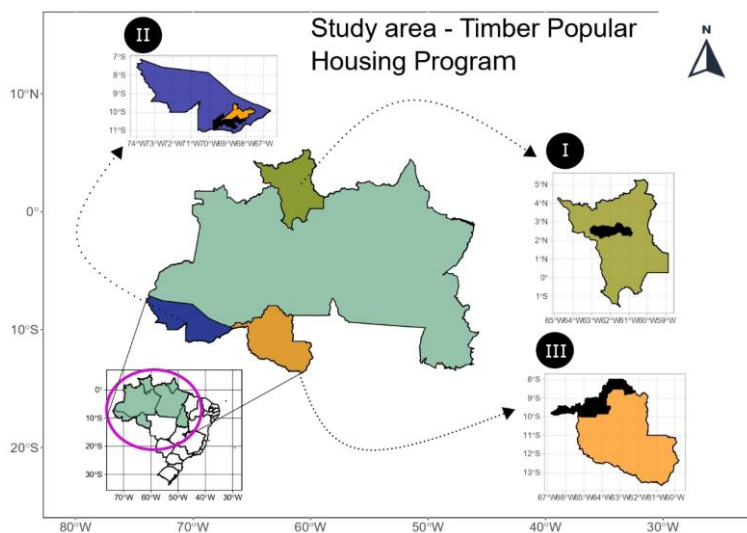


Figure 1. Affordable Wooden Housing Program in the Brazilian Amazon Region.

2.2. The SWOT Matrix

The acronym SWOT stands for strengths, weaknesses, opportunities, and threats. It is a four-quadrant framework that facilitates analyzing and studying both internal and external environments of public and private organizations, their departments, and their operations (28).

Numerous studies have used the SWOT matrix for forestry or natural resource purposes [29–42,74].

The SWOT matrix analysis involved the following experts: six environmental analysts from the Forest Service of the University of Brasília (UnB) and an author of an AWH publication. A brainstorming session about the AWH Project allowed us to compile Table 1. We eliminated duplicated questions or grouped them under a single topic to obtain 10 items per strength, weakness, opportunity, and threat quadrant for wooden houses of the AWH Project.

Table 1. A SWOT matrix for wooden buildings.

| Strengths | Opportunities |
|---|--|
| S1. Regional abundance of the material (wood) | O1. Training and qualification of the workforce |
| S2. Lower cost of construction | O2. Partially subsidized building |
| S3. High availability of local workforce | O3. Possibility of financing the house |
| S4. Shorter construction time | O4. Local population support |
| S5. Thermal comfort | O5. Possibility of self-building or collaborative community building |
| S6. Possibility of upgrades without renovation residues | O6. Leverage of the local wood market (scale) |
| S7. Beautiful buildings | O7. Increase in local jobs and income |
| S8. Easy to clean and preserve | O8. Building permits through Interministerial Ordinance No. 318/2014 |

| S9. High structural safety | O9. Serve beneficiaries from the MCMV Program and Harvest Plan |
|--|--|
| S10. Pre-manufactured components allow scalable production and less solid construction residue | O10. Simple construction process |
| Weaknesses | Threats |
| W1. Unfamiliarity with usable tree species | T1. Competition against conventional brick-laying |
| W2. Wood settling noises | T2. Competition against illegal wood (increasing costs) |
| W3. Easier intrusion and break-ins | T3. Lack of wooden building standards (by the Brazilian National Standards Organization (ABNT)) |
| W4. Lower durability if in contact with the ground (inappropriate construction method) | T4. Absence of economic stimulus for NRHP awareness and dissemination |
| W5. Acoustic discomfort (noises next door) | T5. Bankruptcy of local timber suppliers and distributors, or agents' indifference and lack of technical information to make financial decisions |
| W6. Requires more maintenance (painting and replacement of damaged parts) | T6. Disinterest of NRHP beneficiaries for wooden houses |
| W7. Lower user acceptance (due to image or status) | T7. Lack of institutions promoting timber |
| W8. Doubts about lifespan | T8. Commercial unavailability of timber |
| W9. Fire risk | T9. Lack of wooden building companies |
| W10. Lack of knowledge about the environmental benefits of wood | T10. Scarcity of specialized workforce |

Before collecting data in the field, we decided to apply the SWOT matrix to three groups: wooden house residents in rural areas, brick and wooden house residents in urban areas, and government experts on the affordable house program, as judges in the survey. We aimed to gather different perceptions about AWH Project implementation in the northern region of Brazil.

We grouped the participants, as shown in Table 2, to evaluate whether beneficiaries had extreme or slightly variable opinions compared to government agents, public policies experts, and experts from the AWH Project.

Table 2. Groups, locations, and the number of individuals surveyed with the SWOT matrix.

| Groups | Public | Area | Individuals |
|----------------------------|---|-------|-------------|
| G1 | Government agents, several locations | Urban | 15 |
| G2 | Wooden house residents of the Extractive Reserve Chico Mendes, Xapuri, AC | Rural | 14 |
| G3 | Wooden house residents of Mucajaí, RR | Urban | 3 |
| | Brick house residents of Rio Branco, AC | Urban | 9 |
| | Brick house residents of Porto Velho, RO | Urban | 5 |
| | Wooden house residents of Rio Branco, AC | Urban | 14 |
| Total surveyed individuals | | | 60 |

Owing to the number and diversity of variables, we used k-means clustering to classify objects in groups, thus obtaining clusters that differed as much as possible containing objects as similar as possible (29,30). We defined the ideal number of clusters using the within-cluster sum of squares, achieved when the sum of squares presented little

reduction among different numbers of clusters. We analyzed cluster similarity through principal component analysis (29).

2.3. Strategies Based on the SWOT Analysis

Subsequently, we elaborated relevant strategies using logic combinations of SWOT quadrants to answer the following questions (31,32):

1. Which strength can support which opportunity (S-O combination)?
2. Which threat can combine with which weakness to address political interventions (T-W combination)?
3. Which strength can overcome which threat (T-S combination)?
4. Which opportunity can overcome which weakness (W-O combination)?

We extensively discussed the strategies before submitting them for validation to a group of specialists comprising 14 members of the Brazilian Forest Service, the Forest Products Laboratory, the Ministry of Environment, the National Institute for the Environment and Renewable Natural Resources, the Ministry of Agriculture, Livestock and Food Supply, and professors from the Forest Engineering Department of the University of Brasília.

3. Results

3.1. Cluster Analysis

We verified the optimal number of four clusters for the dataset using the within-cluster sum of squares because higher numbers presented little differentiation gain, as shown in Figure 2.

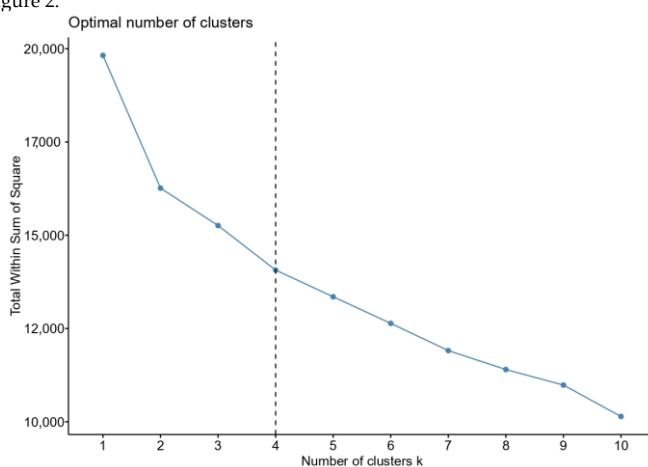


Figure 2. Within-cluster sum of squares to determine the optimal number of clusters.

Consequently, we classified each SWOT matrix variable within its cluster, as shown in Figure 3, where the first principal component explained 23.1% of all variation and the second component explained 8.9%. Clusters 2, 3, and 4 contained the most SWOT variables: 12 each for Clusters 2 and 4 and 10 variables for Cluster 3. Cluster 1 contained six variables. Clusters 2 and 4 contained variables from every SWOT group (external and internal), including 50% of the S-O combination and 50% of the W-T combination. Cluster 3 presented the same pattern, with 40% of the S-O combination and 60% of the W-T combination. Cluster 1 predominantly (66.7%) contained strength and opportunity variables (S-O combination).

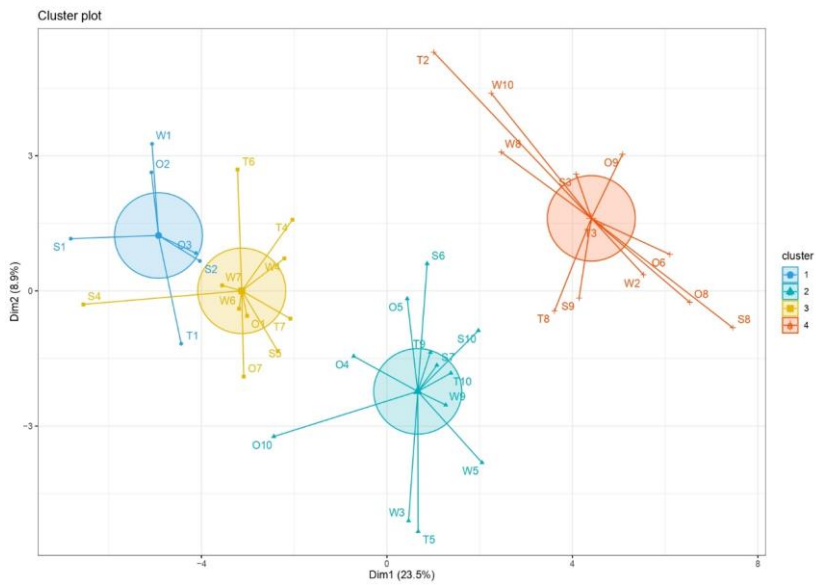


Figure 3. Clusters were determined by principal component analysis considering every surveyed group and 40 variables from the SWOT matrix.

The data analysis results are presented in Table 3, highlighting the six variables from each SWOT quadrant that obtained the highest scores rounded to the second decimal place.

Table 3. Ranking the six variables with the highest scores.

| Strengths | | | | | | Opportunities | | | | | |
|------------|--|-------|-------|-------|---------|---------------|---|-------|-------|-------|---------|
| Item | Description | G1 | G2 | G3 | Overall | Item | Description | G1 | G2 | G3 | Overall |
| | | (%) | | | | | | (%) | | | |
| S1 | Regional abundance of the material (wood) | 15.15 | 15.06 | 13.55 | 14.30 | O2 | Partially subsidized building | 12.24 | 16.23 | 12.15 | 13.13 |
| S4 | Shorter construction time | 12.73 | 15.71 | 13.72 | 13.94 | O3 | Possibility of financing the house | 13.21 | 12.60 | 12.68 | 12.80 |
| S2 | Lower cost of construction | 10.79 | 13.12 | 14.37 | 13.18 | O1 | Training and qualification of the workforce | 11.27 | 12.47 | 13.21 | 12.55 |
| S5 | Thermal comfort | 10.42 | 11.82 | 10.50 | 10.79 | O7 | Increase in local jobs and income | 11.51 | 10.65 | 11.80 | 11.46 |
| S6 | Possibility of upgrades without renovation residues | 10.42 | 9.74 | 10.15 | 10.12 | O10 | Simple construction process | 9.82 | 9.35 | 12.92 | 11.31 |
| S7 | Beautiful buildings | 8.12 | 9.22 | 8.91 | 8.79 | O4 | Local population support | 6.06 | 11.04 | 10.63 | 9.58 |
| Weaknesses | | | | | | Threats | | | | | |
| Item | Description | G1 | G2 | G3 | Overall | Item | Description | G1 | G2 | G3 | Overall |
| | | (%) | | | | | | (%) | | | |
| W1 | Unfamiliarity with usable tree species | 13.21 | 15.19 | 11.84 | 12.96 | T6 | Disinterest by NRHP beneficiaries for wooden houses | 12.74 | 15.05 | 10.33 | 12.03 |
| W7 | Lower user acceptance (due to image or status) | 12.12 | 12.21 | 11.84 | 12.00 | T1 | Competition against conventional bricklaying | 12.26 | 10.86 | 13.03 | 12.33 |
| W6 | Requires more maintenance (painting and replacement of damaged parts) | 11.15 | 12.34 | 11.38 | 11.54 | T4 | Absence of economic stimulus for NRHP awareness and dissemination | 13.23 | 12.70 | 9.68 | 11.27 |
| W4 | Lower durability if in contact with the ground (inappropriate construction method) | 10.30 | 13.25 | 9.97 | 10.82 | T2 | Competition against illegal wood (increasing costs) | 12.62 | 13.35 | 7.69 | 10.24 |
| W3 | Easier intrusion and break-ins | 7.88 | 6.88 | 12.60 | 10.09 | T7 | Lack of institutions promoting timber | 9.46 | 10.99 | 10.97 | 10.60 |
| W9 | Fire risk | 7.88 | 8.31 | 10.91 | 9.55 | T9 | Lack of wooden building companies | 10.31 | 7.33 | 10.68 | 9.81 |

3.2. Relevant Strategies Based on the SWOT Matrix

After analyzing the SWOT matrix applied to the field data, we proposed strategies to overcome the bottlenecks that prevent large-scale AWH Project implementation, which seeks to provide decent housing to affordable housing program beneficiaries. Logical strategic proposals required a minimum of one combinative variable among those with the highest scores.

The strategic proposals facilitated a broader perspective of the perception of timber as a construction material to support the implementation of the AWH Project in the NRPH and Harvest Plan. Fourteen forest experts attributed a score from 1 to 5 to each strategy presented in Table 5 using the Likert scale (33,34) (see Table 4). The 5-point scale measured the perception of efficiency based on coverage, straightforward application, and previous experience (33,34).

Table 4. Validation scale.

| Score | Perception |
|-------|------------|
| 1 | Very Bad |
| 2 | Bad |
| 3 | Neutral |
| 4 | Good |
| 5 | Very Good |

We calculated the weighted mean, standard deviation, and percent deviation for each SWOT strategy, subsequently classifying them from most to least relevant in each combination quadrant, as shown in Table 5.

Table 5. Proposed strategies and expert raking scores regarding AWH Project implementation in Brazil.

| Factors | Strengths (S) | | Weaknesses (W) | |
|--------------------------|--|-------|--|-------|
| | S-O Strategies | Score | W-O Strategies | Score |
| Opportunities (O) | S1-O1/6/7/9: Promote investments in forest infrastructure, subsidizing forest companies to improve the availability of forest resources and bringing together timber companies and their market with the support of local timber unions. | 4.14 | W1-O8: Develop a value chain for wooden houses based on the AWH Project, including new tree species to meet demand. | 4.79 |
| | S2/4-O2/8/9: Establish partnerships among sectors or departments involved with public affordable housing policies to participate in the NRHP and Harvest Plan. | 4.14 | W1-O2: Support the use of timber (purchased by the government or subsidized) to implement a large-scale AWH Project through forest companies. | 4.50 |
| | S5/7-O10: Highlight the thermal comfort, easy construction, and beauty of wooden buildings, in addition to their material durability and environmentally friendly characteristics. | 4.07 | W7/8/10-O4/7/10: Stimulate the use of timber by beneficiaries to contribute to a healthy environment and future generations (focus on sustainability). | 3.57 |
| | S3/10-O1/7: Stimulate new jobs and local workforce qualification with the AWH Project. | 3.86 | W4/6-O10: Clarify to beneficiaries the need for periodic maintenance like any other type of house because of AWH's simple construction. | 3.50 |
| | S5/6/7/8/9/10-O4/5/10: Advertise the AWH Project through government | 3.79 | | |

marketing to educate beneficiaries about using timber for construction to improve the environment.

| | T-S Strategies | T-W Strategies |
|--|---|--|
| Threats (T) | T7/9/10-S3: Favor the local workforce's qualifications to facilitate large-scale implementation of AWH and promote wooden buildings by advertising the benefits. | T4/9-W8: Propose subsidized interest rates within government programs to compete against conventional bricklaying. |
| | 4.43 | 4.43 |
| | T2-S2: Induce the command and control of illegal extraction by government forest departments and support the use of managed forest timber, for example, forest companies. | T1-W3/4/6/8/9: Stimulate the search for comparative demonstrations between affordable houses made of both materials (bricks and timber), focusing on the benefits of timber for the environment, with the support of local unions. |
| | 4.00 | 4.21 |
| | T6-S2/7/9: Encourage visiting and promoting the easy implementation of the AWH Project to educate beneficiaries about using timber for their houses. | T6/7/9-W7: Promote timber as a renewable construction material, ready for building, ecologically friendly, and providing thermal and acoustic comfort. |
| 3.93 | 4.00 | |
| T1-S1/2/3: Encourage the education of beneficiaries about the depletion of non-renewable resources, such as sand, proving that bricklaying has environmental disadvantages compared to wooden construction since mineral inputs such as cement consume a substantial quantity of wood in their production (e.g., ovens). | T7-W10: Support dialogue and collaboration among academics, public employees of the forest sector, professionals, and civil society representatives; assemble work groups to prepare a brochure to publicize the use of timber to beneficiaries of affordable housing programs. | |
| 3.43 | 3.71 | |
| T3-S7/9: Support the participation of a technical group from the Forest Products Laboratory in standardization committees of the ABNT, focusing on the AWH Project. | | |
| 3.36 | | |

The remaining ranking results are presented in Figure 4.

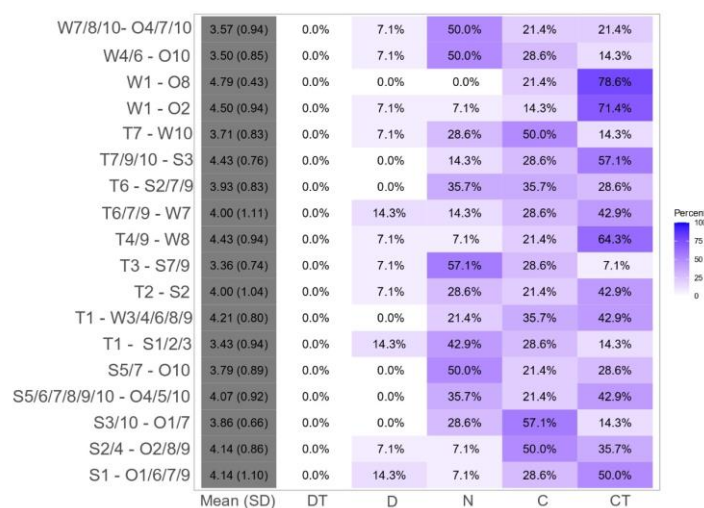


Figure 4. The scores of the proposed strategies after expert validation.

4. Discussion

4.1. The SWOT Analysis

Similar to Falcone et al. (2020), this SWOT analysis highlighted the regional abundance of the natural resource (timber) as the dominant point. While approximately 37% of Italy's territory is covered by forests (32), more than 56% is covered in Brazil, with the Amazon covering 49.3% of the entire country (35–37). The other dominant point indicated by the SWOT analysis is the shorter building time for homes in the AWH Project (16,38,39] because timber is a natural, construction-ready material after extraction, cutting, and drying, whereas concrete requires curing after application (39). A conventional affordable brick home takes up to 120 days for delivery, whereas AWH takes 15 days. Lima et al. (2019) showed that an affordable wooden building costs 30% less than an identical brick building.

Green cities with trees along roads to provide shade to cyclists provide a better quality of life, as trees also provide thermal insulation and oxygen (40).

Wooden buildings are natural carbon fixers, corroborating the thermal comfort of the wooden house (41) as an AWH strong point indicated by the SWOT analysis. There is a possibility of upgrading without renovation residues, and the beauty of wooden buildings is that timber is an appropriate construction material for every stage, requiring only waterproofing as a finishing product.

Regarding the shortcomings of wooden houses in Brazil, the lack of knowledge about indicated species stood out with the highest score, followed by low acceptance by users. The SWOT analysis confirmed the empirical view that there is a lack of acceptance because of a regional prejudice against wooden houses. The affordable housing program beneficiaries of the region prefer brick houses for durability, safety, and status, owing to the notion that brick house owners are wealthier than wooden house owners, which corroborated the results reported by Santos [57].

The other weaknesses indicated by the SWOT analysis included high maintenance (painting and replacement of damaged parts), followed by the material's vulnerability to intrusion and break-ins, and higher fire risk. The lower durability of timber on account of

direct contact with the ground is due to inappropriate construction methods and becomes a weak point if the AWH Project adheres to the prescribed technical specifications.

Every building deteriorates with time without preventive or corrective maintenance (42); therefore, the AWH Project is similar to other projects. However, we agree that it may be easier to break through a wooden wall than a brick wall since the opening points of a house (doors and windows) can be made of different materials (aluminum, glass) that are more subject to intrusion or break-in than wood.

Regarding fire risk, dry wood burns faster than brick buildings, except for the sturdy structural parts. In Pimenta Bueno, Rondônia, a fire destroyed two AWH units in 2019 (43), and only the structural beams and brick bathroom walls persisted.

Regarding the opportunities for the AWH Project and its inclusion in affordable housing programs, the SWOT analysis highlighted that acquisition with state subsidies and financing presented the highest scores, followed by qualifying the workforce to build wooden houses based on a regional architectural project. The reduction or exemption from taxes and creation of adequate public policies could attract investors and project developers, with a view to stimulating the dissemination of wooden houses in Brazil and reducing the housing deficit (44).

By analyzing the quadrants, we can state that affordable housing beneficiaries in the region were unaware of wooden architectural projects. Rejection was also due to associating wooden houses with stilts for riverside people or housing for the suburban poor. We presented a hard copy of the AWH Project to the surveyed individuals and affordable housing program beneficiaries in rural and urban areas, all of whom declared that they would like to build their houses based on the presented model, albeit with a few modifications (e.g., floor slab or an additional room).

The other opportunities presented in the SWOT analysis included creating more jobs and local income, a simple construction process, and local population support. Every infrastructure investment requires a workforce. For large-scale projects (more than 50 units), we suggest qualifying and using the local workforce, thereby creating jobs and increasing regional income. For a simple construction process, we propose pre-manufactured panels (walls). Trained carpenters and joiners can quickly execute the remaining work from the floor to the roof.

Societal support will require acceptance by users, a governmental approach for use of timber in construction, and acquiring the support of other stakeholders involved in public AWH housing programs.

The SWOT analysis showed that the most prominent threat against wooden buildings in the region was lack of interest by users, followed by competition against brick buildings and lack of economic stimulus to raise awareness and disseminate the NRHP—further corroborating the field observations. Beneficiaries were unaware of the possibility of using timber for construction with their architectural project. Most surveyed individuals were unaware of the affordable housing programs, for example, the MCMV Program and the NRHP.

One fact justifies the lack of institutions and companies promoting wooden buildings in Brazil, which is a continental-sized country: Portuguese descendants majorly inhabit the northern region, building durable homes to leave as heritage. The materials used for building those houses are stone, lime, cement, and tile, and these houses have several compartments, such as living rooms, bedrooms, and two kitchens (one displaying furniture and utensils, and the other for daily usage with a wood-burning stove) (45). This justifies the rejection of wooden houses and the threats perceived in the region. In the southern and southeastern regions of Brazil (inhabited by Europeans and Asians), the use of timber for construction is well-accepted and is part of the culture. The MCMV Program has implemented wood frame projects, which is a consolidated technique in North America and Europe (19).

The competition against illegal timber (increasing costs) continuously threatens wooden building construction. Unfortunately, land grabbing is also a regional problem.

Many local sawmills terminated their activities between 1990 and the mid-2000s because of this threat (46). Illegal exploitation has become a global issue (47). Deforestation is also another factor that has caused forest devastation (48).

4.2. Strategies Based on the SWOT Analysis

The proposed strategies aimed to overcome bottlenecks in a large-scale AWH Project, which offer decent housing for beneficiaries of affordable housing programs. Government incorporation should subsidize the inclusion of the AWH Project into the NRHP and Harvest Plan.

[39] proposed Likert-validated strategies, rated as very good and based on SWOT analysis, to drive the transition of the Italian forest sector to a circular bioeconomy. The results of the expert judgment presented in Figure 3 had a predominance of very good and neutral scores. Only the T3-S7/9 strategy (support the participation of a technical group from the Forest Products Laboratory in standardization committees of the ABNT, focusing on the AWH Project) presented strong neutrality. Alternatively, the W1-O8 strategy (develop a value chain for wooden houses based on the AWH Project, including new tree species to meet demand) presented 78.6% of scores rated as very good and 21.4% of scores rated as good (totaling 100%), showing that the experts agreed with this proposed strategy.

The strategies individually capable of potentializing the inner strengths of the AWH Project (S-O) included: promoting investments in forest infrastructure, subsidizing forest companies to improve the availability of forest resources, and bringing together timber companies and their market with the support of local timber unions; establishing partnerships among sectors or departments involved with public affordable housing policies to participate in the NRHP and Harvest Plan; and highlighting the thermal comfort, easy construction, and beauty of wooden buildings. These strategies received good ratings with 4.14, 4.14, and 4.07 points, respectively. Other strategies, for example, stimulating new jobs and qualifying the local workforce and advertising the AWH Project through government marketing to educate beneficiaries about using timber for construction, scored between neutral and good with 3.86 and 3.79 points, respectively.

Experts indicate that promoting investments in forest infrastructure and subsidizing forest companies can stimulate new concessions and extend current agreements.

[39] considered that Italian forests were difficult to access and state investment in infrastructure, especially roads, can help to prevent forest fires, implement forest management, and promote better use of forest resources.

The concession of public forests to prevent illegal exploitation is a recent phenomenon in Brazil [61–63]. The first agreement was signed in 2008, and operations started in September 2010 [48] with gaps that the state could fill. Malaysia and Indonesia have public concessions for tropical forests, with public managers stimulating them through investments in infrastructure to transport the product [64]. In Brazil, the concessionaire needs to invest in infrastructure to exploit forests.

We argue that partnerships among sectors or departments involved in public affordable housing policies should involve the several stakeholders engaged with housing programs. Thus, on a federal scale, the National Congress, the Ministries of Citizenship, Regional Development, Economy, Planning, and Environment, among others, and non-government organizations (NGOs) need to arrange managers that work together with states/provinces and cities represented by departments of housing, works, and citizenship supported by the National Service for Industrial Qualification (SENAI) and the Housing Company (CEHAB or COHAB), public banks (Bank of Brazil and Federal Savings Bank), and the Brazilian army to stimulate the creation of local organizations, enabling large-scale implementation of AWH in urban and rural areas.

Highlighting the thermal comfort, easy construction, and beauty of wooden buildings requires the government to implement the last strategy of advertising the AWH Project through government marketing, which was evaluated as neutral and good by the

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experts, because this study detected the unawareness of beneficiaries about good wooden house projects. In other words, a well-projected wooden house is not a stilt; it is a beautiful home with thermal comfort, durability, and quick execution [51,56].

Stimulating new jobs and qualifying the local workforce is a requirement, and the state will create new jobs and increase local income if it implements a large-scale AWH Project in affordable housing programs throughout the country.

The results from the T-W quadrant showed that three out of four proposals obtained an average rating above 4 points: subsidize interest rates within government programs, competition against conventional bricklaying (4.43); stimulate the search for comparative demonstrations between affordable houses made of both materials (bricks and timber), focusing on the benefits of timber for the environment, with the support of local unions (4.21); and promote timber as a renewable construction material, ready for building, ecologically friendly, and providing thermal and acoustic comfort (4.00).

We understand that these three strategies compose an assertion that the use of timber in construction will be promoted as a final construction resource. Subsidized interest rates for wooden buildings demand comparing similar wooden and brick housing units and promoting the benefits of timber as a renewable construction material to the environment and future generations [65]. In Brazil, most resources subsidize concrete slabs, slab-supporting structures, and temporary buildings, for example, accommodations and warehouses for major construction works [66].

The strategy of supporting the dialogue and collaboration among academics, public employees of the forest sector, professionals, and civil society representatives, and assembling work groups to discuss and create a brochure to share the uses of timber with beneficiaries of affordable housing programs obtained an average rating of 3.71 points, thus evaluated as neutral by experts, despite our understanding that this strategy can be an embryo in the sense of aggregating efforts to highlight the use of timber in construction.

The quadrant containing T-S strategies presented the following results: favor the local workforce's qualification to facilitate large-scale implementation of AWH and promote wooden buildings by advertising the benefits (4.43); induce the command and control by government forest departments against illegal extraction and support the use of managed forest timber, for example, forest companies (4.00); encourage visiting and promoting the easy implementation of the AWH Project to educate beneficiaries about using timber for their houses (3.93); encourage the education of beneficiaries about the depletion of non-renewable resources, such as sand, proving that bricklaying has environmental disadvantages compared to wooden construction since mineral inputs such as cement consume a substantial quantity of wood in their production (e.g., ovens) (3.43); and support the participation of a technical group from the Forest Products Laboratory in standardization committees of the ABNT, focusing on the AWH Project (3.36). Following the sequence of averages, two strategies were good, and three strategies were neutral.

Favoring the local workforce's qualification obtained the highest rate according to the experts, and we noted that this is partially involved with stimulating new jobs and qualifying the local workforce—discussed as a need and consequence of large-scale AWH program implementation by the state.

Alternatively, inducing the command and control of illegal extraction by government forest departments and supporting the use of managed forest timber is also a prominent need. This is because the public departments dealing with forests were dismantled in 2019 [67,68], devaluing Brazilian forest products in the import market and discouraging legally established concessionaires that perform sustainable forest management [69].

Encouraging visiting and promoting the easy implementation of the AWH Project and encouraging the education of beneficiaries about the depletion of non-renewable resources, such as sand, received a neutral expert rating and are intimately connected. This is because using timber as a final construction resource and promoting timber as an environmentally friendly resource can alert the population about the environmental damage caused by large-scale exclusive and indefinite use of other materials.

Supporting the participation of a technical group from the Forest Products Laboratory in standardization committees of the ABNT, focusing on the AWH Project, was meant to fill the normative gap related to wooden buildings found in the SWOT analysis. The experts considered this strategy the least relevant among all strategic proposals. Despite the existing norms (NBR 7190, 1997; NBR 7190-1, 2022) regarding the use of timber in construction [70], we lack norms for wooden buildings built exclusively with timber.

Regarding the W-O quadrant, experts validated developing a value chain for wooden houses based on the AWH Project, including new tree species to meet demand, as the best proposal (4.79). The use of timber as a final construction material is in its incipient stage in Brazil and other Latin American countries covered by the Amazon rainforest. This strategy is essential for feasibly inserting the AWH Project in public affordable housing programs. [39] argued that promoting forest-based value chains can be relevant for forest resources and sub-products in small supply chains, considering regional Italian particularities. Developing this value chain involves standardization, self-construction possibility, a qualified workforce, government marketing, attractive costs and prices, informed beneficiaries, and a distribution network for large-scale production—all included in the proposed strategies.

As a way of sharing the knowledge acquired, we suggest disseminating the value chain developed for the construction of wooden houses based on the AWH Project to Latin American countries that make up the Amazon rainforest, as well as other countries that have tropical forests around the world, since wood as a construction resource is the material that most fixes carbon in nature, thus contributing to the curbing of climate change [71–73].

Supporting the use of timber (purchased by the government or subsidized) to implement a large-scale AWH Project through forest companies obtained an average rating of 4.50 points and became the second most accepted strategy by experts. Using timber from forest concessions to achieve the social goal of offering housing for those in need and decreasing the Brazilian housing deficit is part of the wooden house value chain—thus, a well-regarded subject among forest concessionaires.

The strategies proposing to stimulate the use of timber by beneficiaries to contribute to a healthy environment and future generations (focus on sustainability) and clarify to beneficiaries the need for periodic maintenance like any other type of house because of AWH's simple construction obtained ratings of 3.57 and 3.50 points, respectively, validated as neutral by the experts.

5. Conclusions

After analyzing the SWOT results of 60 interviewees involved with the subject of social housing, as well as the validation by specialists of the 18 potentially possible strategies to be implemented, the research showed that AWH is feasible for the Brazilian Amazon Region due to several positive points, ranging from the quality and durability of wooden buildings (proven by the Brazilian Forestry Service by Forest Products Laboratory), thermal comfort for residents in the Brazilian region with a tropical climate and extremely high temperatures, and finally, the abundant availability of raw materials, labor by the local population, and high potential for improvement to expand dwellings.

The research found that constructions along the lines of the AWH Project are economically and socially viable, and therefore should be included in public housing policies in the Amazon region as well as in other tropical forest-covered regions around the world.

Developing a value chain for the construction of wooden houses for social purposes involves several actors of society, but interest must come from the state, which, by inserting the AWH Project in national housing programs, will enforce the Constitutional norm of housing being a social right of every Brazilian citizen.

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