

Funding Modalities for Timber Housing in Brazil

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Abstract – This paper investigated the existence and participation of public and private real estate credit lines for timber house funding in Brazil. The analysis was completed through face-to-face interviews with Brazilian timber housing producers. Semi-structured questionnaires were applied in this survey method to obtain a sectorial approach of the industry. Accesses to full financing for timber housing and credit for the acquisition of construction materials were the main two issues studied. About 107 producers were fully evaluated from all sectors. Half of the studied companies offer full housing finance and, simultaneously, most loans still come from private banks. Credit directed to raw materials emerges as the most common method of accessing funding for timber-based construction despite the lower economic value of this form of credit compared to other, more complete financial options. Public banks disseminate partial credit more frequently because of lower rates and lower restrictions, such as the absence of insurance requirements against risks from these construction ventures. Full funding proliferation will stimulate this market.

timber house / construction / real estate funding / incentives / interviewing / sectoral research

Kivonat – A faházak finanszírozási módszerei Braziliában. A tanulmány a faházak finanszírozására szolgáló állami és magán ingatlanhitelek meglétét és részesedését vizsgálja Braziliában. Az elemzés a braziliai faház-gyártókkal folytatott személyes interjúk alapján készült. A felmérési módszerben félig strukturált kérdőíveket alkalmaztunk az ágazat szektorális megközelítése érdekében. A vizsgálat két fő kérdését a faházak teljes finanszírozásához való hozzáférés és az építőanyagok megszerzéséhez nyújtott hitelek képezték. Körülbelül 107 gyártót értékeltünk ki minden ágazatból. A vizsgált vállalatok fele teljes lakásfinanszírozást kínál, és egyidejűleg a legtöbb hitel még mindig magánbankokból származik. A faanyagú építmények finanszírozásának leggyakoribb módját a nyersanyagokra vonatkozó hitelek jelentik, annak ellenére, hogy ennek a hitelformának alacsonyabb a gazdasági értéke más, teljesebb pénzügyi lehetőségekhez képest. Az állami bankok gyakrabban nyújtanak részleges hitelt az alacsonyabb kamatlábak és a kevesebb megszorító tényező miatt, mint amilyen például az építési vállalkozások kockázataira vonatkozó biztosítási követelmények mellőzése. A teljes finanszírozás elésegítésével a piac stimulálható.

faház / építkezés / ingatlanfinanszírozás / ösztönzők / személyes interjú / ágazati kutatás

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1 INTRODUCTION

Among its main evaluation components, the Brazilian housing shortage includes improvised homes, rustic houses, and dwellings with excessive densification, cohabitation, and excessive rent burdens. These dwellings may be singular or combined. (IBGE 2013, FIESP 2016, IBGE 2017). The housing shortage also correlates to dwellings that must be built to replace those homes lacking safe conditions or to ensure adequate housing for families without residences (Genevois – Costa 2001).

Housing was a private sector industry in Brazil until the 1930s. No policies to solve housing deficits existed before then, and initial measures to address the issue of housing for low-income people only arose later (Pinto 2015). The number of families residing in precarious housing decreased by about 740,000 (-2.8%) between 2010 and 2014, but 6.2 million families still reside in poor housing conditions, which is a significant number (FIESP 2016, IBGE 2017). The most effective way to reduce this number is to expand low interest credit lines to fund both social housing and larger homes for those from more advantaged social classes.

Federal government programs played a key role in the expansion of housing funding in Brazil in the past decade (Pinto 2015). As a result, brick masonry has been the most popular construction method in this Latin American country.

Masonry houses – which have deep roots in Brazilian culture – will prevail in the popular “My Home, My Life” (Minha Casa, Minha Vida) housing program over the next few years. This will narrow the field of prefabricated housing systems significantly (Santos 2009).

Despite a restrained beginning, this Brazilian program for social housing development has provided the insertion of industrialized techniques such as light-woodframe and steelframe its criteria for acceptable forms of construction. Nevertheless, many restrictions for other and frequently less popular construction methods exists.

The main Brazilian organization for public funding – Caixa Econômica Federal – estimated a 30% increase in popular funding, amounting to R\$ 225,000 for the Brazilian housing program “My Home, My Life” from 2015 to 2016. Local governments continue to bet on growth and job creation on this program, and has adopted important measures such as readjustments in the income profile of beneficiary families to increase all people served; increases in the maximum property value; and reorganization of obstacles present in this program for the public bidding and hiring of construction companies (Brazil 2017). Due to these limitations, this paper aimed to study the funding solutions for timber houses in Brazil. Thereby, this approach justification is also supported by Zani (2013), who demonstrated the timber housing market has persisted in Brazil since the end of the nineteenth century.

1.1 Theoretical Background

In the early 2010s, *Banco do Brasil* bank regulations for the “My Home, My Life” social housing program did not permit funding for wood-based residences (Banco do Brasil 2012). From 2012, rare initiatives were established in the terms of light-woodframe building utilization for popular housing. Ferreira (2013) and Brasil (2015) declared that the target public for such initiatives exclusively includes those families with a monthly income of R\$ 1,600.00. Ferreira (2013) referred the “Residencial Haragano” as the first light-woodframe enterprise for the Brazilian “My Home, My Life” housing program, which is situated in Pelotas, Rio Grande do Sul state, and has 280 units based on 45m²-houses. Platform light-woodframe technique was also applied to other house allotments as mentioned by Brazil (2015), who drew attention to “Moradias Nilo” project that included the construction of 66 light-woodframe houses in Curitiba, Paraná state. However, other timber houses based on similar prefabrication were not applied further in this program.

No timber-based construction systems could attain housing funding for programs that allow its large-scale application (Kiss 2009). A lack of technical references and standard documents has persisted over the last decade. Thereby, Brazil (1998) created the Brazilian Housing Construction Quality and Productivity Program (PBQP-H), whose objective is to support local efforts to modernize and promote basic attributes from the housing sector, and to increase service and goods competitiveness. Brazil (2007) created the Technical Evaluation of Modern Products and Conventional Systems (SiNAT) to prescribe and harmonize requirements, criteria, and methods for the technical evaluation of traditional or modern products, processes, and systems in the National System. In addition, Kiss (2009) cited accredited institutions such as the Technological Research Institute (IPT) and Falcão Bauer Institute as being responsible for granting the Technical Evaluation Document (DATEc) for housing building system testing, while SiNAT rules on evaluation guidelines to stimulate the modernization in civil construction.

Platform light-woodframe insertion as a new housing technique was allowed in the Brazilian program “My Home, My Life” and occurred by its accreditation and approval. Thus, the SiNAT 005 guideline to allow light-woodframe technical evaluation as regulated by PBQP-H (2017) was established for construction systems made with light parts based on lumber or panel finishing. According to Falcão Bauer (2015), the DATEc 020-A typified the first official two-year-valid document whose focus approves light-woodframe as a construction technique based on timber for the production of low cost housing.

Although timely, this strategy still restricts wooden house production for the “My Home, My Life” social program in that only larger companies can present real conditions to charge high investments to perform all the stages from this evaluation.

Against this direction, whose focus was based on modern application, the Brazilian Government also authorized wood for housing on simplified construction techniques such as stilt houses (*palafitas*) for people living in northern regions in the same “My Home, My Life” social program (Alves 2014). No SiNAT guideline was openly shared to regulate these stilt houses, and no DATEc was issued to any local company, thereby permitting the production of this specific low quality wooden construction. This drastic situation sets the precedent for the production of stilt houses without the support of any technical studies, which proves the real disadvantages of this example of precarious housing. This situation is really unclear. Over the years, Blanco Junior (2006), Sá (2009) and Menegassi – Silveira (2015) have detailed that the Brazilian government had formerly performed a key role in the eradication of stilt houses as they were considered substandard solutions.

Due to stilt houses utilization in the northern regions, this public strategy can unfortunately cause the dissemination of an erroneous culture of wooden residences with low technological and production qualities, prejudicing the market of other timber houses based on modern techniques. The stimulus towards the use of advanced timber-based house techniques could eradicate this governmental problem and reduce the housing shortage with those higher added-value examples.

Some credit lines for wood-based houses in Brazil are available with interest rates comparable to funding for masonry. This, despite limitations on the number of financial organizations suitable for this purpose, as well as many restrictions on the type of material used for houses (Santiago 2012). This convenience has been offered by private banks with strategic purposes to provide housing finance for medium to high income people. Evidence that public banking institutions have also provided such funding for timber housing exists, but this information has not been officially disclosed and is not available to everyone. Thus, if public housing policies allow timber house producers greater access to the “My Home, My Life” social program, different timber building techniques could improve their market share, including those populations with better social conditions.

This paper aimed to verify the conditions of public and private funding for timber housing in Brazil through an interview survey conducted with timber house producers. Two hypotheses were emphasized: few producers offer public timber housing finances to their clients; and, credit lines for raw material acquisition have been the main financial solutions for wooden houses.

2 MATERIALS AND METHODS

2.1 Survey method and materials

Earlier, De Araujo (2017) completed extensive research into the Brazilian timber housing sector to check and characterize its current condition, aspects, and other unprecedented views related to producers, manufacturers, and products. The goal was to assist sector development. As suggested by De Araujo et al. (2018 a, b, c, 2019), this present study utilized timber housing producers, standard questionnaires, and bibliographic documents to share data and support the process.

This study was formulated to verify funding for timber houses in Brazil. For this purpose, the methodology was supported with a survey based on personal interviews and a structured questionnaire given to wood-based housing developers in Brazil. This method was fully detailed by De Araujo et al. (2018 a, b, c, 2019). The face-to-face interviewing process was supported by two qualitative queries, with response details for affirmative replies.

The first question was: “Does your company have full wooden house funding for your clients?”. Trichotomous responses “yes”, “no” or “not informed” were indicated; then, in an affirmative statement, multiple open answers were asked to detail such options between private and/or public financial institutions and banks available to fully fund wooden housing produced in each evaluated producer.

The second question was: “Does your company have a credit agreement for raw material acquisition for wooden housing?”. As in first question, trichotomous responses “yes”, “no” or “not informed” were indicated; but in the case of an affirmative statement, two multiple answers were declared, that is, *Construcard* and/or *BB Construção*. This open-hybrid step allowed for the insertion by interviewees of other unlisted responses.

With respect to declarations to add detail the answers, multiple answers were allowed; that is, for both queries, an evaluated company could present two or more answering possibilities to detail each response. Thus, qualitative answers were converted into a percentage and, according to the “Raosoft Sample Size Calculator” (Raosoft, 2004), a margin of error was identified for this surveying, similar to the approaches contained in De Araujo et al. (2018 a, b, c, 2019).

3 RESULTS AND DISCUSSION

3.1 Sectoral estimation and survey

Population estimates from a search of producer websites as well as prescribed and performed sampling amounts are listed in *Table 1*. The margin of error was $\pm 3.325\%$, which is acceptably within 10% standard and close to 5% ideal level as prescribed by Pinheiro et al. (2011). Thus, the survey can be classified as reliable. More than half of the entire sector was evaluated ($n = 107$ producers). The overall listing contains 210 producers as suggested by the extensive research by De Araujo (2017) and its related approaches were referenced as “*” while statistical sampling values prescribed by the literature were referenced as “***” in *Table 1*.

Table 1. Analysis of sectoral population and survey sampling results.

Result	Company (Unit)	Margin of Error (%)
Overall Sectoral Population*	210	–
Prescribed Acceptable Sampling**	66	10.00
Prescribed Ideal Sampling**	136	5.00
Interviewees' Sampling*	107	6.65

* Values from this study and De Araujo et al. (2018 a, b, c, 2019); ** Values according to Pinheiro et al. (2011)

3.2 Housing Funding Modalities for Timber Houses in Brazil

Two housing credit categories were considered: full real estate finance for properties (Figure 1a), and partial funding as exclusive credit for the acquisition of raw materials (Figure 1b).

With full funding for timber housing in Brazil, half of sampled entrepreneurs declared the offering of such financial options in their product lines, that is, timber-based houses (Figure 1a).

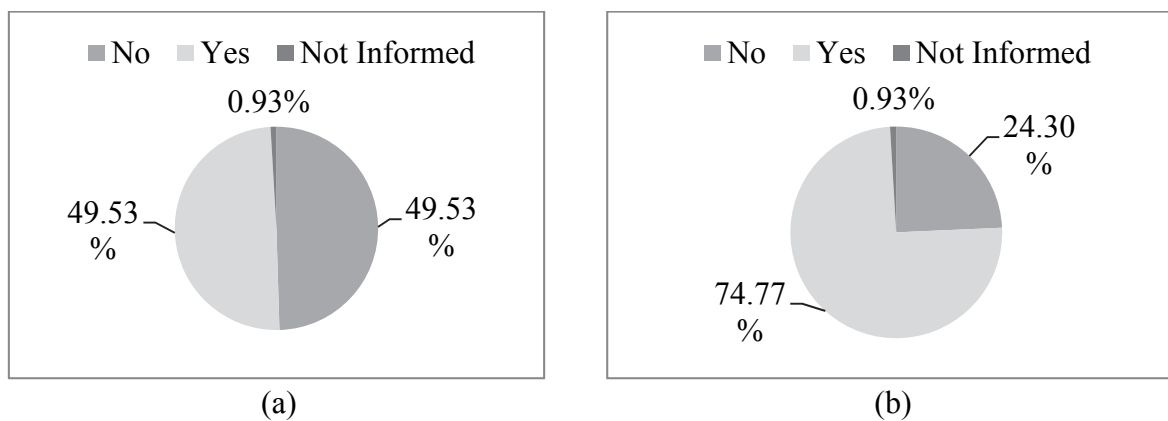


Figure 1. Available funding options to clients of timber housing: (a) full funding, and (b) credit to material purchase (n = 107 interviewees)

Few producers provided this full funding through public organizations (Figure 2), because around 13% of producers shared this financial operation through federal banks (Caixa Econômica Federal and Banco do Brasil) and about 7% in state institutions (Barrisul). Caixa Econômica Federal emerges as a rare public bank offering credit lines for timber houses. The mutual interests for these credit lines are applied without tax incentives or reduced interest rates such as those present in popular funding. This situation is the opposite of the European scenario as revealed by Kuzman – Sandberg (2017) who noted that several nations from this continent have encouraged the use of timber in construction through low-interest loans or subsidies.

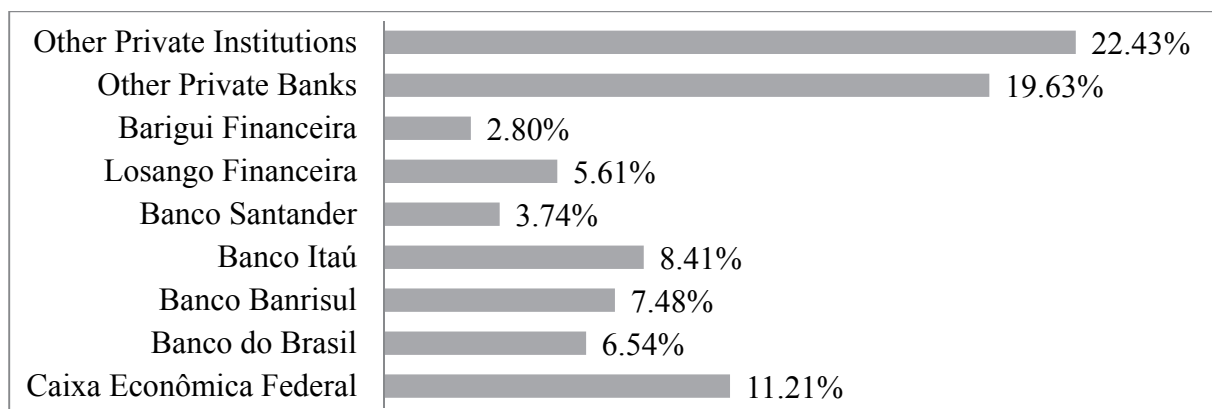


Figure 2. Available organizations: full timber housing funding (n = 107 interviewees).

Full loans are the main preferred public strategy for social housing because they satisfy a broader economic profile of residents, rather than the affluent exclusively (Makachia 2015). However, this strategy could be extended to other social levels and other construction projects such as those built from timber.

In contrast to the public banking approach (*Figure 2*), several sampled producers offer full financing for timber housing through private organizations, whereas around 31% is from banks (*Itaú, Santander, BM Sua Casa, Pan, etc.*) and almost 30% is from financial institutions (*Barigui, Losango, Sicredi, Credipar, Cresol, Visa, etc.*), which do not have a main banking function.

Punhagui (2014) indicated that only two organizations supplied funding for full timber housing. In contrast, this present research verified that – despite the low offering in the producers studied here (*Figure 2*) – at least 13 institutions and banks share this financial payment modality for local clients.

However, the low offering of public funding is related to a current Brazilian government restriction in the expansion of this financial operation for wood-based residences, despite the local presence of these types of housing, which, according to Zani (2013) and De Araujo (2016 a), originated in the nineteenth century. Santiago (2012) suggested that few insurers are able to secure timber houses in Brazil, which limits the market for these housing solutions because funded houses demand insurance against physical damages and against the consumer losses and deaths. In her approach, Punhagui (2014) verified that three insurers offer this insurance service; however, two of these carry some restrictions.

The scenario was quite different regarding the specific credits to acquire raw materials for construction (*Figure 1b*) whereby only about a quarter of studied companies still had not offered this possibility. The results demonstrated an inverse situation to full funding because public credits for material purchases exhibited greater offering to the producers at the detriment of private credits for the same objective (*Figure 3*). Both main public banks *Banco do Brasil* and *Caixa Econômica Federal* enable *BB Construção* and *Construcard* as small public credit lines, respectively; these are exclusive cards for the acquisition of raw materials for construction. The funded amounts are limited because the narrow focus prevents them from being utilized for labor payment and/or other construction objectives.

This situation has demonstrated that these special credits for raw materials have emerged as more convenient options to supply the full funding shortage for timber housing, especially since such modalities do not require insurance and are unhindered by restrictions concerning timber application. This limitation of full real estate funding for wooden houses in Brazil (*Figure 1a*) resulted in the creation and proliferation of exclusive partial credits for raw materials, which have lower restrictions and lower values shared by the financial organizations.

This alternative became popular in the studied companies due to the free acquisition of raw materials, allowing for the use of timber and its engineered composites (beams and panels). This directed credit, which has a low economic value, has been widely used as an efficient alternative to credit access by the clients of wooden houses (*Figures 1b and 3*). The greater popularity these credits from public banks is justified by the generally lower interest rates. This chronic situation is similar to Punhagui (2014), whose credit for material acquisition has become the main way to commercialize houses from this sector, whereas companies sampled in her study declared the inexistence of funding for prefabricated wooden houses.

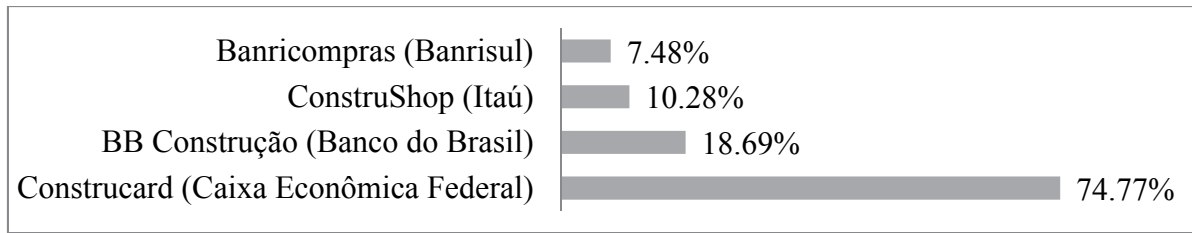


Figure 3. Available organizations: credit to raw material purchase ($n = 107$ interviewees).

The importance of this present evaluation goes in favor to the current global trend regarding sustainable construction projects as well as those based on materials from renewable sources. Timber application and its better utilization for construction has been a persistent topic in several studies including Kniffen – Glassie (1966), Charles (1984), Gold – Rubik (2009), Roos et al. (2010), Kuzman – Grošelj (2012), Zani (2013), Punhagui (2014), Wang et al. (2014), Hurmekoski et al. (2015), Leite – Lahr (2015), De Araujo et al. (2016 a, b, 2018 c, 2019), Koppelhuber et al. (2017), Kuzman – Sandberg (2017), Ramage et al. (2017), Viluma (2017), Franzini et al. (2018), and Sotsek – Santos (2018), etc.

A significant and visible example was identified by De Araujo et al. (2016 a, b), which claimed that timber houses could reach all economic and social classes due to their interesting attributes of innovation, lightness, competitive costs, as well as efficient levels of sustainability, site cleaning, assembly time, low water usage, and material rationalization. Several features are within the main pillars for housing sustainability as defined by Makachia (2015), under which the houses are developed with consideration for the physical, social and economic environment. In this case, timber-based construction emerges as an efficient and healthy housing solution for nearly everyone.

Furthermore, strong industrialization of wooden housing prefabrication could be a focal point in the near future, consonant to housing shortages in underdeveloped and developing countries (De Araujo et al. 2016 b). Financial organizations must note and consider the agility resulting from this industrialization in construction. According to Punhagui (2014), funding for construction payment must be made available within shorter application and granting periods because prefabricated house construction is a rapid and efficient construction method in terms of assembly and production. The faster the work can be completed, the smaller the weekly site overhead cost for producers is (Powell 2012). This would also lead to lower interest payments (Renner-Smith 1981). Bureaucracy in the housing funding processes, be it public or private in nature, must be in accordance with efficient assembly times of timber housing techniques, which De Araujo (2017) assessed in his research. In this case, slowness in loan payments could generate financial problems for timber housing producers and respective suppliers because the sector has more compact economic, production, and machinery dimensions than the traditional masonry construction sector in Brazil does, as suggested in De Araujo et al. (2018 a, b, c, 2019).

These facts should be considered and serve as basis for diffusion of modern funding lines for wood-based housing, especially by public feature. This proposal must diffuse these examples in all of Brazil, as well as expand it to other Latin American countries through networks to mitigate local housing shortages, which could be supplied through modern and accessible houses.

4 CONCLUSIONS

Despite the low diffusion and popularity of housing funding for timber housing in Brazil, two modalities are readily available: full funding with an integral cost, and partial credit lines for raw material acquisition. This analysis also proved there are financial operations for these buildings in this South American nation despite some restrictions and obstacles.

Full funding is restricted and still depends on other financial institutions like insurers to ensure fluid operation. This has limited the program and directed most clients to private banks. Despite the advances in credit access to clients considering wooden housing, Brazil's housing funding system for timber solutions are not as accessible, consolidated, and plural as funding systems in developed countries. In addition, full resources also do not serve all social classes. As a result of these obstacles, credits for raw materials acquisition emerged as the main source of subsidized financial resources for housing in Brazil, by means of public and private institutions.

In Brazil, few wood-based housing producers have full funding for public class programs. The public only has access to timber houses through line credits to raw material purchase. Private banks still dominate this financial market under full funding for timber houses despite their unsubsidized rates. This essentially impedes those from the lower social classes from accessing such loans. These predictions were supported by a wide sampling process including more than half of whole timber construction sector. In addition, this discovery was statistically validated by the almost ideal margin of error, which ensured greater reliability of the survey.

Nevertheless, Brazil still requires greater local and governmental efforts to expand full funding for timber-based housing in order to increase the accessibility of sustainable and rapid residences for all families. A proliferation of these integral funding schemes for populations from lower and middle classes could stimulate Brazilian wood chains – which are dependent on public policies for their expansion – due to market limitation, which is restricted to few people.

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REFERENCES

- ALVES, M.R. (2014): Governo autoriza uso de madeira no minha casa minha vida [Government authorizes the use of wood in my house, my life] (in Portuguese), <http://exame.abril.com.br/brasil/governoautorizausodemadeiranominhacaminhavid/>
- BANCO DO BRASIL. (2012): Programa minha casa minha vida [My house, my life program]. Brasília, DF, Brazil: Banco do Brasil.
- BLANCO JUNIOR, C. (2006): As transformações nas políticas habitacionais brasileiras nos anos 1990: o caso do programa integrado de inclusão social da prefeitura de Santo André [The transformations in brazilian housing politics in years 1990: the case of the integrated program aimed at social inclusion of the Municipality of Santo André]. MSc thesis. University of São Paulo, São Carlos. (in Portuguese)
- BRAZIL. (1998). Portaria n. 134, de 18 de Dezembro de 1998 [Ordinance number 134 of December 18, 1998]. Diário Oficial da União. Brasília, DF, Brazil: Casa Civil. (in Portuguese)
- BRAZIL. (2007). Portaria n. 345, de 3 de Agosto de 2007 [Ordinance number 345 of August 3, 2007]. Diário Oficial da União. Brasília, DF, Brazil: Casa Civil. (in Portuguese)
- BRAZIL. (2015). Minha casa minha vida entrega primeiro residencial com imóveis de madeira [My house my life delivers first residential building with timber houses]. (in Portuguese). <http://www.brasil.gov.br/infraestrutura/2015/03/minhacaminhavidaintregaprimeroresidencialemimoveisdemadeira>

- BRAZIL. (2016). Caixa aposta no mercado de habitação popular em 2016 [Caixa bets on the popular housing market in 2016]. <http://www.brasil.gov.br/economia-e-emprego/2016/01/caixa-aposta-no-mercado-de-habitacao-popular-em-2016> (in Portuguese)
- BRAZIL. (2017). Setor da construção civil aposta em crescimento e geração de empregos com mudanças no MCMV. 2017 [Construction sector bets in its increasing and in the job generation with changes in the MCMV]. www2.planalto.gov.br/acompanhe-planalto/noticias/2017/02/setor-da-construcao-civil-aposta-em-crescimento-e-geracao-de-empregos-com-mudancas-no-mcmv (in Portuguese)
- CHARLES, F.W.B. (1984). Conservation of timber buildings. London, UK: Hutchinson & Co. pp. 1–256.
- DE ARAUJO, V. – NOGUEIRA, C. – SAVI, A. – SORRENTINO, M. – MORALES, E. – CORTEZ-BARBOSA, J. – GAVA, M. – GARCIA, J. (2018a): Economic and labor sizes from the Brazilian timber housing production sector. *Acta Silvatica et Lignaria Hungarica* 14 (2): 95–106. <https://doi.org/10.2478/aslh-2018-0006>
- DE ARAUJO, V.A. (2017): Casas de madeira e o potencial de produção no Brasil [Wooden houses and the potential of production in Brazil]. Ph.D. thesis. University of São Paulo, Piracicaba. (in Portuguese)
- DE ARAUJO, V. A., CORTEZ-BARBOSA, J., GARCIA, J. N., GAVA, M., LAROCA, C., & CÉSAR, S. F. (2016a). Woodframe: light framing houses for developing countries. *Revista de la Construcción* 15 (2): 78–87. <https://doi.org/10.4067/S0718-915X2016000200008>
- DE ARAUJO, V.A. – GUTIÉRREZ-AGUILAR, C.M. – CORTEZ-BARBOSA, J. – GAVA, M. – GARCIA, J.N. (2019): Disponibilidad de las técnicas constructivas de habitación en madera, en Brasil [Availability of timber housing construction techniques in Brazil]. *Revista de Arquitectura* 21 (1): 68–75. <https://doi.org/10.14718/RevArq.2019.21.1.2014>
- DE ARAUJO, V.A. – LIMA JR., M.P. – BIAZZON, J.C. – VASCONCELOS, J.S. – MUNIS, R.A. – MORALES, E.A.M. – CORTEZ-BARBOSA, J. – NOGUEIRA, C.L. – SAVI, A.F. – SEVERO, E.T.D. – CHRISTOFORO, A.L. – SORRENTINO, M. – LAHR, F.A.R. – GAVA, M. – GARCIA, J.N. (2018b): Machinery from Brazilian wooden housing production: size and overall obsolescence. *BioResources* 13 (4): 8775–8786. <https://doi.org/10.15376/biores.13.4.8775-8786>
- DE ARAUJO, V.A. – VASCONCELOS, J.S. – CORTEZ-BARBOSA, J. – MORALES, E.A.M. – GAVA, M. – SAVI, A.F. – GARCIA, J.N. (2016b). Wooden residential buildings – a sustainable approach. *Bulletin of the Transilvania University of Brasov Series II: Forestry • Wood Industry • Agricultural Food Engineering*, 9 (2): 53–62.
- DE ARAUJO, V.A. – VASCONCELOS, J.S. – MORALES, E.A.M. – SAVI, A.F. – HINDMAN, D.P. – O'BRIEN, M.J. – NEGRÃO, J.H.J.O. – CHRISTOFORO, A.L. – LAHR., F.A.R. – GARCIA, J.N. (2018c): Difficulties of wooden housing production sector in Brazil. *Wood Material Science & Engineering* 1–10. <https://doi.org/10.1080/17480272.2018.1484513>
- FERREIRA, R. (2013). MCMV da madeira: conheça a tecnologia e os custos de construção do primeiro empreendimento em wood frame do programa minha casa minha vida [MCMV of timber: know the technology and construction costs of first enterprise in wood frame from my house my life program]. *Guia da Construção*, 66 (146), 16–25. (in Portuguese)
- FIESP. (2016). Levantamento inédito mostra déficit de 6,2 milhões de moradias no Brasil [Unprecedented survey indicates a 6.2 million housing shortage in Brazil]. (in Portuguese) www.fiesp.com.br/noticias/levantamento-inedito-mostra-deficit-de-62-milhoes-de-moradias-no-brasil/
- FRANZINI, F. – TOIVONEN, R. – TOPPINEN, A. (2018). Why Not wood? Benefits and barriers of wood as a multistory construction material: perceptions of municipal civil servants from Finland. *Buildings* 8 (159): 1–15. <https://doi.org/10.3390/buildings8110159>
- GENEVOIS, M.L.B P. – COSTA, O.V. (2001). Carência habitacional e déficit de moradias: questões metodológicas [Housing lacking and dwelling shortage]. *São Paulo em Perspectiva* 15 (1): 73–84. <https://doi.org/10.1590/S0102-88392001000100009> (in Portuguese)
- IBGE. (2013). Atlas do censo demográfico 2010 [Atlas of Demographic Census 2010]. Rio de Janeiro, RJ, Brazil: IBGE. (in Portuguese)
- IBGE. (2017). Pesquisa nacional por amostra de domicílios – PNAD [National survey by dwelling sample]. (in Portuguese) http://www.ibge.gov.br/home/estatistica/pesquisas/pesquisa_resultados.php?id_pesquisa=40

- FALCÃO BAUER. (2015). DATec n. 020-A: sistema de vedação vertical leve em madeira [DATec number 020-A: light system of vertical finishing based on timber]. São Paulo: Falcão Bauer. (in Portuguese)
- GOLD, S. – RUBIK, F. (2009). Consumer attitudes towards timber as a construction material and towards timber frame houses: selected findings of a representative survey among the German population. *Journal of Cleaner Production*, 17 (2): 303–309.
<https://doi.org/10.1016/j.jclepro.2008.07.001>
- HURMEKOSKI, E. – JONSSON, R. – NORD, T. (2015). Context, drivers, and future potential for wood-frame multi-story construction in Europe. *Technological Forecasting and Social Change*, 99: 181–196.
<https://doi.org/10.1016/j.techfore.2015.07.002>
- KISS, P. (2009). Você sabe o que é SiNAT? [Do you know what SiNAT is?]. (in Portuguese)
<http://techne.pini.com.br/engenharia-civil/150/artigo287681-1.aspx>
- KNIFFEN, F. – GLASSIE, H. (1966). Building in wood in the Eastern United States. *Geographical Review* 56 (1): 40–66. <https://doi.org/10.2307/212734>
- KOPPELHUBER, J. – BAUER, B. – WALL, J. – HECK, D. (2017). Industrialized timber building systems for an increased market share – a holistic approach targeting construction management and building economics. *Procedia Engineering* 171: 333–340.
<https://doi.org/10.1016/j.proeng.2017.01.341>
- KUZMAN, M.K. – GROŠELJ, P. (2012). Wood as a construction material: comparison of different construction types for residential building using the analytic hierarchy process. *Wood Research* 57 (4): 591–600.
- KUZMAN, M.K. – SANDBERG, D. (2017). Comparison of timber-house technologies and initiatives supporting use of timber in Slovenia and in Sweden - the state of the art. *iForest* 10: 930–938.
<https://doi.org/10.3832/ifor2397-010>
- LEITE, J.C.P.S. – LAHR, F.A.R. (2015). Diretrizes básicas para projeto em wood frame [Basic guidelines for design in wood frame]. *Construindo* 7 (2): 1–16. (in Portuguese)
- MAKACHIA, P.A. (2015). Innovative housing financing for sustainable growth. Working Paper Series. Nairobi, Kenya: Kenya Bankers Association. pp. 1–32
- MENEGASSI, J. – SILVEIRA, T. (Orgs.) (2015). Estratégias de ação plano local de habitação de interesse social: município de Vila Velha / Espírito Santo [Action strategies of local plan of social housing: Vila Velha / Espírito Santo]. Vila Velha, ES, Brazil: Latus. (in Portuguese)
- PBQP-H. (2017). Diretriz SiNAT: n. 005 – revisão 02 [SiNAT guideline: number 004 – revision 02]. Brasília, DF, Brazil: SNH. (in Portuguese).
- PINHEIRO, R.M. – CASTRO, G.C. – SILVA, H.H. – NUNES, J.M.G. (2011): Pesquisa de mercado [Market research]. Editora FGV, Rio de Janeiro. (in Portuguese)
- PINTO, E. G. F. (2015). Financiamento imobiliário no Brasil: uma análise histórica compreendendo o período de 1964 a 2013, norteada pelo arcabouço teórico pós-keynesiano e evolucionário [Real state financing in Brazil: a historic analysis comprehending 1964 to 2013, guided by the post-Keynesian and evolutionary theoretical framework]. *Economia & Desenvolvimento*, 27 (2): 276–296.
- POWELL, G. (2012). Construction contract preparation and management: from concept to completion. New York, USA: Palgrave Macmillan.
- PUNHAGUI, K.R.G. (2014): Potencial de reducción de las emisiones de CO₂ y de la energía incorporada en la construcción de viviendas en Brasil mediante el incremento del uso de la madera [Potential of reduction of CO₂ emissions and embodied energy in the housing construction in Brazil through the increasing of wood utilization]. PhD thesis. Universitat Politècnica de Catalunya / University of São Paulo, Barcelona / São Paulo. (in Spanish)
- RAOSOFT. (2004): Raosoft sample size calculator, <http://www.raosoft.com/samplesize.html>.
- RAMAGE, M.H. – BURRIDGE, H. – BUSSE-WICHER, M. – FEREDAY, G. – REYNOLDS, T. – SHAH, D.U. – WU, G. – YU, L. – FLEMING, P. – DENSLEY-TINGLEY, D. – ALLWOOD, J.; DUPREE, P. – LINDEN, P.F. – SCHERMAN, O. (2017). The wood from the trees: the use of timber in construction. *Renewable and Sustainable Energy Reviews* 68 (1): 333–359.
- REINER-SMITH, S. (1981). Sprayed-concrete sandwich. *Popular Science*, 218 (5): 97–97.

- ROOS, A. – WOXBLOM, L. – MCCLUSKEY, D. (2010). The influence of architects and structural engineers on timber construction – perceptions and roles. *Silva Fennica* 44 (5): 871–884. <https://doi.org/10.14214/sf.126>
- SÁ, W.L.F. (2009). Autoconstrução na cidade informal: relações com a política habitacional e formas de financiamento [Self-construction in the informal city: relations with housing policy and financing forms]. MSc thesis. Federal University of Pernambuco, Recife. (in Portuguese)
- SANTIAGO, F. (2012). Financiamento de casas que fogem da alvenaria convencional [Financing of those houses that are different from the conventional masonry]. <http://casa.abril.com.br/materiaisconstrucao/financiamentodecasasquefogemdaalvenariaconvencional/> (in Portuguese)
- SANTOS, A. (2009). Alvenaria vai predominar no minha casa, minha vida [Masonry will dominate My House My Life]. 2009. (in Portuguese) www.cimentoitambe.com.br/alvenariavaipredominarnominhacasaminhavid/
- SOTSEK, N.C. – SANTOS, A.P.L. (2018). Panorama do sistema construtivo light wood frame no Brasil [Brazilian light wood frame system overview]. *Ambiente Construído*, 18 (3): 309–326. <https://doi.org/10.1590/s1678-86212018000300283> (in Portuguese)
- VILUMA, A. (2017). The situation with use of wood constructions in contemporary Latvian architecture. *Mokslas – Lietuvos Ateitis* 9 (1): 9–15. <https://doi.org/10.3846/mla.2017.1007>
- WANG, L. – TOPPINEN, A. – JUSLIN, H. (2014). Use of wood in green building: a study of expert perspectives from the UK. *Journal of Cleaner Production* 65: 350–361. <https://doi.org/10.1016/j.jclepro.2013.08.023>
- ZANI, A.C. (2013): *Arquitetura em madeira* [Wooden architecture]. Eduel / Imprensa Oficial do Estado de São Paulo, Londrina / São Paulo. pp. 1–396. (in Portuguese)

