

Economic and Labor Sizes from the Brazilian Timber Housing Production Sector

Victor DE ARAUJO^{a*} – Claudia NOGUEIRA^b – Antonio SAVI^c –
Marcos SORRENTINO^d – Elen MORALES^c – Juliana CORTEZ-BARBOSA^c –
Maristela GAVA^c – José GARCIA^d

^a Research Group on Development of Lignocellulosic Products (LIGNO), Itapeva, Brazil

^b Secretariat of the Defense of Environment of Piracicaba city (SEDEMA), Piracicaba, Brazil

^c Timber Engineering course, São Paulo State University (UNESP), Itapeva, Brazil

^d Department of Forest Sciences, University of São Paulo (USP), Piracicaba, Brazil

Abstract – Brazilian timber housing producers were evaluated through a survey, which was based on face-to-face interviewing supported by a semi-structured questionnaire. Derived from expansive research, this paper aimed to identify labor size and to characterize economic size from this production sector. The sampling process evaluated 50.95% (n = 107) of all producers (n = 210) whose performance was considered close to ideal. This sector is mostly concentrated in micro and small-scale companies, though a small portion of medium-sized companies owned by sole proprietors, families, or small groups of entrepreneurs does exist. Due to compact sizing, no producer was classified as an industry or a large corporation. The main contrast was indicated by the number of direct jobs, whose estimation was about 3,700 workers for the whole studied sector, representing 1% of the overall Brazilian timber industry. Around 95% of timber housing producers are considered micro or small from a labor perspective. Unprecedented information could support discussions for the creation of assertive public policies.

economic size / employment / wooden construction / personal interviewing / sectoral research

Kivonat – A brazil faház termelő ágazat gazdasági és munkapiaci súlya. A braziliai faház-termelőket félig strukturált kérdőív segítségével végzett személyes interjú alapján értékeltük. A kiterjedt kutatásokból kiindulva a jelen tanulmány célja e termelési ágazat munkapiaci helyzetének meghatározása és gazdasági súlyának jellemzése. A mintavételi eljárás során az összes gyártó (n = 210) 50,95%-át (n = 107) értékeltük, akiknek a teljesítményét az ideálshoz közeleink tekintettük. Ez a szektor leginkább a mikro- és kisvállalkozásokra koncentrálódik, de létezik néhány olyan közepes méretű vállalkozás, amely az egyéni vállalkozók, családok vagy kisvállalkozói csoportok tulajdonában van. Az egyezményes méretkategóriák szerinti osztályozás miatt egyetlen termelő sem minősül iparinak vagy nagyvállalatnak. A fő különbséget a közvetlen munkahelyek száma mutatta, amely a becslések szerint az egész tanulmányozott ágazatra vonatkozóan körülbelül 3700 munkavállalót jelent, ami a teljes brazil faipari ágazat 1%-át teszi ki. A faház-termelők mintegy 95%-át munkaerő szempontjából mikro-, vagy kisvállalkozásnak tekintik. A példa nélküli információk alkalmasak az érdekérvényesítő állami politikák létrehozására irányuló megbeszélések támogatására.

gazdasági méret / foglalkoztatottság / fa szerkezet / személyes interjú / ágazati kutatás

* Corresponding author: victor@usp.br; BR-18409-010 ITAPEVA (SP), Geraldo Alckmin 519, Brazil

1 INTRODUCTION

Most timber operations in the southern Mediterranean area of Italy are considered to be in an early stage of mechanization (Proto et al. 2018). Forest-based industries, especially the primary processing industries, have low yield and generate large amounts of waste (Barbosa et al. 2014). Several Brazilian sawmills share low levels of reliability due to the absence of dependable technology (Scanavaca Junior – Garcia 2004). Formerly, self-built housing production in Brazil was based on simple and immediate solutions that adhered to carpentry principles and knowledge (Zani 1997, 2013). Compared to the local forestry and sawing industries, Brazilian timber housing producers possess relatively new machines, which are visibly composed of compact solutions such as hand tools, portable equipment, and medium-sized machinery (De Araujo et al. 2018a). Though some large enterprises exist, small businesses form the bulk of the forest and civil construction industry due to the basic and/or rudimentary activities, specific operational focuses, and vast number of companies in the sector. These facts suggest most companies in the industry will remain small over time.

The volume of research focusing on large companies is greater than the research focusing on small companies. Nevertheless, several authors have discussed the strategic management peculiarities of micro and small companies, but unlike research into large companies, little action has been taken in empirical terms on the quantitative side (Santos et al. 2007). This scenario has been repeated in several Brazilian production sectors. This creates a demand for new studies focusing primarily on more elementary organizational characteristics. Small-scale forestry-based activities mean different things in different countries (Harrison et al. 2002). From economic and social perspectives, several timber production activities such as woodworking and sawmilling as well as some timber house production and furniture production could be classified as small scale.

This paper aims to characterize economic size as determined by the Brazilian government, and to quantify direct employees from the local timber housing sector. Thereby, two hypotheses were listed: many producers are economically self-declared as micro or small sized; and, compared to the whole timber industry, the studied sector has an almost imperceptible labor force comprising of only a few jobs per company.

1.1 Theoretical background

According to Lakatos (1990), every company can be classified as an economic activity complex developed under the control of a legal entity such as a natural person, a mercantile society, a cooperative, a non-profit private institution, or a public organization. Small and medium-sized companies could act as a maturation mean to large companies as well as executive and entrepreneurial laboratories, and opportunity and/or job generator (Kassai 1997). By means of a combination of economic indicators of the political and social character, the association of quantitative and qualitative criteria seems to allow for a more appropriate analysis for company categorization purposes (Pineiro 1996).

According to Antonik – Muller (2016), there are two ways to classify a business, be it a commercial, service or industrial enterprise: annual gross income (*Table 1*) or labor force size (*Table 2*). The authors also indicated that a combination of these criteria could be applied; company listing on a stock exchange is a good example of this. Brazil (1976) proclaimed law 6404, which summarizes those share-holding companies that could possess open or closed capital. Open society democratizes its capital by accepting a minimum number of shareholders appointed by the National Monetary Council from the Central Bank of Brazil (Requião 1968).

In contrast, closed-end companies do not access the capital market through stock listings, or through securities on the stock exchange, or over-the-counter market since the focus of

closed-end companies concentrates on aspects such as size, societal and legal compositions, maturity, etc. (IBGC 2014).

Table 1. Business classification according to annual gross income

Size	Revenue (US\$ million)*
Individual entrepreneur	< 0.015
Micro company	< 0.6
Small company	0.6 – 4.0
Medium company	4.0 – 22.5
Medium-to-large company	22.5 – 75.0
Large company	> 75.0

* Exchange rate: US\$1.00 to R\$4.00; Sources: Antonik – Muller (2016), Brazil (2006, 2016), BNDES (2015).

Table 2. Business classification according to the amount of direct employees

Size	Industrial (people)	Commercial and Services (people)
Micro company	< 19	< 9
Small company	20 – 99	10 – 49
Medium company	100 – 499	50 – 99
Large company	> 500	> 100

Sources: SEBRAE (2013), Antonik – Muller (2016).

Obtaining actual and updated annual gross income value from any company is a complex stage in the survey data collection process due to possible entrepreneur constraint in this disclosure. Conversely, analyzing company size through the number of employees provides a more accurate and interesting alternative that eliminates the delicate issue of disclosing income.

Furthermore, labor is currently considered the main organizational capital, especially considering that it is a basic unit of work, production, and development (Valizadeh – Ghahremani 2012) as well as a successful organization's main asset (Siqueira – Kurcgant 2012).

2 MATERIALS AND METHODS

2.1 Materials

According to De Araujo (2017) and De Araujo et al. (2018a,b), the indispensable materials utilized for this study were the timber housing producers themselves, bibliographic materials about relative topics, and a standard questionnaire. Though the outlay cost on displacements for personal interviewing was high, the overall cost for the research materials was low.

2.2 Survey method

Surveys are the best way to collect actual and real information to define and characterize any population through delimited samples. Roos et al. (2010), Kuzman – Grošelj (2012), Dobsinska – Sarvasova (2016), De Araujo (2017), Koppelhuber et al. (2017), De Araujo et al. (2018a,b) and other studies are good examples for the application of surveys on forest and timber industries.

The visible lack of information about the timber housing sector and its respective producers was verified, which was justified by few studies and the absence of associations (De Araujo 2017). Producer association is a controversial topic worldwide. Hrib et al. (2017) revealed a timely example of small-scale forest owners in the Czech Republic who are reluctant to join associations or form associations. In contrast, associative initiatives are available for timber housing producers in Lithuania (Medinių Namų Gamintojų Asociacija 2007), Estonia (Eesti Puitmajaliit 2009) and Spain (Asociación de Fabricantes y Constructores de Casas de Madera 2009), and include mostly small-scale companies. A discordance regarding Brazilian sectoral populations was noted in two singular studies. Sobral et al. (2002) listed about 15 timber housing producers from São Paulo State in 2001. However, in 2014, Punhagui (2014) estimated the prefabricated housing sector in Brazil consisted of 50 timber companies. Such inconsistencies reinforce the need for new sectoral analyses.

Thus, this present paper was specially produced from an unprecedented wide-scoped survey study by De Araujo (2017) with a focus on the analysis of timber housing production sector. Targeting of the timber housing sector was based on an overall comprehension of the current situation, and the characterization of its aspects and hindrances was used to generate updated information that could be applied for to new public policies that have been created to support sectoral demands and, consequently, the development of timber housing sector itself.

2.3 Questionnaire preparation for data collection

The general manager of this project (first author) and his advisor (last author) developed a standardized questionnaire to collect data for this study. In addition, several timber-forest chain professionals contributed by assisting with the query pre-test, refining, and validation processes. The third version of the questionnaire was approved; the general survey manager was the sole interviewer (De Araujo 2017).

The design of this paper focused on determining the economic and labor sizes of Brazilian timber housing producers in the studied sector. Two queries were prepared to investigate the real scenario. Closed answering was the applied strategy in both analyzed queries. The first question considered four responses according to main economic standards prescribed by Brazil (2006) and BNDES (2015). On the other hand, a second investigation included seven categories for employee number (*Table 3*).

Table 3. Questionnaire for this approach on economic and labor sizing

Query	Response
How is your company characterized regarding economic size?	Micro company; small company; medium company; and large company
In total, how many employees does your company possess as direct hired job?	< 5; 6 – 9; 10 – 19; 20 – 29; 30 – 39; 40 – 49; > 50

Three direct employee estimates (minimum, average, and maximum) were also obtained for this studied sector from a second query, which was supported by the declared amounts from these ranges through the proportionality principle. According to Silva – Guerra (2011), this method consisted of linear functions to establish correlations for percentage dimensions and financial mathematics among other mathematical and related disciplines.

2.4. Result analysis of collected data

For a comparison of the obtained results in each query (Table 3), all qualitative responses were converted into percentages, whose mechanism, according to Gil (2008), offers a stringent sampling. Therefore, as prescribed by Miles and Huberman (1994), three triangulation modes were considered: analyses by distinct places, a wide population sampling, and a qualitative view through literature.

Margin of error was obtained from percentages whose calculation was supported by the statistical software “Raosoft Sample Size Calculator” available from Raosoft (2004).

Raosoft (2004) considered the establishment of two variables to an efficient approach; that is, a 95% confidence level and a 50% response distribution. If the sampling process is not poor in terms of data collection, then the survey research could be classified as ideal or acceptable by the obtained margin of error according to Pinheiro et al. (2011). If the obtained margin is within these two acceptable levels, the survey performance can be validated as suggested by De Araujo et al. (2018a,b).

3 RESULTS

3.1 Sectoral estimation and survey

Table 4 shows the total estimated population of the timber housing sector in Brazil, which was obtained through this research study and through De Araujo et al. (2018a, b) as well as the sampling performed here; the obtained margin of error of $\pm 3.325\%$ was calculated by Raosoft’s online software. In addition, two efficient situations were pointed out from the sample amount based on Pinheiro et al. (2011); more specifically, ideal and acceptable levels of sampling.

Table 4. 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. (2018a,b); **Obtained values according to Pinheiro et al. (2011)

3.2 Economic sizing in the Brazilian timber housing sector

In the identification of the economic sizes of enterprises from the Brazilian timber housing production sector, about 80% (86 producers) of the studied samples are currently formed by micro and small producers whose margin of error ranged $\pm 3.325\%$. In contrast, medium companies represented a fifth of the whole sampling. No large-sized company was identified in the sector (Figure 1).

This fact proved the first mentioned hypothesis concerning a panorama broadly based on micro or small-sized producers (Figure 1). Thereby, all studied samples were revealed to be compact businesses that were family-owned, sole proprietorships, or owned by a small group of entrepreneurs or microentrepreneurs.

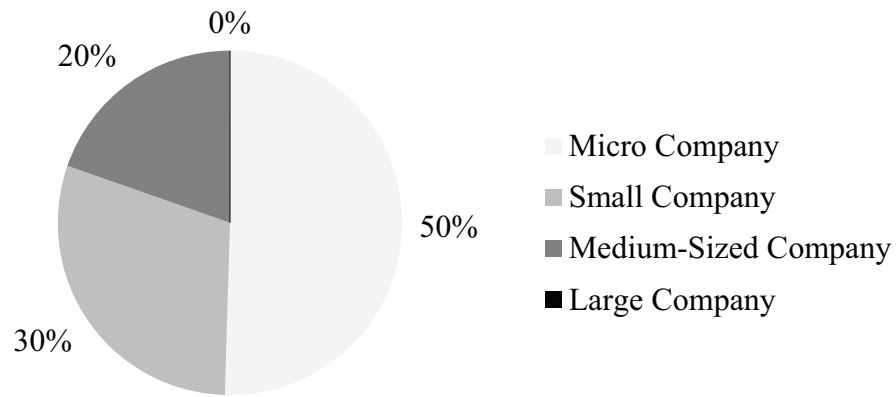


Figure 1. Economic size of Brazilian timber housing producers

3.3 Labor sizing in the Brazilian timber housing sector

Figure 2 shows the size categories according to direct jobs for the timber housing production sector in Brazil. Seven ranges were evaluated, and the results indicated that three-quarters of companies have hired fewer than 20 direct workers. Only one of the six companies that exceeded the limit of 50 direct workers had more than 100 workers. The remaining five producers hired fewer than 100 workers. This revealed that compact companies form the majority from the job perspective.

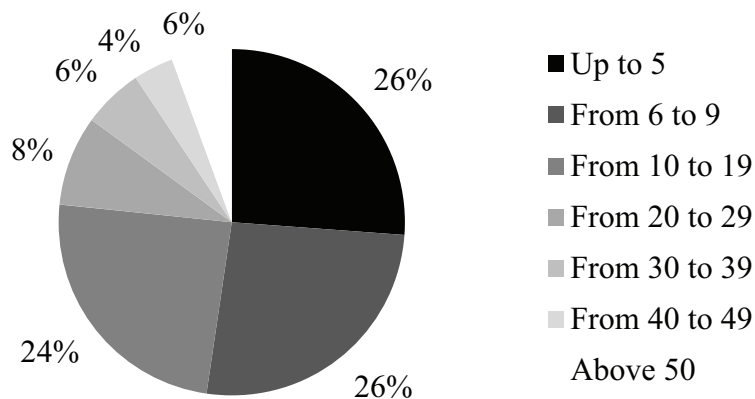


Figure 2. Direct job size of Brazilian timber housing producers

From the data in Figure 2, Figure 3 identifies three population scenarios (maximum, average, and minimum) estimated for studied producer sampling (n = 107) and similar respective projections for the whole sector focused on timber housing production (n = 210).

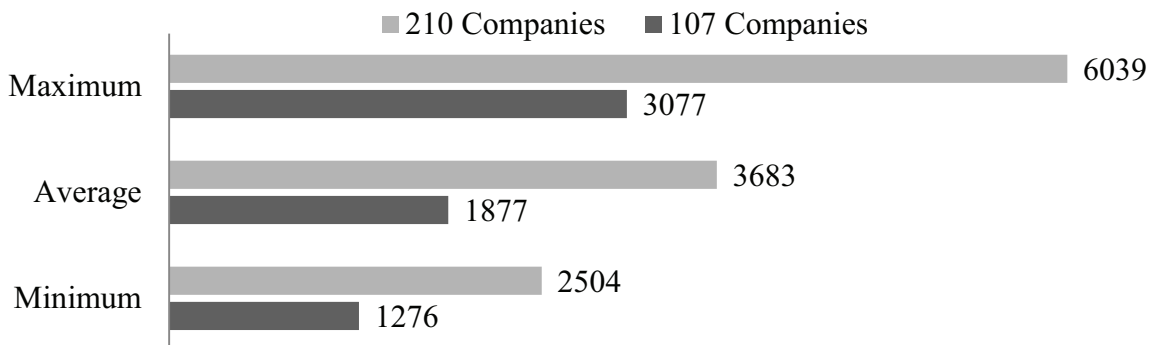


Figure 3. Direct job estimations (worker amount) in the Brazilian timber housing sector

4 DISCUSSION

4.1 Sectoral estimation and survey

Formerly, only a few studies focusing on the timber housing sector described the population of this sector – which was formed by 15 producers in São Paulo State (Sobral et al. 2002), and 50 producers in Brazil (Punhagui 2014). From the obtained overall estimated population for this sector (*Table 4*), the current situation regarding producer listing differs extensively. Punhagui's study is both important and novel, but sectoral evaluation is not its main objective. In light of this, the present study challenges her initial listing by including 50 Brazilian companies. From statements made in De Araujo et al. (2018a,b), this refutation occurred because Punhagui's producer listing was visibly different from the one used in the present study; more to the point, Punhagui's listing was four times smaller than the overall estimated population and two times smaller than the sampling executed here.

Nearly 51% of the entire production sector – 107 of 210 companies – were evaluated in the data collection of the present study – (*Table 4*). Six states – Santa Catarina, Rio Grande do Sul, Paraná, São Paulo, Minas Gerais, and Distrito Federal – from three Brazilian regions were considered in this survey. These facts successfully reinforced the obtained sampling in this study through triangulations that took different places and a wide population into consideration. Due to high performance costs, triangulation by the evaluation method was not possible, neither for other simultaneous interviewers, nor for the methodological analyses (De Araujo et al. 2018a,b).

According to Pinheiro et al. (2011), the margin of error obtained in this study revealed that the survey process (*Table 4*) was within the acceptable level of 10% and closer to the ideal of 5%. This performed sampling conforms to the literature as it is between two cited levels and is strictly closer than ideal. Therefore, this research can be efficiently statistically tested and validated.

4.2 Economic sizing in the Brazilian timber housing sector

The predominance of smaller enterprises in the civil construction industry has become the most widespread production mode in Brazil. Production simplification has ensured greater popularity of these smaller companies in Brazil, whereas according to Batista – Ghavami (2005), a large portion of houses are still built in conventional systems that are traditionally produced on the construction site.

This scenario is due to intrinsic factors within the Brazilian construction industry and its respective timber housing sector; these factors include unskilled and untrained labor, compact work teams, low investment, low industrialization levels, and rudimentary machines and tools (Ponce 1995, Lanier – Herman 1997, Shimbo – Ino 1997, Batista – Ghavami 2005, Thallon 2008, Alves 2012). As a result, these micro and small-sized producers contribute a considerable part of the income and employment generation throughout the country, which is the reason why the Brazilian government is working on implementing public policies to support and encourage the development of these small companies (Cunha et al. 2014). Such stimuluses have occurred even in those countries that are traditionally recognized for their timber utilization. Kuzman – Sandberg (2017) stated that promotion strategies to stimulate the increased use of timber in construction have been successfully applied in Sweden and Slovenia in an effort to develop sustainable housing, this despite the advanced stage of the industry in both respective countries. Luo et al. (2018) mentioned that Japan is also experiencing similar industrial development and government policy initiatives.

If compact companies continue to be the main timber house producers in Brazil (*Figure 1*), the sector they occupy will be dissonant regarding the traditional construction industry, which

is strongly based on masonry. The situation of small timber house producing companies is a direct contrast to the current civil construction scenario in which large corporations that monopolize and deteriorate the housing market are dominant. This fact is a result of the more inclusive and sustainable corporate view of the timber housing sector. Kuzman – Sandberg (2017) stated that high prefabrication, partnerships, and other factors could contribute to development of sustainable timber construction. In addition to such statements, the production efficiency and standardized quality provided by prefabricated timber houses will also guide strategies for timber house sectoral consolidation in the face of artisanal masonry.

4.3 Labor sizing in the Brazilian timber housing sector

The plural presence of small businesses could be observed from the perspective of direct job creation. About 95% of sampled companies individually self-declared a concentration of fewer than 50 jobs (*Figure 2*). By means of classification from SEBRAE (2013) and Antonik – Muller (2016) (*Table 2*), the studied producers were considered, for the most part, as micro- or small-sized examples.

Pulp and paper activities are present in 18 Brazilian states and provide around 115,000 direct jobs. From these, 68,000 jobs are industrial while 47,000 jobs are forest based (CNI 2012). In 2015, the segments of the Brazilian timber industry concentrating on panel, sawn wood, and pulp and paper directly employed around 540,000 workers (IBÁ 2016). Despite this highly visible job amount, the timber housing production sector was not declared nor counted in this projection. For this, simultaneous projections could be performed by local agencies to characterize this studied sector. Therefore, from average results (*Figure 3*), there are 1,800 and 3,700 direct workers for sampled amount ($n = 107$ producers) and the whole sector ($n = 210$), respectively. The Brazilian timber housing sector can be considered small from a labor perspective since this sector maintains less than 1% of direct jobs in relation to the whole timber industry, which is about 150 times greater. This fact supports the veracity of last hypothesis. From the aforementioned results, the investigation of social and economics situations obtained by this survey, particularly about economic and labor sizes, became necessary, and revealed findings to support the entire wood chain of production in Brazil.

This focus is justified by Thomas-Seale et al. (2018), which verified the existence of the potential to economically target industrial and engineering context-specific development strategies. This survey could be applied for other countries' panoramas and industrial contexts such as studies from Bui et al. (2005), Hrib et al. (2017), Sekot (2017), etc.

5 CONCLUSIONS

Similar to the Brazilian civil construction industry, most business activities within the local timber housing sector is concentrated in micro or small companies despite a noticeable presence of medium-sized organizations. The main difference is the absence of large-sized producers in this studied sector. Maintenance of such a scenario could be very beneficial for this sector if more compact company sizes are maintained, which could allow greater production control and presence in smaller cities.

The establishment of partnerships between the compact organizations, through the possibility of greater production efficiency compared to conventional processes based on traditional artisanal masonry house production, can provide a consistent number of locally-produced timber houses. This strategy could be reached through social orientation to mitigate the current Brazilian housing deficit – about 6.2 million dwellings according to FIESP (2016) – without the dependence of large and monopolistic corporations focused on timber

techniques, that is, contractors and/or constructors despite the non-existence of these, as was verified in this study for timber housing production.

With respect to labor size, the contrast is intensified, especially compared to the overall timber industry whose job amounts analyzed from projections is almost 150 times less than that of the whole timber chain, which includes a massive presence of pulp and paper, panels, and other timber companies.

Unprecedented sectoral information shared here could also serve as an effective instrument to support discussions for the creation of assertive public policies and inclusive to compact-size companies, aiming the development of this promising sector from Brazilian civil construction.

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REFERENCES

- ALVES, I.F. (2012): Veja 7 setores para pequenas empresas ganharem dinheiro na construção civil [See 7 sectors for small businesses make money in construction]. (in Portuguese) <https://economia.uol.com.br/noticias/redacao/2012/03/22/veja-7-setores-para-pequenas-empresas-ganharem-dinheiro-na-construcao-civil.htm>
- ANTONIK, L.R. – MULLER, N.A. (2016): Análise financeira – uma visão gerencial. [Financial analysis - a managerial view] Alta Books, Rio de Janeiro. 240 p. (in Portuguese)
- ASOCIACIÓN DE FABRICANTES Y CONSTRUCTORES DE CASAS DE MADERA. (2009): Servicios para asociados [Services for Associated], <http://www.casasdemadera.org/servicios.html> (in Spanish)
- BATISTA, E.M. – GHAVAMI, K. (2005): Development of Brazilian steel construction. Journal of Constructional Steel Research 61 (8): 1009–1024. <https://doi.org/10.1016/j.jcsr.2005.02.011>
- BARBOSA, L.C. – PEDRAZZI, C. – FERREIRA, E.S. – SCHNEID, G.N. – WILLE, V.K.D. (2014): Avaliação dos resíduos de uma serraria para a produção de celulose kraft [Evaluation of wood waste of one sawmill to kraft pulp production]. Ciência Florestal 24 (2): 491–500. (in Portuguese) <http://doi.org/10.5902/1980509814589>
- BNDES – BANCO NACIONAL DE DESENVOLVIMENTO ECONÔMICO E SOCIAL. (2015): Apoio às micro, pequenas e médias empresas [Support to small and médium companies]. BNDES, Rio de Janeiro. (in Portuguese)
- BRAZIL. (1976): Lei n.º 6404, de 15 de dezembro de 1976 [Law 6404, December 15, 1976]. Diário Oficial da União. Casa Civil, Brasília. (in Portuguese)
- BRAZIL. (2006): Lei complementar n.º 123, de 14 de dezembro de 2006 [Supplementary Law 123, December 14, 2006]. Diário Oficial da União. Casa Civil, Brasília. (in Portuguese)
- BRAZIL. (2016): Lei complementar n.º 155, de 27 de outubro de 2016 [Supplementary Law 155, October 27, 2016]. Diário Oficial da União. Casa Civil, Brasília. (in Portuguese)
- BUI, H.B. – HARRISON, S. – LAMB, D. – BROWN, S.M. (2005): An evaluation of the small-scale sawmilling and timber processing industry in northern Vietnam and the need for planting particular indigenous species. Small-scale Forestry 4 (1): 85–100. <https://doi.org/10.1007/s11842-005-0006-9>
- CNI – CONFEDERAÇÃO NACIONAL DA INDÚSTRIA. (2012): Florestas plantadas: oportunidades e desafios da indústria brasileira de celulose e papel no caminho da sustentabilidade [Planted forests: opportunities and challenges of the Brazilian pulp and paper industry on the path to sustainability]. CNI, Brasília. (in Portuguese)
- CUNHA, C.L.F. – OLIVEIRA, C.G. – COSTA, C.N. – SILVA, F.S.P. – BASTOS JÚNIOR, J.C. – VARELLA, M.D. – BASTOS, M.P. – COSTA, N.H. – ALVES, R.T. (2014): Tratamento diferenciado às micro e pequenas empresas: legislação para estados e municípios [Differential treatment for micro and small companies: legislation for states and municipalities]. SMPE/DREE, Brasília. (in Portuguese)

- 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. – 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. (2018a): 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. – 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. (2018b): Difficulties of wooden housing production sector in Brazil. *Wood Material Science & Engineering* 1–10. <https://doi.org/10.1080/17480272.2018.1484513>
- DOBSINSKA, Z. – SARVASOVA, Z. (2016): Perceptions of forest owners and the general public on the role of forests in Slovakia. *Acta Silvatica Lignaria Hungarica* 12 (1): 23–33. <https://doi.org/10.1515/aslh-2016-0003>
- EESTI PUITMAJALIIT. (2009): Estonian woodhouse association, <http://www.puitmajaliit.ee/association-1>
- FIESP – FEDERAÇÃO DAS INDÚSTRIAS DO ESTADO DE SÃO PAULO. (2016): Levantamento inédito mostra déficit de 6,2 milhões de moradias no Brasil [Unprecedented survey shows a deficit of 6.2 million homes in Brazil], <http://www.fiesp.com.br/noticias/levantamento-inedito-mostra-deficit-de-62-milhoes-de-moradias-no-brasil>
- GIL, A. C. (2008): Métodos e técnicas de pesquisa social [Methods and techniques of social research]. 6th ed. Atlas, São Paulo. (in Portuguese)
- HARRISON, S. – HERNBOHN, J. – NISKANEN, A. (2002): Non-industrial, smallholder, small-scale and family forestry: what's in a name? *Small-scale Forest Economics, Management and Policy* 1 (1): 1–11.
- HRIB, M. – SLEZOVÁ, H. – JARKOVSKÁ, M. (2017): To join small-scale forest owners' associations or not? motivations and opinions of small-scale forest owners in three selected regions of the Czech Republic. *Small-scale Forestry* 17 (2): 1–18. <https://doi.org/10.1007/s11842-017-9380-3>
- IBÁ – INDÚSTRIA BRASILEIRA DE ÁRVORES. (2016): IBÁ 2016. Relatório anual [IBÁ 2016. Annual report]. Ibá, São Paulo. (in Portuguese)
- IBGC – INSTITUTO BRASILEIRO DE GOVERNANÇA CORPORATIVA. (2014): Caderno de boas práticas de governança corporativa para empresas de capital fechado: um guia para sociedades limitadas e sociedades por ações fechadas [Notebook of corporate governance good practices for private companies: a guide for limited and closed-end Corporations]. IBGC, São Paulo. (in Portuguese)
- KASSAI, S. (1997): As empresas de pequeno porte e a contabilidade [Small-sized companies and accountancy]. *Caderno de Estudos* 9 (15): 60–74. <http://doi.org/10.1590/S1413-92511997000100004> (in Portuguese)
- 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>
- LAKATOS, E.M. (1990): Sociologia geral [General sociology]. 6th. ed. Atlas, São Paulo. (in Portuguese)
- LANIER, G.M. – HERMAN, B.L. (1997): Everyday architecture of the mid-Atlantic: looking at buildings and landscapes. John Hopkins, Baltimore.
- LUO, W. – MINEO, K. – MATSUSHITA, K. – KANZAKI, M. (2018): Consumer willingness to pay for modern wooden structures: a comparison between China and Japan. *Forest Policy and Economics* 91: 84–93. <https://doi.org/10.1016/j.forpol.2017.12.003>

- MEDINIŲ NAMŲ GAMINTOJŲ ASOCIACIJA. (2007): Lithuanian wood houses industry, http://www.timberhouses.lt/lithuanian_wood_houses_industry.
- MILES, M. B. – HUBERMAN, A. M. (1994): Qualitative data analysis. Sage, Thousand Oaks.
- PINHEIRO, M. (1996): Gestão e desempenho das empresas de pequeno porte: uma abordagem conceitual e empírica [Management and performance of small businesses: a conceptual and empirical approach]. PhD thesis. University of São Paulo, São Paulo. (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)
- PONCE, R.H. (1995): Madeira serrada de eucalipto: desafios e perspectivas [Eucalypt sawn wood: challenges and perspectives]. In: Proceedings of the I Seminário Internacional de Utilização de Madeira de Eucalipto para Serraria. São Paulo, IPT/IPEF/ESALQ-USP. 1995. 50–58. (in Portuguese)
- PROTO, A.R. – MACRÌ, G. – VISSER, R. – HARRILL, H. – RUSSO, D. – ZIMBALATTI, G. (2018): A case study on the productivity of forwarder extraction in small-scale Southern Italian forests. *Small-scale Forestry* 17 (1): 71–87. <https://doi.org/10.1007/s11842-017-9376-z>
- 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>.
- REQUIÃO, R. (1968): As sociedades anônimas de capital autorizado e de capital aberto [Open and closed capital joint-stock companies]. *Revista da Faculdade de Direito UFPR* 11 (0): 133–143. <http://dx.doi.org/10.5380/rfdufpr.v11i0.6741> (in Portuguese)
- 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>
- SANTOS, L.L.S. – ALVES, R.C. – ALMEIDA, K.N.T. (2007): Formação de estratégia nas micro e pequenas empresas: um estudo no Centro-oeste mineiro [Strategy formation in micro and small companies: a study on Midwestern of Minas Gerais]. *Revista de Administração de Empresas* 47 (4): 59–73. <http://dx.doi.org/10.1590/S0034-75902007000400006> (in Portuguese)
- SCANAVACA JUNIOR, L. – GARCIA, J.N. (2004): Determinação das propriedades físicas e mecânicas da madeira de *Eucalyptus urophylla* [Determination of the physical and mechanical properties of the wood of *Eucalyptus urophylla*]. *Scientia Forestalis* 65: 120–129. (in Portuguese)
- SEBRAE – SERVIÇO BRASILEIRO DE APOIO ÀS MICRO E PEQUENAS EMPRESAS. (2013): Anuário do trabalho: micro e pequena empresa [Work year catalogue: micro and small companies]. SEBRAE / DIEESE, Brasília. (in Portuguese)
- SEKOT, W. (2017): Forest accountancy data networks as a means for investigating small-scale forestry: a European perspective. *Small-scale Forestry* 16 (3): 435–449. <https://doi.org/10.1007/s11842-017-9371-4>
- SHIMBO, I. – INO, A. (1997): A madeira de reflorestamento como alternativa sustentável para produção de habitação social [Wood from Planted Forest as sustainable alternative for the production of social housing]. In: Proceedings of I Encontro Nacional sobre Edificações e Comunidades Sustentáveis, Canela, ANTAC. November 1997. 157–162. (in Portuguese)
- SILVA, D.P. – GUERRA, R.B. (2011): Para que ensinar regra de três? [Why do we teach cross-multiplication?]. In: Proceedings of 23th Conferência Interamericana de Educação Matemática, Recife, CIEM. 2011. 1–13. (in Portuguese)
- SIQUEIRA, V.T.A. – KURCGANT, P. (2012): Job Satisfaction: a quality indicator in nursing human resource management. *Revista da Escola de Enfermagem da USP* 46 (1): 151–157. <http://dx.doi.org/10.1590/S0080-62342012000100021> (in Portuguese)
- SOBRAL, L. – VERÍSSIMO, A. – LIMA, E. – AZEVEDO, T. – SMERALDI, R. (2002): Acertando o alvo 2: consumo de madeira amazônica e certificação florestal do Estado de São Paulo [Targeting 2: Amazon wood consumption and forest certification in the State of São Paulo]. Imazon, Belém. (in Portuguese)

- THALLON, R. (2008): *Graphic guide to frame construction*. 3. ed. Taunton Press, Newtown.
- THOMAS-SEALE, L.E.J. – KIRKMAN-BROWN, J.C. – ATTALLAH, M.M. – ESPINO, D.M. – SHEPERD, D.E.T., (2018): The barriers to the progression of additive manufacture: perspectives from UK industry. *International Journal of Production Economics* 198: 104–118.
<https://doi.org/10.1016/j.ijpe.2018.02.003>
- VALIZADEH, A. – GHAREMANI, J. (2012): The relationship between organizational culture and quality of working life of employees. *European Journal of Experimental Biology* 2 (5): 1722-1727.
- ZANI, A.C. (1997): *Arquitetura de madeira: reconhecimento de uma cultura arquitetônica norte paranaense, 1930/1970* [Wooden architecture: recognition of an architectural culture Northern Paraná State, 1930/1970]. Ph.D. Thesis. Universidade de São Paulo, São Paulo. (in Portuguese)
- ZANI, A.C. (2013): *Arquitetura em madeira* [Wooden architecture]. Eduel / Imprensa Oficial do Estado de São Paulo, Londrina / São Paulo. 396 p. (in Portuguese)