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STRUCTURAL SAWN WOOD PRODUCTION IN THE CHILIEAN SAWMILL INDUSTRY, DATA ANALYSIS FROM SURVEYS CARRIED OUT FOR 4 YEARS

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ABSTRACT

The sawmill industry produce around of 8 million cubic meters annually, setting Chile as the tenth world producer of sawn wood. Since Chile is a foretry country, the current sectoral policy has among its strategic axis the promotion of quality wood construction. From here it emerges the necesity of reinforce graded structural sawn wood supply, boosting this product demand by the construction industry.

In this context, INFOR began to generates specific statistics on structural sawn wood (MAE), this activity accumulates four years of measurments. In the present research, it is presented the main results of the analysis of data obtained from these measurments, through surveying in the sawmill industry. To carry out the survey on MAE (structural sawn wood), sawmills with production higher than 10,000 cubic meters annually were selected, gathering information from a sample of 100 sawmills per year, from 2018 to 2021; these sawmills represents near of 80% of the sawn wood national production.

Results indicate that the knowledge about MAE concept has just slightly increased during four years of measurments; while the interest of sawmill in participating in MAE production it is determined by the greater access to higher pirces, a more stable demand, and a greater reliability in logs availiability.

KEYWORDS: Structural lumber market; classified structural lumber, structural lumber production

1 INTRODUCTION

In 2021, the sawmill industry in Chile had 1,233 sawmills, from which 922 were in operation. The industry consumed 16.7 million cubic meters of wood in logs, resulting in a production of 8.7 million cubic meters of sawn wood, from which 97.7% corresponds to *Pinus radiata.* From the national total production, 24.8% it is destined to exports, while 75.2% stays in the internal market [1]. According to FAO, these levels of production place Chile in the eleventh position at world level as a sawn wood producer [2].

Regarding the sawmills production range, historically plants with production lower than 5,000 m³/year have been the most numerous, representing 80% of the total number of sawmills in operation in 2021 [3].

In terms of mobility, sawmills are divided in permanent, and mobile. The number of permanent sawmills reaches a share of 48.6% in a historical growing trend, and a decrease of mobile sawmills. This is mainly due to a significant decrease in native sawn wood production, where mobile sawmills dominated [1].

In 2021, La Araucanía region concentrated the greater number of sawmills in operation with 202 units (21.9%), followed by Biobío region, and Los Lagos region with 144 units each, and Maule region with 135 units. These four regions concentrate 67.8% of the total in-operation sawmills in the country [3].

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Since Chile is a forestry country, with a highlighted roll as a wood producer, the supply of sawn wood for structural use in construction, graded as such, and in accordance with requirements demanded by the norm in force, is very low. On the other hand, from building statistics it is deduced that 60.7% of predominant materiality in walls was concrete, far surpassing wood as a structural material, which reached 10.6% of the total housing, and non-housing authorized area of new works in 2020 (13.1 million m²) [1]. These figures differ a lot when compared with other wood-producer countries, where the structural use of this material in housing construction exceeds 85% as in case of United States, and Canada, and above 60% in case of Australia, and New Zealand [4].

The promotion of wood construction is a challenge that has been considered as a strategic axis in the current forestry policy. State agencies, companies, and private associations related to the forestry, and construction sectors, as well as the academies, and I+D centers, are developing several initiatives focused on promoting wood as a construction material.

In this regard, INFOR has surveyed during four year a representative statistical sample of sawmills in the country, in order to gather information that allows to know the wood supply for construction. From this information, in the present research, a characterization, and an analysis of the structural sawn wood production is provided.

1.1 DEFINITIONS

1.1.1 Sawn wood for structural use

The sawn wood refers to solid pieces of wood obtained from a sawmill, with different features, and dimensions, which are used in construction with structural ends, mainly in roofing, and walls, but without being subjected to a formal classification process.

1.1.2 Graded structural sawn wood and its requirements

In order for radiata pine sawn wood to meet the structural requirements in construction, there are certain essential specifications that allow to ensure its good performance inside the structure. These are: structural grade, dimensions, moisture content, and preservation. [5].

a) Structural grade

The structural grade corresponds to a category of pieces of sawn wood having the same capacity to resist loads, and stress, that can be measured through the visual grading technique (NCh1207 [5], and NCh1198 [6]), which assign a structural grade to the sawn wood in terms of size, and knots location, pith, missing edges, wrapping, among others; The visual grading results in the following classifications: GS, G1, and G2; or also through a mechanical grading, based on a set of non-destructive tests, which allows to determinate the stiffness, and to be classified in a structural grade, which are: C16, C14, MGP10, and MGP12. (NCh3028 [7] part 1, and part 2, and NCh1198).

In table 1 [5], the different types of structural classifications that the sawn wood can be graded into are presented.

Table 1: *Structural grades for Radiata pine sawn wood, and its mechanical features*

Allowable stress for radiata pine wood							
Grading system	Structural grade	Bending (Mpa)	Parallel compression (Mpa)	Parallel traction (Mpa)	Normal compression (Mpa)	Shearing (Mpa)	Modulus of elasticity in bending (Mpa)
Visual	GS	11	8.5	6	2.5	1.1	10,500
	G1	7.5	7.5	5	2.5	1.1	10,000
	G2	5.4	6.5	4	2.5	1.1	8,900
Mechanical	C24	9.3	8	4.7	2.5	1.1	10,200
	C16	5.2	7.5	3.5	2.5	1.1	7,900
	MGP12	13.5	15.5	6	2.5	1.1	12,700
	MGP10	8.4	10	4	2.5	1.1	10,000

b) Dimensions

In compliance with the 1207 Chilean norm regarding the visual grading, it is stipulated that the allowed dimension tolerance in sawn wood must be in compliance with the 2824 Chilean norm [8]. This stipulates the nominal thickness, and width of the sawn and planed radiata pine wood, establishing a dimensional tolerance for the use of sawn wood of +3 mm thickness, and +5 mm wide. The length of the pieces permits a maximum tolerance of 0.1m.

c) Moisture content

Each piece of radiata pine sawn, or planed wood destined for structural use must be dry, with a moisture content lower or equal to 19%, as stated in the norm NCh 2150 [6].

d) Preservation

In compliance with the *Odenanza General de Urbanismo y Construcciones*, the different species of wood used more frequently are classified in 5 categories according to its durability: very durable, durable, moderately durable, low durability, and non-durable. The radiata pine wood is located in the category of non-durable, consequently, as the *Ordenanza* stipulates, must be preserved in compliance with the NCh 819 [10].

2 MATERIALS AND METHODS

INFOR carry out a sampling of the sawmill industry each year, where information is gathered from around a thousand sawmills from Coquimbo region, to Magallanes region. Since 2019, sawmills are selected to an additional survey on structural sawn wood. The selection requirements are: a production higher than 10,000 cubic meters annually, with a facility with minimum

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infrastructure to produce graded sawn wood, as in case of wood drying chambers, or the access to them.
The number of sawmills selected in each year of measurement is: 116 sawmills in 2018, 119 sawmills in 2019, 134 sawmills in 2020, and 136 sawmills in 2021. From the second year, the selection is in accordance with the follow-up of productive units surveyed last year.

The sawmills in the sample were classified in 8 ranges of annual production: lower or equal to 5 thousand m³; 5 thousand to 10 thousand m³; 10 thousand to 20 thousand m³; 20 thousand to 50 thousand m³; 50 thousand to 100 thousand m³; 100 thousand to 200 thousand m³; 200 thousand to 300 thousand m³; and higher than 300 thousand m³.

The quantitative, and qualitative information collected on structural sawn wood consist in: the knowledge on the concept of graded structural sawn wood, and the requirements for its production; annual amount produced; sales orders received, and business done; number of trained operators in wood grading; available equipment to produce structural wood, interest in producing it, and main factors in making the decision to enter the business.

Through the Forestry Statistics Platform from INFOR, the data was stored, and processed to its following analysis.

The information obtained was subjected to a correlation analysis to search for relations between the MAE volume produced, and other variables collected through surveys. The Spearman's rank correlation coefficient was used, since this is a non-parametric measure of statistical dependency between two variables [11]. The statistical significance of correlation between two variables was evaluated with a 95% confidence level.

3 RESULTS

The selected sample to characterize MAE production represents 28.3% average of the period from active permanent sawmills in the country, and around of 13% of the total of sawmills. The 2021 production of sawmills in the sample represents 88.3% of the national sawn wood production.

Table 2: *Number of surveyed sawmills, permanent, and in total in the 2018-2021 period.*

Year	2018	2019	2020	2021
Sawmills Sample MAE	116	119	134	136
Permanent sawmills	448	448	440	448
Active sawmills in the country	984	957	938	922

The surveyed sawmills are concentrated in the southern-central zone of the country, being Maule, Biobío, and La Araucanía regions the ones concentrating approximately 80% of the surveyed sawmills in average during four years of analysis.

In regard of sawmills size in the sample, more than half is concentrated in a production range of 10,000 to 50,000 cubic meters annually.

The sawmills were consulted about their knowledge on the concept MAE (Structural sawn wood), which indicated a positive result, going from 75.0% in 2018, to 86.8% in 2021. This represent a broad knowledge of the concept, which could be helpful in generating classified wood supply.

It is important to mention that, in all production ranges, the knowledge is superior to 66.7%, reaching near to 100% in higher production ranges sawmills, slightly decreasing in lower production ranges.

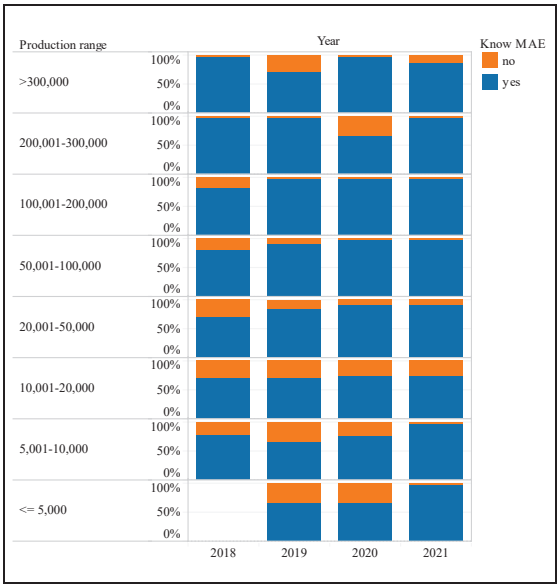

Figure 1: *Knowledge on MAE by production range, and year.*

In case of geographical location, Biobío region is the one with the greater knowledge on the concept, while Los Rios region is the one with lowest levels of knowledge on the concept.

It should be noted that when consulting about MAE concept, it was not mentioned the requirements this product must fulfil. At the period's beginning, 34.5% of the sample declared they produce structural wood, while in 2021, 45.6% of sawmills in the sample declared they produce it, they being located in production ranges of 10,000 to 20,000 m³.

The knowledge of the requirements has also had a slight variation, but negative, from 51.7% of sawmills in 2018 that indeed knew the requirements, to 47.8% in 2021.

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In practice, structural sawn wood is identified in a lot of sawmills by its use in construction, however, in few opportunities this wood is subjected to a formal classification process. As a consequence of this, there is no certainty in meeting the structural requirements.

In regard of MAE orders, in the first measurement in 2018, 15 units claimed they had received orders to produce MAE, it was not different in 2021, confirming the orders by 15 sawmills; in average during the period's study, 11.6% of sawmills in the sample received MAE production orders. It should be highlighted that MAE production orders are concentrated in ranges of 10,000 to 20,000 m³, and 20,000 to 50,000 m³.

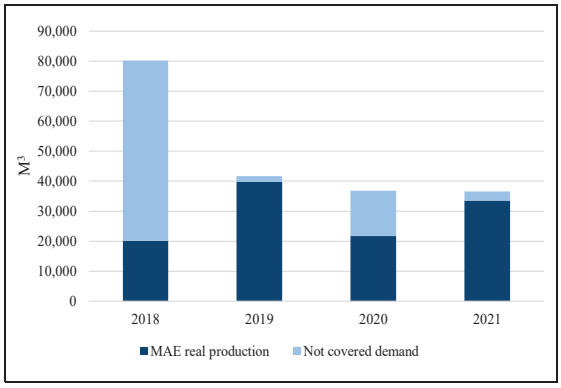

Figure 2: *Structural Sawn Wood demand, and production in 2018-2021 period.*

The volume of MAE requested has had a negative evolution, dropping from 80,120 m³ in 2018, to 36,607 m³ in 2021. On the other hand, the MAE's effective volume produced, and sold presents an increase of 66.1% since 2018 to 2021, amounting a total of 115,109 m³ during the period, meeting 59.9% of the demand in the period.

The demand unmet by sawmills, that is to say, the volume of MAE requested minus the effective produced volume has decreased (See Figure 2), representing in 2021 near of 3 thousand m³, this great variation can be explained by the increase in MAE knowledge y the real capacity of sawmills to produce this product, it is observed that requests in last three years have been adjusting to the real production.

The trained operators to carry out classification tasks have increased from 66 workers in 2018, to 92 in 2021, showing a certain interest by the sawmills in MAE production, promoting external training over internal training.

The main decision factors considered by sawmills during the period to produce, and sell MAE are: obtaining better prices for the product, reach a more stable demand, and reliability in log supply.

Another interesting way of examining the variables was though the correlation analysis, in Figure 3 are presented the main variables, those with a greater correlation with each other, excluding other variables less like-minded with the elements of the survey.

In figure 3, when the variables are closer to 1 (blue), it means a greater correlation. In case of "x", these indicates correlations without statistical significance.

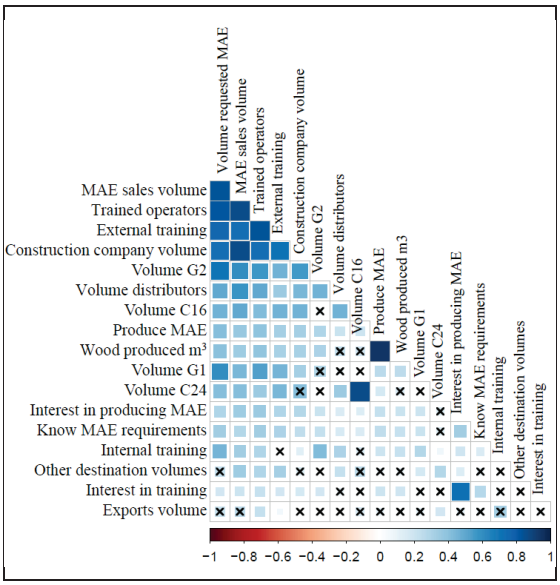

Figure 3: *Outline of main variables correlation of MAE survey*

It is observed that exist a high correlation between MAE requested volume, and actual MAE sales, in addition to trained operators, a key factor in visual grading. It also emerges that MAE requests come from construction companies, which prefer wood graded as G2, followed by G1.

To address the question if sawmills are interested in producing MAE, it is observed that this is linked to the interest in training operators, followed by the knowledge of requirements to produce MAE.

4 CONCLUSIONS

Four years of analyzed samples shows the following:

- Slight increase in knowledge of the graded structural sawn wood concept.
- In average only 5.7% of the wood for structural use marketed in construction corresponds to MAE.
- 59.0% of MAE demand was met by sawmills, of a total of 195,000 cubic meters requested during the research period.
- From the selected sawmills total production, 0.4% corresponds to MAE sales.
- Approximately, per year 10 sawmills participates actively in MAE sales, however, around of 40 are interested in production.

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- The main decision factors observed by sawmills in order to produce, and sell MAE during the research period were: higher prices, more stable demand, and reliability in logs availability.

- While there is an interest in producing MAE, the industry recognizes the importance of training their operators externally in order for them to be able to carry out a proper wood grading.

After 4 years of measurements on MAE production, and its features, it is observed that there have been no fundamental changes in supply nor in demand of the product, thus sawmills are still under observations, since MAE production is still not an attractive business in which they can rely on a certain level of demand, and prices.

For this reason, it is necessary to implement policies, and public instruments with biding effect, wood labeling or promoting instruments like subsidies in grading training, to trigger production, supply, and demand to massive level.

The current forestry industry development, new technologies in construction, in addition to sawn wood, and logs prices, it emerges the necessity of making a difference, and to add value to production in sawmills, creating opportunities to exploit graded structural sawn wood production destined to construction.

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REFERENCES

[1] Álvarez González, V., Poblete Hernández, P., Soto Aguirre, D., *et al.* Anuario Forestal 2022. Santiago, Chile. Instituto Forestal (INFOR). 276p. 2022.
[2] INFOR. El Sector Forestal Chileno 2020. Instituto Forestal. 52p. 2021.
[3] Álvarez González, V., Pardo Velásquez, E., Poblete Hernández, P. La Industria del Aserrío 2022. Instituto Forestal. 136p. 2022.
[4] Gysling Caselli, J., Kahler González, C., Soto Aguirre, D., *et al.* Madera y Construcción, Hacia una Simbiosis Estratégica. Instituto Forestal. 224p. 2021.
[5] Gysling Caselli, J., Kahler González, C., Soto Aguirre, D., *et al.* El Mercado de la Madera Aserrada para Uso Estructural en Chile. Instituto Forestal. 138p. 2020.
[6] Instituto Nacional de Normalización. Pino radiata-Clasificación visual para uso estructural - Especificaciones de los grados de calidad. (NCh N° 1207). Santiago, Chile: INN. 23p. 2005.
[7] Instituto Nacional de Normalización. Madera - Construcciones en madera - Cálculo. (NCh N° 1198). Santiago, Chile: INN. 214p. 2014.
[8] Instituto Nacional de Normalización (INN). Madera estructural - Determinación de propiedades físicas y mecánicas de la madera clasificada por su resistencia - Parte 1: Métodos de ensayo en tamaño estructural. (NCh N°3028). Santiago, Chile: INN. 14p. 2017.
[9] Instituto Nacional de Normalización. Madera Preservada - Madera - Pino radiata - Unidades, dimensiones y tolerancias. (NCh N° 2824). Santiago, Chile: INN. 9p. 2003.
[10] Instituto Nacional de Normalización. Pino radiata-Clasificación visual para uso estructural - Especificaciones de los grados de calidad. (NCh N° 819). Santiago, Chile: INN. 22p. 2012.
[11] Spearman, C. The Proof and Measurement of Association Between Two Things. In J. J. Jenkins & D. G. Paterson (Eds.), *Studies in individual differences: The search for intelligence* (pp. 45–58). Appleton-Century-Crofts, 1961

https://doi.org/10.52202/069179-0093