Australian Journal of Crop Science AJCS

AJCS 16(01):152-161 (2022) ISSN:1835-2707
doi: 10.21475/ajcs.22.16.01.p3404

Identification of critical production factors in planted forests of southern Brazil

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Abstract

This work has analyzed the forest-based production chain in the state, especially in the segment consisting of pinus and eucalyptus producing companies, under the prism of the principles of public policy development. The critical factors of the forest production link were detected and prioritized, using the component factor analysis to determine the critical factors and the Friedman test to verify the existence of differences between factors and order them. The Wilconxon test was used to verify the existence of differences in the perception of integrated and non-integrated companies in relation to critical factors. The use of the content analysis technique, theoretically based on the Pestel framework, allowed us to analyze the external environment through the identification of challenges and opportunities and their respective generating macro-environments. Based on the analysis of this compilation of critical factors identified in bibliographical research, 30 critical factors related to forest production were structured. The use of factor analysis and its subsequent interpretation provided the reduction of 30 critical factors in 10 factors. These were considered the critical performance factors of the forest production activity. Based on the analyzes carried out, the great relevance of the application of specific statistical analyzes is verified, aiming at the compilation of critical factors, which are added to the decision-making and articulations that favor forest planning. The critical factors for this study were technology, macroeconomics, logistical and social costs, and legislation. In this context, it is recommended to encourage small and medium-sized forestry companies to take the interactions between the critical factors into account. This needs the forestry-based segment to follow through the development of a joint forestry and industrial policy. In addition, it is recommended that the articulation between the private and government sectors in the search for the development of actions take advantage of the current context of pursuit of sustainability by the end consumer and the state's forestry potential.

Keywords: Critical factors. Planted forests. Public policies.

Introduction

The Brazilian planted forest sector comprises of a range of companies, investors and entrepreneurs operating from the supply of specific inputs and machines for forestry activities, from the provision of specialized services, such as the production and planting of seedlings, harvesting and transport, to the transformation of wood into intermediate and final goods.

In this sense, the state of Paraná is highly representative in the planting of Pinus and Eucalyptus, which are used for the production of various products, such as cellulose, reconstituted wood panels, furniture, and charcoal, in addition to energy purposes (Eisfeld and Nascimento (2015). Such diversification confirms that the market for products arising from this activity in the state is consolidated and diversified, attracting large forestry companies and the transformation industry.

However, even with the great importance of the state in the forestry segment, public policies aimed at fostering the expansion of activities are still incipient. Schmithüsen (2005) explained how expression public policy indicates the contents and decisions related to specific fields or sectors, as determined by the predominant plans, objectives and measures that regulate issues of public interest.

According to Hoeflich (2014), such negotiations are because incentive measures are little worked, especially with regard to the inclusion of small rural properties in the productive dynamics. Furthermore, the Brazilian forest policy has a great direction in command and control actions to the detriment of the very concept of development.

In this context, recognizing the indispensability of public and private planning in forestry activities, it is essential to identify and prioritize the critical factors that involve the production system, as well as the understanding of the challenges and perspectives that involve the links of the wood production chain in the segment of planted forests in this regional section.

Given this scenario, added to the lack of actions aimed at planning the forestry-based sector and policies for effective conduction of forestry activities from the perspective of sustainable development, this work aimed to identify the critical factors that involve the production of planted forests in the state of Paraná.

Results and Discussion

Qualitative approach

The bibliographical review allowed the compilation of several factors related to forest production and wood industrialization. Table 1 presents the diagnosis of the scientific studies evaluated, with their respective critical factors and categorizations.

Based on the analysis of this compilation of critical factors identified in bibliographical research, 30 critical factors related to forest production were structured (Table 2).

Quantitative approach

Based on these factors, Table 3 presents the values of the commonalities that presented satisfactory values, after the factor analysis of the main components.

Table 4 presents the reliability of the sub-measures assessed by the Kaiser-Meyer-Olkin (KMO) tests, Barlett's sphericity test and Cronbach's alpha.

Cronbach's alpha value was 0.864, which confirms the reliability of the analytical scale used, according to Field (2005). The results of the other tests ensure the applicability of the principal component factor analysis, except for the KMO value of 0.391, which is 0.05 below the value recommended by Hair Junior et al. (2005).

The extraction of the correlation matrix factors made it possible to identify the factors that form a linear combination of the correlation matrix variables, highlighting the critical factors formed by the correlation of the critical factors evaluated by the respondents. Thus, the solution for 11 factors was chosen based on the criteria of the “scree test” and the percentage of accumulated variance (Figure 1).

Based on the application of the test, after the eleventh factor, there was a stabilization of the curve, corroborating the concept of the method in which the number of load factors is determined by the appearance of a smooth slope indicating the presence of minor factors.

Based on the total variance of 85.0% for the choice of 11 factors, the factors extracted before and after matrix rotation are evaluated as explained in Table 5.

Eleven factors were extracted, which were representative of the perception attributed to the critical factors, according to the interrelation established by the methodology. Factors and rotated factor loadings are presented in Table 6, according to the order of extraction by the varimax rotation of the matrix.

To assess the internal consistency of the formed factors, Cronbach's Alpha was calculated for each grouping of variables. According to Hair Junior et al. (2005), Cronbach's Alpha is one of the most used measures to verify the internal consistency of a group of variables. The idea of this measure is to assess whether the variables considered in the multiple scale are highly correlated with each other.

The factor loadings were also observed, as they represent the correlations between the original variables and the factors, being an important aspect of the analysis, whereas the greater the factor loading, the greater the correlation with a given factor.

Finally, the interpretation of factors was mainly based on theoretical analyzes and technical criteria, aiming to identify the underlying dimensions that represent the theoretical constructs of the instrument.

The resulting factors after matrix rotation were considered as critical factors and named based on the dimension they represent. Table 7 presents the identified critical factors, the variables that formed them, factor loadings and Cronbach's alpha calculated for each factor.

The first factor is composed of four variables that were related to the credit dimension, showing good internal correlation (Cronbach's Alpha 0.80). With the exception of the variable “public image of the sector”, the factor loadings confirm a high correlation of the variables with the factor. The correlation of the variable "forest certification" with the other variables in the group presents a perception of the influence of certification on issues related to the availability and cost of credit, leading to the assumption that certification occurs as a differential in relation to obtaining and cost of credit.

The second factor had the highest internal consistency among the 11 factors (Cronbach's Alpha 0.84) and due to two variables having the highest individual correlation with the factor, the variables "environmental pressures" and "social pressures" (factorial load 0, 9 and 0.8, respectively). It was called the critical logistic/social costs factor, since environmental and social pressures generate indirect costs to companies' operations.

The critical factor called “technology” presented good consistency, representing the perception of the influence of the technology applied in all stages of the forest production activity, on the company's performance. On the other hand, the influence of the macroeconomic environment presented high factor loadings, highlighting its correlations with the factor.

The fifth factor evidenced is composed of two variables with reasonable intercorrelation and was characterized as planting/location cost due to costs related to planting and occurring locally. The variables of labor qualification, informality and tax and fiscal incentives form the critical support factor. This denomination comes from the interpretation of the influence of support actions for the qualification of the labor, which is related to governmental and private actions, and actions to curb informality (companies that are outside the environmental and tax laws) and tax and fiscal incentives, the latter at the governmental level.

The critical factor legislation presented a weak intercorrelation, reflecting the influence of laws, ordinances, norms, resolutions that regulate and affect forest production, related to fiscal, tax and labor issues.

During the interpretation of the factors initially called “raw material” and “growth”, great similarity in the nature of the variables grouped in these two factors was evident. After examining the internal correlations of these factors, we decided to group them into a single critical factor, called expansion.

The raw material critical factor grouped the following variables: environmental legislation, available areas and suppliers. On the other hand, the Growth Factor, encompassed the availability of labor and the expansion of production. It is important to note that environmental legislation is perceived as a limiting factor for the expansion of the productive area. The critical variable expansion of production concerns public incentives to expand forestry production and adequate scales of production. Furthermore, it appears that the availability of labor considerably influences the expansion of forest production.

The pests and diseases, and wood consumption variables did not form factors. Individual analysis of variable pests and diseases were considered extremely important by 24% of

Table 1. Scientific papers evaluated respective critical factors and categorizations.

Authors	Title of Work	Critical Factors
SIMIONI (2007)	Diagnostic and prospective analysis of the biomass energy production chain of forest origin in the Southern Plateau of Santa Catarina	Forest production: problems related to environmental legislation; forest production technology; sector image and social pressures; regional planning
		Wood industrialization: environmental license; educational level of human resources; extractive and non-associative local culture; technological standard; deficiencies in process management; lack of statistical data; regional strategic planning; low added value of products
SINPACEL (2014)	Sectorial overview 2013/2014	Tax Burden; labor legislation; shortage of skilled labor; raw material quality; foreign competition; informality; expansion of production capacity
SOTSEK (2014)	A prospective analysis of the MDF panel sector in the state of Paraná	Production cost; availability of raw material; national economy; energy and labor cost; wood/chip/particle price trend; incentives for the installation of new industries and/or incentives to increase the nominal capacity of existing industries; substitute products (market entry)/development of new MDF products, another application beyond floors and furniture; availability of areas for reforestation; consumption of MDF panels; availability of electricity
SENAI (2008)	Strategic routes for the future of the industry of Paraná: paper and cellulose *roadmapping* – 2018 horizon	Infrastructure and logistics; public policies; specialized HR; raw material; interaction between actors; technology transfer; recycling; industry *marketing*; consumer market
BRASIL (2007)	Wood production chain	Related to the determinants of demand: *per capita* income (internal demand); demographic growth; increased life expectancy; replacement with other products and raw materials; substitute products from other production chains; recycling in the use of wood and its derivatives
		Related to the determinants of supply competitiveness: genetic improvement technologies and forest management; planted forest base; suitable manufacturing scales; significant set of equipment suppliers in the country; in some segments the degree of concentration is very high
		Related to trade and international negotiations: high competitiveness of Brazilian companies; exports products with low added value and reduced contribution margin; the reduced size of Brazilian economic groups compared to the largest international groups
YUBA (2014)	Eucalyptus sawn wood production chain for sustainable housing production	Low reforestation speed (decreasing supply of wood); low quality of marketed products; losses due to defects; lack of reliable data on the production chain; problems with the user

Source: Authors, 2020.

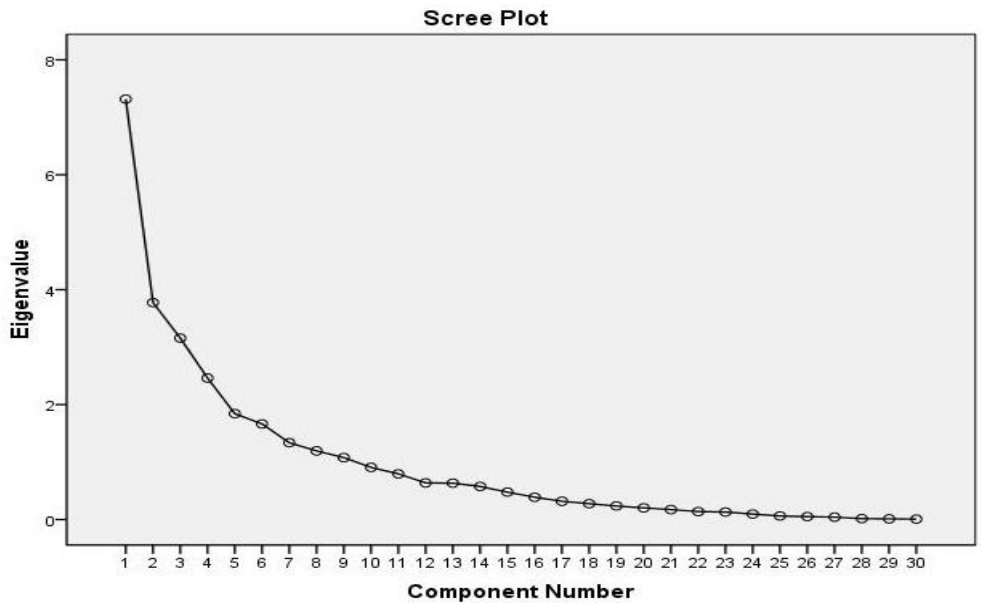

Figure 1. Solution of the 11 factors chosen based on the criteria of the "scree test" and the percentage of accumulated variance
Source: Authors, 2020.

Table 2. Critical factors identified.

Initials	Variable	Factor definition
EFC	Energy/Fuel Cost	Cost of energy/fuel spent on wood production operations
LC	Labor Cost	Cost of labor required for production
TC	Transportation costs	Cost for transporting wood
COI	Cost of Other Inputs	Cost of other inputs needed for production
PE	Production Expansion	Public incentives for the expansion of forest production; adequate scales of production
QOL	Qualification of Labor	Availability of labor with the necessary requirements for efficient production
AOL	Availability of Labor	Sufficient labor
EL	Environmental legislation	Laws, ordinances, norms, resolutions that regulate and affect forest production, related to the environment
LL	Labor legislation	Laws, ordinances, norms, resolutions that regulate and affect forest production, related to work
TFL	Tax and fiscal legislation	Laws, ordinances, norms, resolutions that regulate and affect forest production, related to fiscal and tax issues
TFI	Tax and fiscal incentives	Existence of tax and fiscal incentives for investment, innovation
EP	Environmental Pressures	Existence of pressure from NGOs and agencies related to the environment, in relation to forest plantations, highlighting aspects of exotic culture, invasive species, among others
SP	Social pressures	Existence of pressure from NGOs and bodies related to social movements in relation to forest plantations, highlighting aspects of exotic culture, invasive species, among others
FC	Forest Certification	Forest production conducted under the principles of economic, social and environmental sustainability
PT	Production Technology	Development of technologies that help forest production
PIS	Public Image of the Sector	Society's perception of commercial forestry activity
PM	Processes management	Control of internal processes related to forest production, internal control mechanisms aimed at quality and efficiency
NEC	National economy	Behavior of the national economy
WEC	World economy	Behavior of the world economy
EV	Exchange Variation	Appreciation or devaluation of the real against the dollar
SUP	Suppliers	Existence of suppliers compatible with the company's needs. Significant set of equipment and input suppliers in the country
WC	Wood consumption	Increased wood consumption, increased demand, demographic growth and increased average income
CA	Credit Availability	Existence of specific financing lines in public institutions (non-commercial banks)
CC	Credit Cost	Rates compatible with the activity
IE	Infrastructure	Infrastructure for production flow
PD	Pests and Diseases	Risk of occurrence of pests and diseases that compromise the sustainability of the crop
GET	Genetic Enhancement Technologies	Set of techniques used to maximize forest growth
IN	Informality	Companies that are outside the environmental and tax laws
AA	Available Areas	Availability of areas for planting
FM	Forest management	A set of techniques used in planting and managing forests

Source: Authors, 2020.

Table 3. Determined commonalities for the main data matrix.

Variable	Value of commonalities	Variable	Value of commonalities
EFC	0.935	PIS	0.759
LC	0.791	PM	0.797
CT	0.842	NEC	0.828
COI	0.886	WEC	0.900
PE	0.816	EV	0.912
QOL	0.832	SUP	0.845
AOL	0.849	WC	0.877
EL	0.854	CA	0.893
LL	0.823	CC	0.912
TFL	0.898	IE	0.834
TFI	0.819	PD	0.787
EP	0.930	GET	0.915
PS	0.808	IN	0.859
FC	0.790	AA	0.890
PT	0.820	FM	0.827

Source: Authors, 2020.

Table 4. Analysis reliability tests.

Tests performed	Value obtained
Kaiser-Meyer-Olkin (KMO)	0.391
Bartlett's sphericity	
Chi-square	879.06
Degrees of freedom	435
Significance	0.000
Cronbach's Alpha	0.864

Source: Authors, 2020.

Table 5. Total explained variance.

Component	Extraction of the sum of loaded squares			Rotation of the sum of loaded squares		
	Total	% of variance	Accumulated %	Total	% of variance	Accumulated %
1	7.317	24.391	24.391	3.558	11.859	11.859
2	3.775	12.584	36.975	3.252	10.839	22.698
3	3.157	10.523	47.498	2.776	9.254	31.952
4	2.462	8.207	55.705	2.766	9.22	41.171
5	1.842	6.141	61.847	2.134	7.115	48.286
6	1.663	5.545	67.391	2.127	7.089	55.375
7	1.338	4.459	71.85	2.093	6.976	62.351
8	1.195	3.983	75.833	2.053	6.842	69.193
9	1.077	3.591	79.424	1.846	6.154	75.347
10	0.907	3.025	82.449	1.648	5.494	80.841
11	0.794	2.648	85.097	1.277	4.256	85.097

Note: Extraction method: principal component analysis.
Source: Authors, 2020.

Table 6. Factors and factor loadings of the rotated matrix

Critical factors	Factors										
	1	2	3	4	5	6	7	8	9	10	11
CA	0.895										
CC	0.758										
FC	0.726										
PIS	0.489									0.455	
PA		0.912									
OS		0.842									
CT		0.629									
IE		0.546	0.426			0.539					
EFC	0.498	0.519						-0.498			
GET			0.825								
FM			0.801								
PM			0.554								
PT	0.466	0.400	0.531								
EV				0.920							
CA	0.895										
CC	0.758										
FC	0.726										
PIS	0.489									0.455	
PA		0.912									
OS		0.842									
CT		0.629									
IE		0.546	0.426			0.539					
EFC	0.498	0.519						-0.498			
GET			0.825								
FM			0.801								
PM			0.554								
PT	0.466	0.400	0.531								
EV				0.920							

Note: Extraction method: principal component analysis. The rotation converged with 17 iterations. Rotation method: varimax with Kaiser Normalization
Source: Authors, 2020.

Table 7. Identified critical factors, variable, factor loadings and Cronbach's alpha.

Factors	Critical factors	Variable	Factor loadings	Cronbach's Alpha
1	Credit	Credit availability	0.895	0.80
		Cost of credit	0.758	
		Forest certification	0.726	
		Public image of the sector	0.489	
2	Logistics/social costs	Environmental pressures	0.912	0.84
		Social pressures	0.842	
		Transportation costs	0.629	
		Infrastructure	0.546	
		Energy/Fuel Cost	0.519	
3	Technology	Genetic improvement technologies	0.825	0.80
		Forest management	0.801	
		Processes management	0.554	
		Production technology	0.531	
4	Macroeconomics	Exchange variation	0.920	0.83
		World economy	0.850	
		National economy	0.765	
5	Planting/location cost	Cost of other inputs	0.811	0.72
		Labor cost	0.728	
6	Support	Qualification of labor	0.707	0.64
		Informality	0.624	
		Tax and fiscal incentives	0.561	
7	Legislation	Tax and fiscal legislation	0.801	0.66
		Labor legislation	0.765	
8	Raw material	Environmental legislation	0.803	0.67
		Available areas	0.658	
		Suppliers	0.479	
9	Growth	Availability of labor	0.864	0.59
		Production expansion	0.542	
10	Plant health	Pests and Diseases	0.822	NA
11	Demand	Wood consumption	-0.847	NA

Source: Authors, 2020.

Table 8. Difference in importance attributed to each factor and detection of the most important factors, verified with the application of the Friedman test.

Cluster table		
Factors	Sum	Clusters
Demand	301.5	a
Technology	273.0	a
Macroeconomics	273.0	a
Logistics/social costs	273.0	a
Legislation	267.0	a
Planting/location cost	204.0	b
Plant health	180.5	bc
Expansion	179.5	bc
Credit	152.0	c
Support	151.5	c

Source: Authors, 2020.

the companies, being classified among the ten least important critical factors. On the other hand, the wood consumption variable was considered extremely important by 59% of the companies, being ranked as the second most important critical variable. The variables pests and diseases were called the critical demand factor. This reflects the risk that compromise the sustainability of the crop, which was defined as a critical factor for plant health. The consumption variable reflects the increase in wood consumption, due to the increase in demand, demographic growth and increase in average income. The use of factor analysis and its subsequent interpretation provided the reduction of 30 critical factors in 10 factors. These were considered the critical performance factors of the forest production activity, since they aggregated the variables considered important for the performance of the company and the production chain under study.

In addition to reducing the data, it was possible to analyze the structure of the correlations of the variables, identifying a clear aggregation of variables related to the economic environment (macroeconomic factor) and aggregation of variables within the companies' internal scope in the technology factor. The verification of the correlation of the forest certification variable with the cost and credit

availability variables gives indications of a differentiation caused by the certification. This aspect is reinforced when we analyzed the perceptions reported in this research, in which managers perceive forest certification as an opportunity and an important challenge for the next five years.

The verification of the difference in importance attributed to each factor and detection of the most important factors are carried out with the application of the Friedman test (Table 8).

The result of Friedman test was significant. The null hypothesis was rejected, which confirmed the existence of a difference between factors, indicating the existence of two distinct clusters. Based on the ordering of factors performed by the test, it is possible to conclude that companies participating in the research perceive the first cluster as the most important.

Government action is directly or indirectly related to all aspects that concern the performance of the production chain or of a production activity. However, it is possible to distinguish a greater or lesser control of companies in relation to some factors.

Most countries assume and agree that command and control actions, based on strong and limiting legislation on forest productive activities, initially lead to the expansion of forest degradation processes. In a second moment, the decrease in the offer and maintenance of permanent jobs in these activities; and in the long term, environmental recovery with economic losses that harm local and regional development (Siqueira, 2003).

Almeida (2010) explained that although Caron (2003) separates the factors that affect competitiveness into systemic and endogenous ones according to the degree of influence of the government and companies on these factors, the government, may influence, even indirectly, the way in which companies operate, increasing its importance even further. In this sense, it is up to the government to create an economic, technological and competitive environment that encourages the company to innovate and modernize itself, sustaining the competitive advantage gained through the permanent updating of innovations in its products and services.

The technology critical factor is a factor considered internal to the company, as several aspects related to it are under the sphere of private decision. The State, in this case, is not decisive, but ends up playing the role of facilitator, through research institutes and universities, and more directly, through tax incentives for innovation. Thus, the factor becomes extremely relevant when one observes the role of technology and innovation in the performance of companies and for the competitiveness of a production chain or sector.

The critical logistic/social costs and demand factors, according to Coutinho and Ferraz (1994), are related to structural factors that determine competitiveness. These critical factors, even if not entirely controlled by the company, are partially under its area of influence and characterize the competitive environment it faces on a daily basis. These factors are influenced by macroeconomic policies and materialize through the interaction of supply and demand.

Macroeconomic policy can be understood as government intervention in the economy to control aggregate demand and supply and create the foundations for growth and development. Its objectives are price stability, balance of payments and economic growth (increase in the national product through economic policies that encourage productive activity), equitable income distribution and sustainable development.

The great influence of the macroeconomic environment on critical factors does not exempt private participation from facing these factors, since private initiative actions, such as the opening of new markets, development of new products and uses and programs to encourage the use of wood, directly impact demand.

Materials and Methods

Characterization of the study area

The research covered the state of Paraná, located in the southern region of Brazil, with an area of 199,307.945 km², corresponding to approximately 2.35% of the Brazilian territory (Santos et al., 2004). In addition, traditionally, the state had great prominence in logging based on the cutting of species such as Araucaria and Imbuia, which at the beginning of the 20th century represented one of the main economic activities.

However, the scarcity of native wood and the advent of the tax incentive law boosted the beginning of forest plantations in the mid-1960s, corroborating the rise of the state as a raw material supplier for the industry, especially with species of the genus Pinus.

Currently, the study region has a large industrial complex, based on planted forests of Pinus and Eucalyptus, contributing to a segment of great representation in the Brazilian economy (Eisfeld and Nascimento, 2015).

Data collection and validation

For this study, data from companies producing forestry raw material of planted origin that operate in the state of Paraná were used. Such information was obtained through contact with the organizations, together with the Paraná Association of Forest-Based Companies (APRE), Organization of Cooperatives of the State of Paraná (OCEPAR), Paper Industries Union, Cellulose and Wood Pulp for Paper, Cardboard and Paper and Cardboard Artifacts of the State of Paraná (SINPACEL) and the Brazilian Association of Mechanically Processed Wood Industry (ABIMCI).

The sample was then composed of companies producing planted forest raw material, adopting the segmentation between integrated and non-integrated companies, which corresponded to 17 and 24 companies, respectively.

For the collection of information, secondary data was sought through bibliographical research through scientific publications (scientific articles, dissertations and theses), sectorial publications and yearbooks of institutions linked to the production chain. Then, primary data, with the application of a structured and undisguised questionnaire, with open, closed and multiple-choice questions, aimed at companies and institutions operating in the segment and in the first segments of wood industrialization in the forest-based production chain.

To validate the questionnaire, consultations were performed with the faculty and researchers of the Federal University of Paraná, leaders of associations and companies producing raw material for forests.

Subsequently, the questionnaire consisted of two main parts: (A) Identification of the sample and (B) Evaluation of critical factors regarding the degree of influence. To compose the collection of information relevant to the assessment of critical factors, closed questions were

prepared and configured by a scale of importance and satisfaction.

The measurement of the respondents' perception was performed using the "Likert scale" method. According to McDaniel (2003), the Likert scale consists of a series of statements that express a favorable or unfavorable attitude towards the study concept.

Furthermore, the questions were structured based on the critical factors identified during the literature search. Respondents were asked to answer the following question: What is the degree of influence of this variable on the performance of forestry/industrial production activity in the next five years? Using the following scale of value 1 (no influence/importance); 2 (little influence/importance); 3 (medium influence/importance); 4 (high importance/influence); 5 (very high importance/influence); NA (not applicable).

Data analysis and processing

Identification of critical factors

The identification of critical factors related to forestry production was obtained through a literature review, aiming to define the list of variables that will be evaluated by the companies participating in the research. Castro et al. (1998) treat critical factors as those with the greatest impact on performance and which explain the current and past functioning of the production chain. The concept of performance, on the other hand, is approached as the lasting capacity for survival and growth of companies in the markets in which they operate. Farina (1999) says that the competitive performance of the system is what is at stake and not of an individual company, because sectorial interventions generate systemic effects and tend to generate involuntarily systemic interventions.

Treatment of primary data

The data collected through the questionnaires were tabulated, resulting in different matrices related to critical factors in a database with information regarding the profile of participating companies.

For the analysis of the information, electronic spreadsheets were used to tabulate and systematize the information obtained. Descriptive statistics tools consisted of multivariate statistical techniques (factorial analysis) and non-parametric statistical tests using the statistical packages SPSS 13.0 (*Statistical Package for Social Sciences*) and *Action Stat*.

Prioritization of critical factors

The prioritization of critical factors was operationalized through the collection of perceptions regarding the importance/influence of each critical factor, performed with the help of the Likert scale and the value scale presented above. The critical factors perceived as the most important/influential were considered the priority.

The analytical instruments used to analyze the data matrix were: the technique of factor analysis of the main components of the multivariate analysis method and the non-parametric tests of Friedman (1937) and Wilcoxon. According to Hair et al., (2005) factor analysis can be used to assess correlations between a large number of variables, defining a set of common latent dimensions, called factors, which, when interpreted and understood, describe the data in a much smaller number of concepts than the original individual variables.

Factorial techniques have two goals: structure identification through data summarization and data reduction. Hair et al. (2005) emphasized that factor analysis techniques may achieve their goals from an exploratory or confirmatory perspective. In the present work, the exploratory perspective was used.

The factor analysis technique was previously applied with the objective of aggregating the correlated variables. That is, those that have similar response patterns throughout the cases, forming the corresponding critical factors. The information related to the perceptions of the importance or influence of each critical factor were subjected to factor analysis of main components, highlighting issues that aggregate the critical factors.

The commonality values that represent the total amount of variance with shared original variable with all other variables were determined. A variable that does not have a single variance (or random variable) has a commonality of 1.0. On the other hand, a variable that has no relation of its variances to any other variable has a commonality of zero.

Factor extraction involves determining the smallest number of dimensions that can be used to best represent the interrelationships between the set of variables. This process involves the balance between two contradictory needs: the need to find a simple solution with few factors and the need to explain a large percentage of variance (Pallant, 2005).

The reliability of the sub measure is assessed by the "*Cronbach's Alpha*", an accepted formula for assessing the reliability of a comparative measure, indicated by Peter (1979). Cronbach's alpha is a measure that varies from 0 to 1, with a value of 0.6 considered the lower limit of acceptability.

There are some criteria for adopting a number of factors in the construction of the factor model such as Kaiser criterion (reference and year) and the Scree test. Furthermore, it is not uncommon to consider a solution that explains 60% of the total variance (and in some cases even less) as satisfactory. The Scree test is used to identify the optimal number of factors that can be extracted before the amount of explained variance is unrepresentative (Hair Junior et al., 2005).

To assist in the interpretation process, the factor matrix was orthogonally rotated by the Varimax method, which, according to Hair Junior et al. (2005), provides a better separation, and consequently, facilitates the interpretation of results, as it reduces the load of the first factor and increases the load of other factors in a smaller number of variables. Thus, the factors, which already had a greater load, are even more highlighted.

For an analysis and framing, the factor loadings – the correlation of each variable with the factors – less than or equal to 0.50, were discarded, according to the definitions formulated and recommended by Hair Junior et al. (2005), aiming to ensure the significance of the representativeness of the variables considered for the volume of observations in the approach.

In order to verify the existence of differences between factors resulting from the factor analysis and highlight what was perceived as the most important, the Friedman test was used. For the difference in perception between integrated and non-integrated companies, regarding the factors, the Wilcoxon test was used.

According to Siegel (1975), these non-parametric tests are indicated when the measurement scale is ordinal, with the Friedman test being applied to three or more paired samples and the Wilcoxon test applied to two paired samples.

Friedman's test does not use the numerical data directly, but the ranks occupied by them after the ordering made for each group separately. This test uses the ranks of the data instead of their raw values to calculate the test statistic. This test is a generalization of the Wilcoxon test for situations with more than two options for comparing data. It is used when it is not possible to apply the ANOVA test with repeated measures, as the data do not follow a normal distribution. Therefore, the hypotheses are defined by the median and not the mean.

In the Friedman test, multiple comparisons can be made and, after sorting, the null hypothesis is tested. When the null hypothesis H0 is rejected, at least one of the groups is found to be different from the others.

To verify the existence of a difference between the critical factors, the Friedman test hypotheses were:

- H0: there is no difference between the formed factors;
- H1: There is a difference between the formed factors.

In Wilcoxon test, if the null hypothesis is accepted, it means that the median difference is null, while populations do not differ in location. On the other hand, if the null hypothesis is rejected, when the median of the difference is not null, the populations differ in location.

Conclusions

Regarding the regional cut, the south of Brazil presents itself as a producer, consumer and exporter of planted forest-based products with contributions to expressive national indicators. This position derives mainly from the history of economic activities related to wood, which aims at the formation of an agro-industrial complex based on planted forests formed by several production chains and managed forest plantations aiming at multi-products to supply the production chains. Based on the analysis performed, the great relevance of applying specific statistical analyzes aiming at the compilation of critical factors is verified. This adds to the decision-making and articulations that favor forest planning. Thus, with the identification of critical factors, we found that the most relevant for this research were demand, technology, macroeconomics, logistical and social costs and legislation. The finding of the critical demand factor, characterized only by the critical variable consumption of wood, which was not perceived as related to the critical macroeconomic factor, indicating a specific and regional perception regarding wood consumption. For this factor, we recommend the articulation between the private and governmental sectors in the search for developing actions to take advantage of the current context of the search for sustainability by the final consumer and the state's forestry potential. These actions must materialize through the instruments of information and persuasion policy, which need to prioritize information and communication for public acceptance, technological development in the manufacture of products and training of qualified personnel, seeking to replace other materials with wood and the development of new products and uses.

In this context, it is recommended to encourage small and medium-sized forestry companies, through the development of a joint forestry and industrial policy, which takes into account the interactions between the critical factors creating the forestry-based segment.

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