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THE INFLUENCE OF OAK RAW TIMBER DIAMETER ON THE EFFICIENCY OF DECORATIVE VENEERS

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Abstract: *This article contains a statistical analysis of the efficiency of decorative oak veneer according to diameter classes, species and geographical origin. Specific validation tests of statistic model were applied and the indicators of central tendency, variation and distribution shape of veneer and special veneer efficiency were determined. Referring to experimental data, it was performed a comparative analysis of veneer efficiency in relation to categories of origin and species. The resulting analysis could provide substantial economical improvements for decorative oak veneer.*

Key words: *efficiency, statistical analysis, decorative oak veneers, efficiency of special veneer.*

1. Introduction

Minimum diameter, as a factor in accepting or rejecting a log in terms of dimensional ratio is seen differently from one country to another. While in the EU the median diameter is analyzed, in Romania, for most species there are not regulations corresponding to European standards, therefore the minimum diameter considered for the dimensional assessment is the thin end [1], [2].

The valuable wood shaped for veneer is advisable to have as large as possible diameters, thus granting the beneficiary a greater efficiency in processing. But usually, the greater the diameter, the lower the likelihood that the quality characteristics are better represented. The decision of admitting the shaped log into the category of valuable commercial wood is exclusively up to the sorter. In fact, the diameters of the pieces are not upper restricted but they only have a lower limit.

2. Statistical Analysis of the Efficiency of Decorative Oak Veneer

The case study is based on the statistical analysis of decorative oak veneer efficiency.

Descriptive statistics of the efficiency of oak veneer and special veneer are presented in Table 1 and Table 2.

In order to elaborate analysis, it was used a specialized software program called STATISTICA 7.

The process of obtaining the oak veneer sheets is performed according to flow diagram shown in Figure 1 [3], [4].

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The indicators of central tendency for veneer efficiency Table 1

Characteristics	**Sample size, Parts no.**	**Average**			**Mean Standard Error**	**Median**	**Min**	**Max**
		Value	**Confidence Interval**					
Veneer Efficiency	1232	782.58	769.56	795.60	6.64	781.94	39.33	2634.33
Special Veneer Efficiency	1232	648.69	634.03	663.35	7.47	674.05	0	2241.13

Indicators of variation and distribution shape of veneer efficiency Table 2

Characteristics	**Standard Deviation**	**Variation Coefficient**	**Asymmetry**	**Sa**	**Excess**	**Se**	**Shapiro-Wilk Test**	
							W	**p [%]**
Veneer Efficiency	232.94	29.77	0.68	0.07	4.98	0.14	0.96	< 0.001
Special Veneer Efficiency	262.33	40.44	0.08	0.07	1.44	0.14	0.98	< 0.001

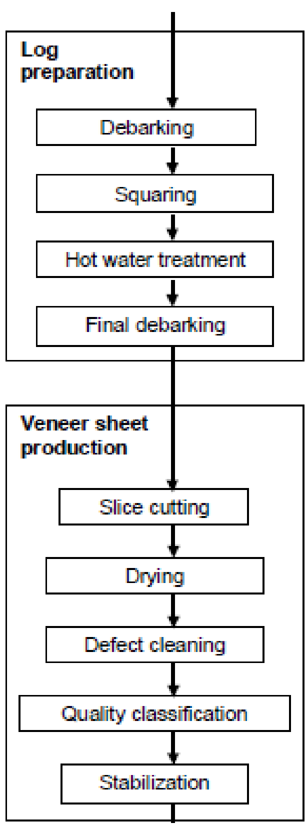

Fig. 1. *Flow chart for veneer production*

The following notations were used:

- *Sa* - standard error of the asymmetry index;
- *Se* - standard error of the Kurtosis index.

To validate the statistical model, the Shapiro-Wilk Test was applied (Table 2).

The analyzed sample is relatively homogeneous in terms of efficiency in veneer because the coefficient of variation is less than 30%. The efficiency of special veneer is heterogeneous, which allows stratification of its values by analyzing variation factors - source of raw material and species.

After analysis, the efficiency histogram for oak veneer and special oak veneer is drawn (Figure 2).

A suggestive image, representing the dispersion of the results of efficiency for oak veneer and special oak veneer is shown in Figure 3.

Differences between pieces regarding veneer efficiency are confirmed statistically (Table 3) and this allows further stratification of the sample.

The statistical significance of differences between species in point of efficiency in veneer is presented in Table 4.

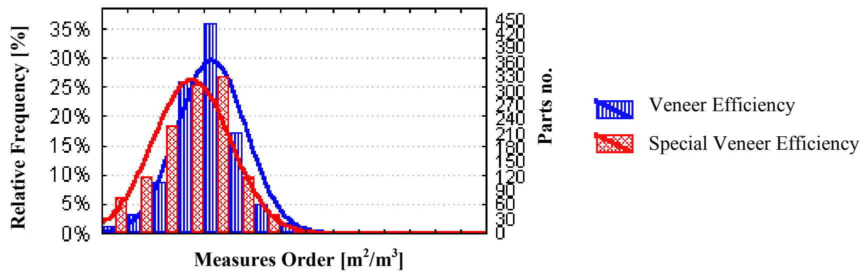

Fig. 2. *Histogram of veneer efficiency*

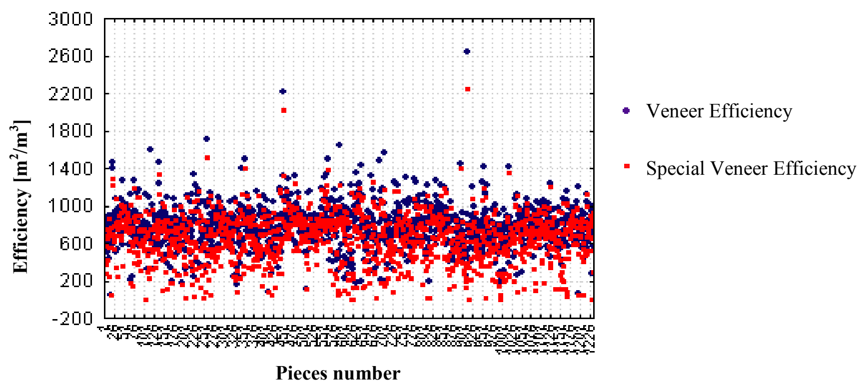

Fig. 3. *Variance of veneer efficiency and special veneer efficiency*

There are no differences, detectable by statistical methods of investigation, between the two species regarding both types of performance rating under discussion.

Table 3

Statistical data of veneer efficiency

Indicators	**Test**		
	Z	**p [%]**	**Significance Level**
Veneer Efficiency	35.07	< 0.001	H1
Special Veneer Efficiency	35.07	< 0.001	H1

The process of testing the significance of differences was performed with a non-parametric test because both variables represent non-normal distributions.

Table 4

Statistical data of differences between species considering veneer efficiency

Indicators	**Kruskal-Wallis Test**		
	H	**p**	**Significance Level**
Veneer Efficiency	1.277	25.85	H2
Special Veneer Efficiency	1.055	30.44	H2

The statistical significance of the differences between the geographical origins of veneer efficiency is centralized in Table 5.

The geographical origin of the logs that were cut into veneer is a factor of influence on their quality - given by an indicator namely special veneer efficiency, which varies significantly according to the factor of influence. As a result, it is shown below the distribution of the observed values of this stratified indicator according to the source.

Table 5

Statistical data of differences between geographical origins regarding veneer efficiency

Indicators	**Kruskal-Wallis Test**		
	H	**p**	**Significance Level**
Veneer Efficiency	15.13	8.74	H2
Special Veneer Efficiency	20.76	1.38	H1

Variations between geographical origins situation of veneer efficiency, for the first ten provenances is shown in Figure 4 and the sources 11 to 19 is centralized in Figure 5.

It was considered the following values classes of pieces diameters:

Table 6

Categories of pieces diameters

Level 1	40-55 [cm]
Level 2	56-70 [cm]
Level 3	71-85 [cm]
Level 4	> 85 [cm]

The correlation coefficients determined for veneer efficiency and the quantitative results for the parts are presented in Table 7.

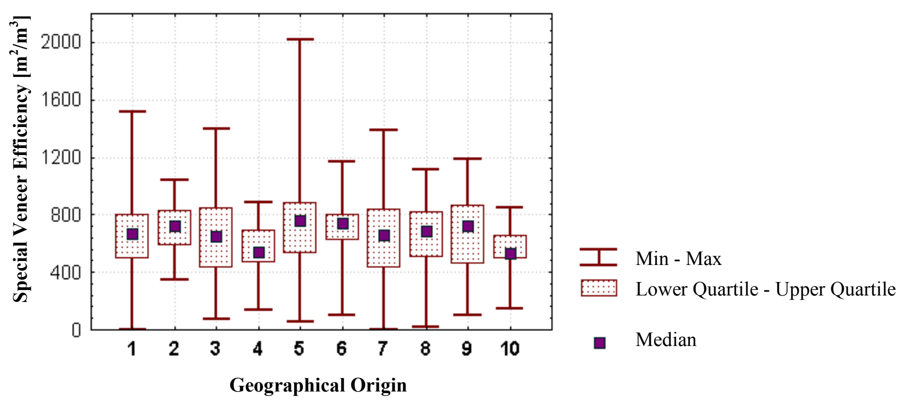

Fig. 4. *Veneer efficiency values specific to geographical origins* (*first 10 sources*)

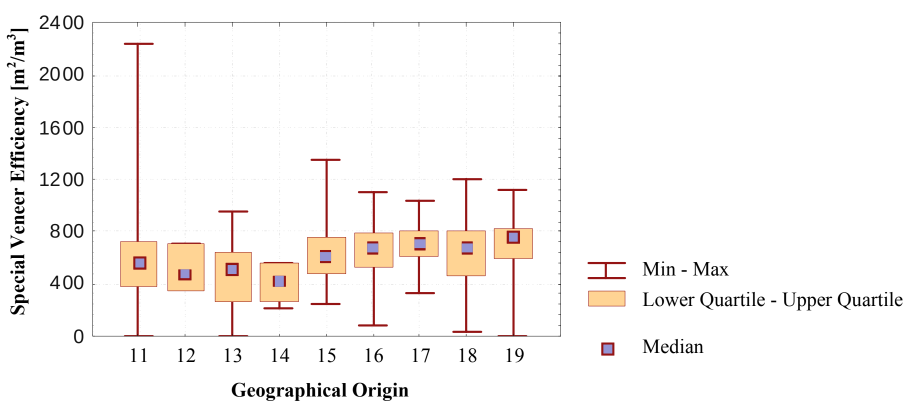

Fig. 5. *Veneer efficiency values specific to geographical origins* (*11÷19 sources*)

The correlation between veneer efficiency and piece dimension Table 7

Variables	Sample size, Parts no.	*R*	"*t*" Test for correlation coefficient significance	
			t (*N*–2)	p [%]
Piece length - veneer efficiency	1232	–0.136	–4.80	<0.001
Piece length - special veneer efficiency	1232	–0.064	–2.24	2.5200
Piece diameter - veneer efficiency	1232	0.226	8.12	<0.001
Piece diameter - special veneer efficiency	1232	0.264	9.61	<0.001
Piece volume - veneer efficiency	1232	0.150	5.31	<0.001
Piece volume - special veneer efficiency	1232	0.207	7.41	<0.001

In Figure 6 is graphically presented the correlation between the diameter of veneer manufacturing parts and their cutting efficiency. Types of interpolation were tested and the following polynomial interpolation equation was obtained:

$$y = 224.91 + 81.48 \cdot x - 2.77 \cdot x^2 + 0.05 \cdot x^3 - 3.27 \cdot x^4 + 8.64 \cdot x^5 . \quad (1)$$

In Figure 7, the statistical indicators of variability and the central tendency of values for stratified veneer efficiency are graphically presented according to diameter category of the logs' conversion process.

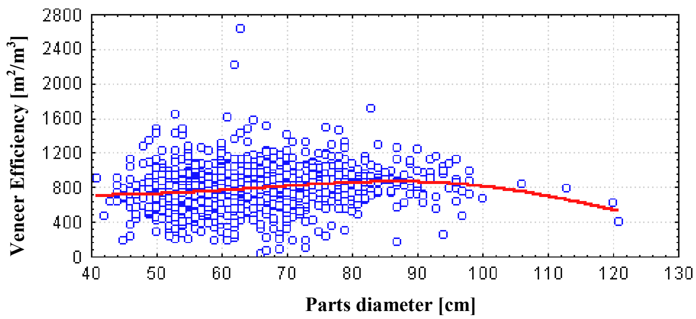

Fig. 6. *The variance of veneer efficiency values versus part diameters*

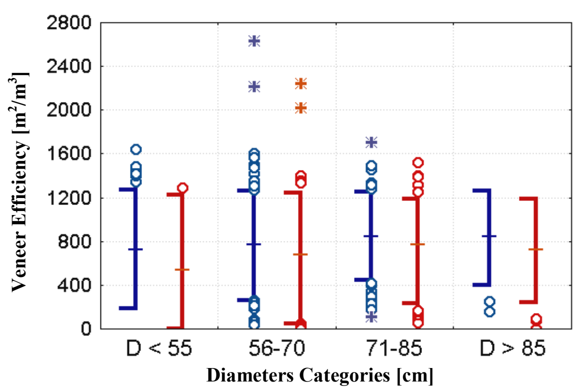

Fig. 7. *The amplitude of veneer efficiency versus part diameters*

3. Conclusions

- Analyzing Figure 1, the distribution of observed values of veneer efficiency is asymmetrical and especially strong excess to the normal distribution. The distribution of special veneers efficiency is not asymmetrical, but it is obvious excess. Moreover, the test of normality applied to confirm the distributions difference from normal distribution.
- The deviation from normality is confirmed by the Shapiro-Wilk test (statistically significant) - Table 2.
- When applying the "t" test, it can be observed that the relationship between veneer performance and part dimensions is statistically significant, but of low intensity.

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