Valorization of Wood Resources for the Cutting of Decorative Veneer in the Context of Sustainable Development of Romanian Forests

Adela-Eliza Dumitrascu,[a] Valentina D. Ciobanu,[b] and Badea Lepadatescu [a,]*

The overall aim of the research was to better understand the influence of raw material characteristics on the quality of decorative veneer, to identify phenotypes of oak and sessile oak valuable for veneer use, and to promote quality in relationship with sustainable development of Romania's forests. This paper describes specific aspects regarding wood defects and quality conditions imposed on raw materials for veneer slicing. The experiments focused on identifying and analyzing defects in oak veneer found in six regions from Romania. Taking into account the dimensional and quality requirements, and obtaining a sufficient quantity of decorative oak veneer, Pareto diagrams corresponding to each region were created. The Pareto analysis allowed for a hierarchy of main defects and also enabled adequate decision-making for improving the quality of the studied products in accordance with specific international standards. Also, by knowing the types of defects, decisions can be made to conserve natural resources and to utilize wood resources by sustainable reuse of waste.

Keywords: Decorative oak veneer; Wood quality; Forest management; Pareto diagram; Special veneer efficiency

*Contact information: a: Department of Technological Engineering and Industrial Management, Transilvania University of Brasov, M. Viteazul Street, no. 5, 500174 Brasov, Romania, b: Department of Silviculture and Forest Engineering, Transilvania University of Brasov, Sirul Beethoven Street, no. 1, 500123, Brasov, Romania; *Corresponding author: lepadatescu@unitbv.ro*

INTRODUCTION

In order to satisfy the ever-increasing demand for wood, various research projects related to wood products have been carried out intensively to solve complex scientific and technical problems that arise in two main areas of activity: the production of wood and its use.

In the field of wood production, it is necessary to increase the wood quantity, but forests products in Romania are limited and declining, especially with respect to the harvesting of sufficient quantities of forest wood having suitable quality relative to the applications. It is a challenge to produce more wood in a shorter period, while still meeting appropriate quality requirements for different applications and the technologies that are used to obtain various products. Sustainable forestry should meet these requirements of increased wood consumption while ensuring and enhancing the social functions of forest protection (Ciobanu *et al.* 2011; Luostarinen and Verkasalo 2000).

In the wood utilization field, the complete and superior usage of the entire available timber is needed, with the economic use of each piece of wood valued according to its quality and conversion technologies.

The quality of a product is one of the determinant factors that induce customers to buy a particular wood product. However, quality is not accidental, but it is the result of efforts involving the entire supply chain. Quality is planned, run, and controlled. All persons in the organization are involved and everyone contributes to the quality improvement of the products and services. By applying effective quality management, the organization is oriented toward customer satisfaction through a set of processes that enable effective satisfaction of customer requirements.

Quality management involves the establishing of work procedures and responsibilities so that every employee becomes aware of his place and role within the organization as a whole. Management and control of specific processes of decorative veneer production are the essence of processes management. This allows for maintaining constant effective processes and/or efficiently meeting customers' requirements for satisfaction (Morariu 2006; Russell and Bernard 2003).

The variation of wood properties and the relationship between forestry, environmental factors, wood, and finished product properties are complex issues. A wide range of differences in structure and chemical composition are found in the same tree, between trees, and among forests. In addition, wood and fiber structure influence the performance characteristics of the product (Baleaux 2004; Teishchinger 2005). When analyzing the relationship between wood properties and product performance, the specific origin of the wood as a raw material must be considered. Wood is an anisotropic material with physical and mechanical properties that are largely different between species, and as a biological material it presents a hierarchical structure at the nano, micro, and macroscopic levels. Therefore, for effective measurement, a series of characteristics in various stages must be taken into account: trees, stem, wood, fiber, chemical composition of the fibers, *etc.* (Dzbeński and Wiktorski 2004; Martinis *et al.* 2004). The variability of different properties and relations between variables must be identified (Sorici *et al.* 2010).

With regard to user requirements, it is important that these be defined so as to allow sustainable and rational valorization of natural resources along with environmental protection. It is imperative that user requirements fully meet the technological requirements of the manufacturing process of various goods, and the requirements of the consumers of these goods.

Quality Conditions Imposed on Raw Material for Cutting Veneers

In forestry and especially for the exploration and utilization of wood; wood quality represents all the characteristics that give wood its ability to meet user needs (Ciobanu *et al.* 2011).

Defects and abnormalities in tree growth, in structure, aspect, or the chemical composition of wood, which represent deviations from the normal, act in most cases as an impairment factor for physical and mechanical characteristics (Brunetti *et al.* 2010; Catena 2004; Ozarska 2003).

Wood defects

Invariably present in all species of wood, defects are a basic factor in the sorting and classification of various types of wood quality (Teishchinger 2005). Wood defects can be classified as structural defects, shape defects, chromatic indicators, destruction defects, specific defects in wood utilization, and defects due to injury.

Wood fibers are normally straight and parallel to the longitudinal axis of the trunk, branches, and roots. As a result of deviations from this structure, fiber deviations can occur. In the case of the oak trunk, twilled fibers frequently occur, namely fibers with helical deviation around the longitudinal axis of round wood that remain parallel to each other.

The cutting of round wood timber with twilled fiber results in pieces with rough sides which are hard to work, especially in finishing, which are slightly deformed after drying with a tendency to crack and damage the fibers. Veneer flitches show similar deficiencies, which reduce their value. The cleavage process results in more or less helical-shaped surfaces.

The most important shape defects of an analyzed trunk are curvature, conicity, sprawl, and ovality. The quality of oak veneer obtained by cutting a flat surface is evaluated by examining the appearance of the veneer surface. Two elements are crucial: color and grain pattern. The grain pattern results from annual growth rings with their areas of early wood, formed by more or less large vessels, and the areas of late fiber wood. The presence of rays also contributes to the grain pattern. The grain pattern will also vary depending on the way the wood is sliced (Ciubotaru *et al*. 2009; Dumitrascu *et al.* 2011).

Color is considered by users as an essential quality parameter in determining the commercial value of the wood, especially in association with shape and dimensions when the wood is processed into veneer, but also for many other products.

Abnormal coloration of wood is a type of defect determined by the presence, on the surface and therein, of portions that differ in color from the healthy wood of the species without visible signs of decomposition. They are usually caused by fungi and bacteria that feed on the sapwood and the parenchyma cells.

Fungi and bacteria can be associated with physiological causes (wood cell response to the attack of microorganisms and environmental factors' negative action) or chemical in nature (especially oxidation). Since the cell walls remain intact, the physical and mechanical properties of wood do not change significantly.

Another important category of wood defects is caused by biotic destruction (bacteria, fungi, parasitic plants, insects, marine pests) by which the structure is seriously affected, and by chemical composition and integrity (Ciubotaru *et al.* 2009). Wood may be affected by various forms of wood-destroying factors both in standing trees and in felled trees, whether they are raw or processed, used in construction, or used for the production of various products.

Nodes are part of the branches of trees and are embedded in the wood due to the increase in trunk thickness. Their presence is dependent upon branches and they are inevitable defects of wood.

Nodes in round wood can be classified according to the degree of adhesion to the surrounding wood, size, position, state of health, and coloration. Andes' distribution across the tree is influenced by the wood species and growing conditions.

Injuries are lesions on trees consisting of destruction of tissues and anatomical dislocation of elements and formations from their normal connections. The main defects of injury are scars, bark, dead wood, cancer, pruning wounds, and burnt bark.

Quality Classification of Oak Wood for Decorative Veneer Slicing

Among the quercine species that inhabit the forests of Romania, the sessile oak *Quercus petraea* (Matt.) Liebl. enjoys great commercial interest. This can be ascribed to the large size they can attain and especially to the physical, mechanical, and aesthetic properties of the wood.

In the literature, several classification rules are mentioned (AFRDI 2001; AS/NZS 4266.11:2004; EN 338:2003). Such requirements relating to the characteristics of wood varieties are included in the standards that are based on a size/quality/use sorting system, in which all three criteria are taken into account as a whole by the operator and are contained in the norms for both the furnisher and user. In all these cases, the ideas behind the standards are to allow the optimal valorization of wood and to facilitate the regulation of the supplier–user relationship.

In Australia, there are no specific standards or rules for decorative veneer sheet classification. Most veneer manufacturers in Australia use the standard AS/NZ 2270 (1999), which provides requirements for veneer facets and ends and is applicable to both rotary cutting and slicing methods of veneer processing.

The European Union norms for defining raw wood sorts indicate significant differences in comparison with Romanian standards, which are easier to apply. A great simplification results from the absence of criteria usage in Romania. It is obvious that in accordance with the requirements imposed by these standards, the manufacturer is equally interested in producing the most valuable assortments in accordance with market requirements.

There are only two criteria by which wood sorts are defined: dimensional and quality. In the case of the quality, in addition to the characteristics commonly stated in the Romanian standards, the sapwood width and color homogeneity (for most species), along with the annual ring width (for most oaks, sessile oak, beech, spruce, pine, larch, *etc*.) are considered. The particularities and defects are defined in the European Norm SR EN 1316-1 (2001) specifically with respect to common oak and sessile oak, also includes the quantified sapwood width for quality classification of logs, which is missing in the Romanian standard. The major difficulty hindering high-efficient marketing of the two species of wood consists in the fact that most of the features and defects newly introduced into the European norm are not reflected in Romania's standards, such as data on the frequency of spread, size, and the distribution of the logs.

In accordance with the SR EN 1316-1 (2001) norm, only four quality classes are specified, of which the first two provide restrictions regarding the sapwood radial width as follows:

- Q-A is a class of exceptional quality, where the sapwood radial width should not be greater than 3.0 cm;
- Q-B is a common class, where the sapwood width to radius should not be greater than 4.0 cm;
- Q-C is a low-quality class, which allows any width of sapwood;
- Q-D is a quality class that includes any log that does not fall into the first three categories.

The classification of raw wood is in relation to several criteria, including species and size (diameter, length), and quality plays a determinant role (Jayaraman 1999; Kruch 2010). The quality differences between two types of raw wood are given by the differences that exist between their characteristics. Thus, the concept of wood quality overlaps with wood sorting.

EXPERIMENTAL

Research Methods

The choice of species was determined by the current realities of the technological process and market demand for decorative veneers. The influence of quality was cascade-monitored, starting with raw log acquisition, followed by defect examination, recording, and ending with the finished product. The geographic particularities of wood quality were highlighted for aesthetic veneers cutting by probing a statistically satisfactory number of Romanian-origin wood samples. In order to evaluate the influence of variation factors on the quality of aesthetic veneers, a sample of 1232 pieces of wood were selected from six indigenous origins: Plopeni, Gura Ocnitei, Vrancea, Podu Iloaiei, Babeni, and Snagov.

In order to assess the oak log quality, the relative width (percentage) of the sapwood diameter section was considered, and the percentage of sapwood to sectional area removed was calculated (Morosanu 2011).

According to standard EN 1316-1, logs classification is made taking into account logs restrictions on sapwood width. In this respect, measurements were made at both ends of the 25 logs, radially in the two orthogonal directions, in the same position to all parts. At each cross section, the following measurements were made: log diameter within bark (2 values) and sapwood width (4 values), settling one average value on section for each feature.

The distribution of quality classes can be observed looking at the percentage of logs of the Q-A quality class compared with those of the Q-C class (Table 1).

Table 1. Quality Classes Distribution of Log Sections in Relation to Sapwood Width-Range

Quality Class	Condition of Width for Sapwood (cm)	Oak	
		Parts	(%)
Q-A	≤ 3	12	48
Q-B	≤ 4	8	32
Q-C	Any value	5	20
Sum		25	100

The pieces selected for examination were run through the normal stages of the cutting technology flow, along with quantitative determinations of the efficiency of processing the raw material into veneers.

The Influence of Oak Raw Timber Defects on Decorative Veneer Cutting—Pareto Analysis

To emphasize the importance of raw materials quality for decorative veneers, several case studies were performed based on the analysis of oak tree defects from six Romanian regions and a region from Croatia. Six categories of defects were identified: buds, wood studs (inter-grown knots – nodes that are not seen on the outer surface of the log), curvature, insect holes, conicity, and buttress roots (root swelling). In order to determine the quality defects, it is important to know the defects category from the analyzed area (Fig. 1). The raw oak timber acquired from the Snagov, Gura Ocnitei, and Babeni regions resulted in the highest percentages of defects.

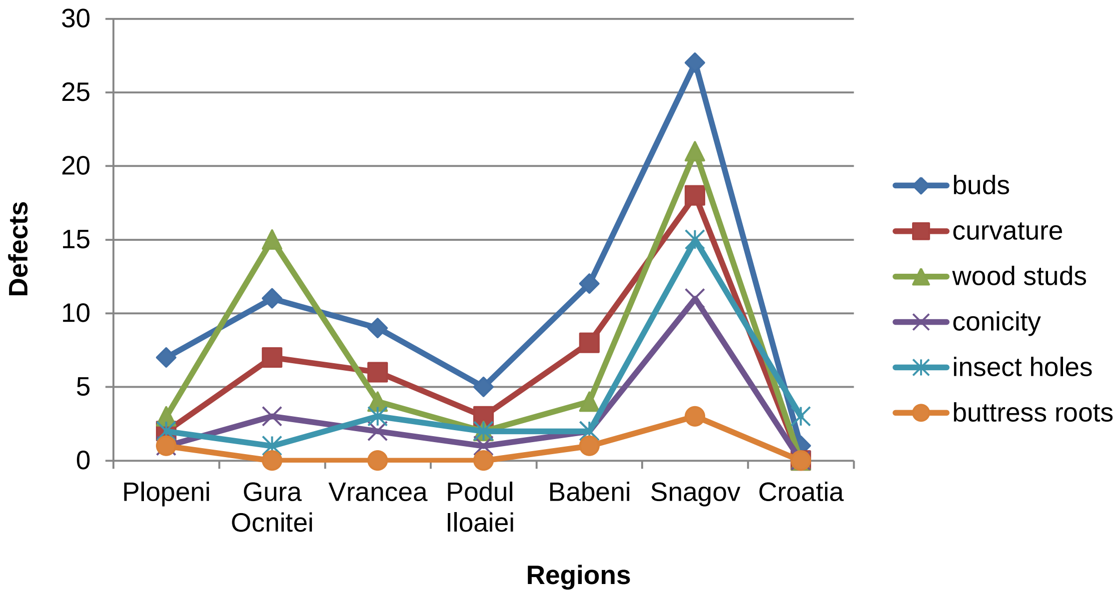

Fig. 1. Representation of defects depending on their weight and region of origin

Application of Pareto diagrams can analyze, determine, and prioritize the main defects for each category of oak veneer based on the cumulative relative frequency. The Pareto analysis technique is used primarily to identify and evaluate nonconformities, although it can summarize all types of data. A Pareto chart can help to focus efforts on achieving the greatest improvements. It is perhaps the diagram which is most often used in management presentations (Anghel 2001; Duicu and Dumitrascu 2011; Gibra 1973).

In these cases, the Pareto diagram can be applied. A Pareto chart is a good tool to use when the process to be investigated produces data that are segmented into categories and we can count the number of defects occurring in each category.

Using the experimental data, Pareto diagrams corresponding to each geographic region were created. Figures 2 to 8 illustrate cumulative relative frequency distributions specific to analyzed Romanian regions.

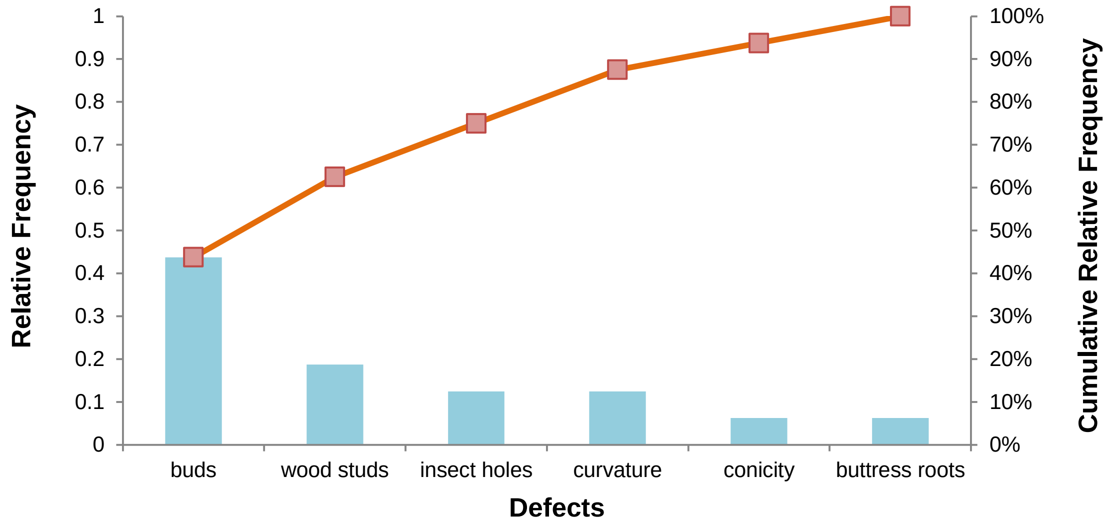

Fig. 2. Pareto diagram for specific defects in oak from Plopeni region

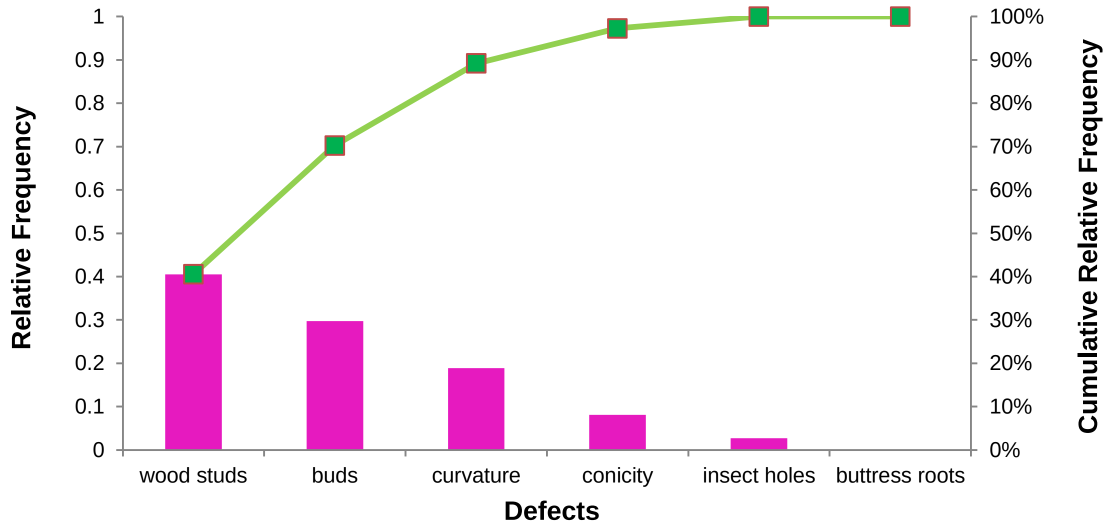

Fig. 3. Pareto diagram for specific defects in oak from Gura Ocnitei region

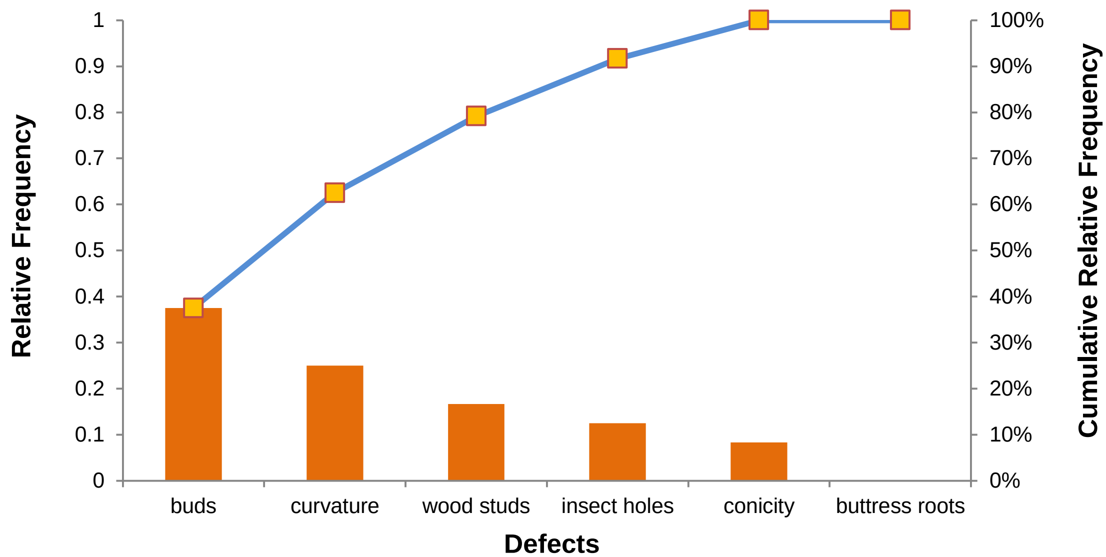

Fig. 4. Pareto diagram for specific defects in oak from Vrancea region

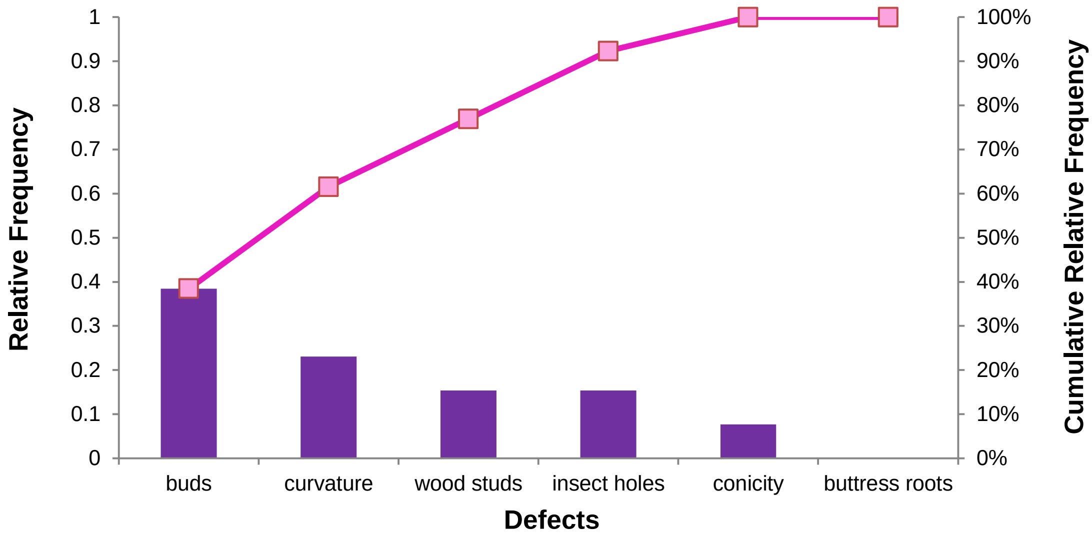

Fig. 5. Pareto diagram for specific defects in oak from Podu Iloaiei region

Fig. 6. Pareto diagram for specific defects in oak from Babeni region

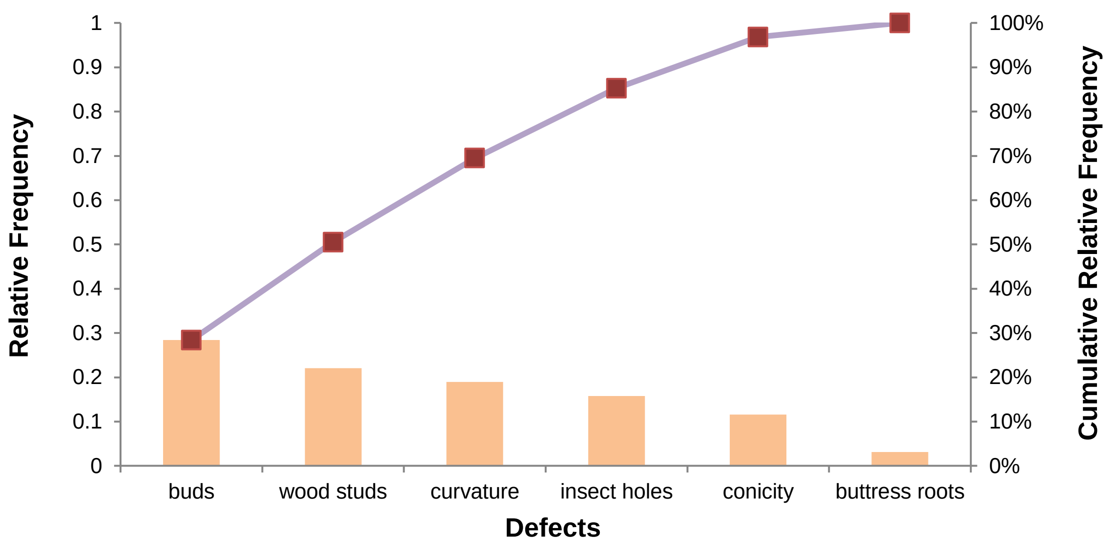

Fig. 7. Pareto diagram for specific defects in oak from Snagov region

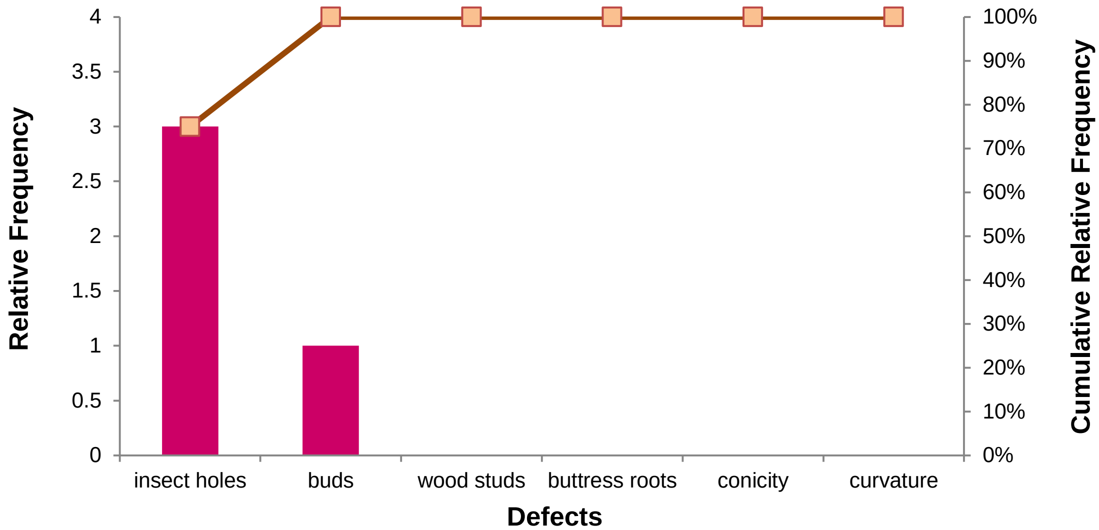

Fig. 8. Pareto diagram for specific defects in oak from Croatia region

Statistical Analysis of the Efficiency of Decorative Veneer Cutting

To obtain a high volume yield from the equal quantity of raw material, it is necessary that the manufacturing be conducted with careful attention to the most and modern working procedures that maintain quality and efficiency.

Efficiency measurements were:

- Quality class distribution of log sections, compared with sapwood width by radius;
- Variation of sapwood width indicators;
- Determination of wood mass losses;
- Establishment of the used volume of wood.

Descriptive statistics of oak veneer and special veneer efficiency are presented in Tables 2 and 3.

Table 2. Indicators of the Central Tendency for Veneer Efficiency

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

Table 3. Indicators of Variation and Distribution Shape of Veneer Efficiency

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

The special veneers efficiency was expressed as the amount of finished products placed in the first quality class that resulted from the processing of 1 m^3 of wood. For the studied material, special veneer efficiency constituted 82% of the overall efficiency (Table 2).

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

RESULTS AND DISCUSSION

To make a qualitative classification of quality defects, heartwood and sapwood percentages were identified.

Hierarchical classification of the main causes of quality defects in their order of importance gave the following results:

- Plopeni region: 63% were caused by the first two defects: buds and wood studs;
- Gura Ocnitei region: 70% were caused by the first two defects: wood studs and buds;
- Vrancea region: 63% were caused by the first two defects: buds and curvature;
- Podu Iloaiei region: 62% were caused by the first two defects: buds and curvature;
- Babeni region: 69% were caused by the first two defects: buds and curvature;
- Snagov region: 51% were caused by the first two defects: buds and wood studs;
- Croatia region: 75% were caused by insect holes.

Taking into account that high frequency defects can be reduced more easily than lower frequency ones, the results indicate that it would be more useful to focus on the improvement of primary causes—fewer in number but more important—in contrast to the secondary ones, which are numerous but insignificant.

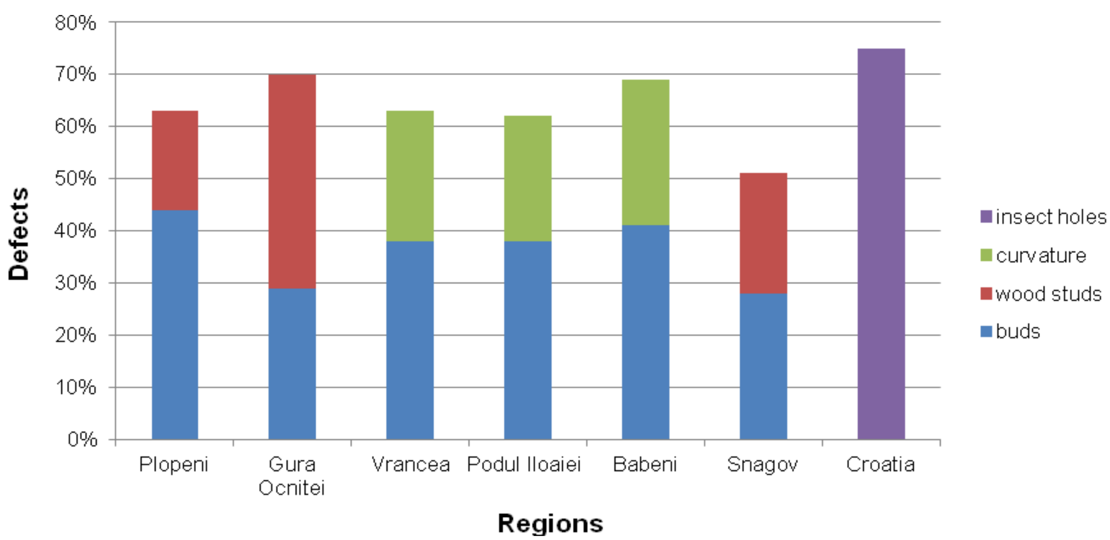

Fig. 9. Distribution of the quality defects of raw oak timber

Comparing the results obtained from Romania, a comparative analysis was also made with a region from Croatia. The distribution of oak quality defects from raw timber specific to the analyzed regions is illustrated in Fig. 3. The most important defects found in regions of Romania were buds, wood studs, and curvature, compared with Croatia where there were mainly insect holes.

For the acquisition of wood mass, special attention should be given to the Gura Ocnitei and Babeni regions where most of the defects were found.

Regarding veneer efficiency, the geographic origin of logs cut into veneer is an influence factor of their quality given by the indicator of special veneer efficiency, which varies significantly.

Inferential statistics were applied to the experimental results to obtain information necessary to support decisions on the studied phenomena. To graphically compare multiple data sets obtained for the analyzed geographic origins, distributions of the observed values of this stratified indicator, according to their source, are illustrated in Fig. 10.

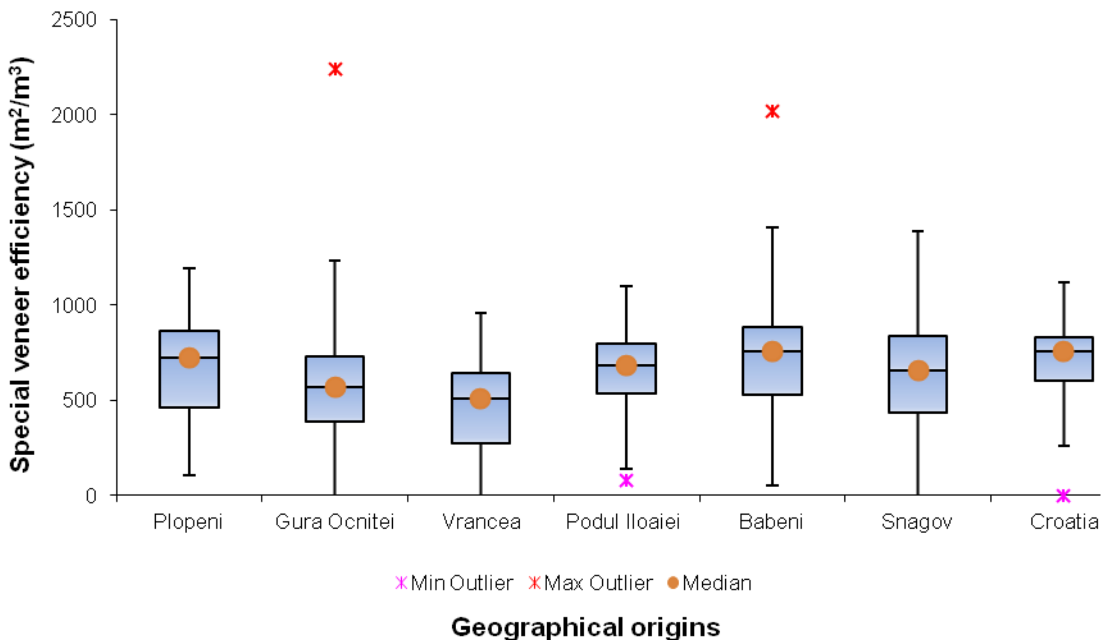

Fig. 10. Comparative analysis of special veneer efficiency specific to geographic origins

The classification of special veneer efficiency resulted in ranking the geographic regions Babeni and Plopeni first, and Vrancea last. Also, knowing the category defects indicates the resulting analysis could provide substantial economic improvements for decorative oak veneer.

Knowing the types of defects, one can avoid the acquisition of wooden material from those source areas or negotiate a reasonable price depending on the benefits. Also, in order to valorize the wood resources, the residues can be reused sustainably.

Apart from the defects study, the data obtained through laboratory tests regarding the physical, mechanical, and technological properties play an extremely important role in determining wood quality. Another issue that could be of interest is represented by the various macroscopic and microscopic characteristics, which due to their major influence on wood structure could allow the prospect of better quality estimation.

CONCLUSIONS

1. The sustainable management of Romanian forests is an imperative for our time, due to the intensive management of trees, the mechanization of forestry work, and the usage of modern processes in both work culture and the exploitation of timber.
2. The interest in identifying and taking advantage of superior quality wood, which are economically motivated, but also are encouraged by the increasing scarcity of this type of raw material justifies the rationale of this study, which relates oak wood quality for decorative veneer with the origin of the raw logs.
3. For the acquired raw oak timber, the defects were recorded to justify the choice of the purchase price. Recording these defects has allowed the analytical and graphical examination of their influence on the purchase price.
4. To our knowledge, this is the first time in the field of wood quality analysis that a Pareto diagram was employed, allowing the identification and classification of the relevant influences for each of the examined defects. The performed analyses allowed for the establishment of a hierarchy of main defects, enabling adequate decision making for improving the quality of the studied products. Considering the dimensional and quality conditions and obtaining good efficiency in producing decorative oak veneer, the implementation of Pareto analysis in the forestry industry field offers a series of benefits: focus on the problems or causes of the problems that have the greatest impact, such as a comparative analysis of veneer yield efficiency, reduction of acquisition costs, and improvement in the use of limited resources. Also, a comparative analysis of veneer efficiency was performed in relation to the categories of origin. The resulting analysis could provide substantial economical improvements for decorative oak veneer manufacture. In addition, with knowledge of the types of defects, decisions can be made to conserve natural resources.
5. In the implementation of sustainable forest management and effective use of valuable trees in Romania, the conducted research contributes to promoting quality of wood to obtain competitive national and international market. However, defective wood can be used after judicious sorting, for aesthetic and technical veneer, technical quality timber, and barrel staves. Thus, according to visible defects (curvature, buttress roots, *etc*.), there are chosen proper trees (in quality terms) for future development and are created optimum conditions for growing and exploitation, thus obtaining high quality wood reflected in the final product of veneer. In this respect, the percentage of aesthetic veneer will be higher than technical veneer.

   In order to improve hardwood quality, the forest managers must use their experience with respect to:
   - Deep knowledge of wood characteristics that give value for veneers;
   - Adopting the forestry practices that it will promote quality of wood for veneers; in the case of decreased consistency of stands, the application of specific treatments intends to minimize the effects of branches arise.

REFERENCES CITED

AFRDI/Furntech (2001). *Technical Notes for Finishing Timber Veneers*, Australasian Furnishing Research and Development Institute, http://www.woodsfurniture.com.au/

Anghel, C. (2001). "Statistical process control methods from the viewpoint of industrial application. Economic quality control," *International Journal for Quality and Reliability* 16, 49-63.

AS/NZS 2270 (1999). Plywood and Blockboard for Interior Use, Australia, New Zealand Standard.

AS/NZS 4266.11 (2004). Reconstituted Wood Based Panels—Methods of Test, Australia, New Zealand Standard.

Baleaux, P. (2004). "Les défauts du bois," *Silva Belgia* 5, 23-28.

Brunetti, M., Brancheriau, L., Nocetti, M., and Nicolotti, G. (2010). "Méthodes pour le diagnostic de l'intégrité des structures bois et des arbres sur pied," 10ème Congrès Français d'Acoustique, 12-16 April, Lyon. http://hal.archives-ouvertes.fr/docs/00/55/22/87/PDF/000635.pdf

Catena, A. (2004). "Thermographie et dendrodensimetre pour l`evaluation de la stabilité des arbres: Comparaison de résultats," *Revue Forestiére Française* 2, 164-170.

Ciobanu, V., Alexandru, V., Borz, S. A., Mihaila, M., and Dumitrascu, A.-E. (2011). "Calculus and evaluation methods for forest roads execution impact upon the environment," *International Journal of Energy and Environment* 5, 686-693, http://www.naun.org/multimedia/NAUN/energyenvironment/2011.html

Ciubotaru, A., Cârpea, I. L., and David, E. C. (2009). "Research regarding the damages produced by harvesting operations to the standing trees," *Forest Journal* (in Romanian: *Revista Padurilor*) 4, 7-12.

Duicu, S., and Dumitrascu, A.-E. (2011). "Researches concerning risk assessing using Pareto diagram for design process of technological processes," *Recent Advances in Signal Processing, Computational Geometry and Systems Theory*, pp. 189-192.

Dumitraşcu A.-E., Moroşanu C., and Ciobanu V. (2011). "The influence of oak raw timber diameter on the efficiency of decorative veneers," *Bulletin of the Transilvania University of Braşov* 4(53), 27-32.

Dzbeński, W., and Wiktorski, T. (2004). "Influence of some structural wood defects on ultrasonic wave spectrum," *Forestry and Wood Technology* 55, 156-163.

EN 338 (2003). *Structural Timber-Strength Classes*, CEN European Committee for Standardization.

Gibra, I. N. (1973). *Probability and Statistical Inference for Scientists and Engineers*, Prentice Hall, Englewood Cliffs, New Jersey.

Jayaraman, K. (1999). *A Statistical Manual for Forestry Research*, Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.

Kruch, J. (2010). "On aspects regarding the utilization of density in wood management," *Forest Journal* (in Romanian: *Revista Padurilor*) 2, 35-38.

Luostarinen, K., and Verkasalo, E. (2000). "Birch as sawn timber and in mechanical further processing in Finland. A literature study," The Finnish Society of Forest Science (Silva Fennica). http://www.metla.fi/silvafennica/full/smf/smf001.pdf

Martinis, R., Socco, L. V., Sambuelli, L., Nicolotti, G., Schmitt, O., and Bucur, V. (2004). "Tomographie ultrasonore pour les arbres sur pied," *Annals of Forest Science* 2, 157-162.

Morariu, C. O. (2006). *Quality Management System* (in Romanian: *Sistemul de Management al Calitatii*), Transilvania University Publishing House, Brasov.

Morosanu, C. (2011). "Study regarding the qualities of wood from pediculate oak and sessile oak having as destination aesthetic veneers," Doctoral dissertation, Transilvania University of Brasov.
Ozarska, B. (2003). "Causes of discolouration in decorative veneered panels," FWPRDC/DWVA Research Project.
Russell, R. S., and Bernard, W. (2003). *Operations Management*, Prentice Hall, Inc., Upper Saddle River, New Jersey.
Sorici, I., Dumitrascu, A.-E., and Ciobanu, V. (2010). *Project Management and Sustainable Development* (in Romanian: *Managementul Proiectelor si Dezvoltarea Durabila*). Transilvania University Publishing House, Brasov.
SR EN 1316-1 (2001). *Hardwood Round Timber—Qualitative Classification. Part 1: Oak and Beech*, ASRO (Asociaţia de Standardizare din România). http://magazin.asro.ro/index.php?pag=2&adv=1&lg=1&search=SR EN 1316-1:2001
Teishchinger, A. (2005). "Interrelation of wood properties and product quality—Challenges for a new design of the process chain," *ProLingo* 2, 15-26.

Article submitted: March 20, 2013; Peer review completed: June 7, 2013; Revised version accepted: July 3, 2013; Published: July 9, 2013.