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A SURVEY OF THE VOLUME, SPECIES, ORIGIN OF LUMBER AND EQUIPMENT USED FOR KILN DRYING OF LUMBER IN REPUBLIC OF KOSOVO

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Abstract:

This study presents data on the capacity and operating practices of the lumber drying industry in the Republic of Kosovo. The study is based on data collected directly in the field on sawn timber subjects.

The results found that there are 35 companies in Kosovo that commercially kiln dry lumber. These companies can be further classified by the degree of additional processing of the material including lumber drying: 3 companies only kiln dried dry lumber; 3 companies are involved in sawing green lumber and processing this lumber through the kiln drying; 4 companies are engaged in the primary sawing of the lumber, drying and further mechanical processing post drying; 24 companies are involved in both lumber drying and further downstream mechanical processing of the dry lumber; and one company used an unconventional specialty electrical dryer to dry lumber.

The total annual drying capacity of all the firms in the study is estimated to be 28,000m^3 of lumber, while the amount of lumber actually dried in kilns is approximately 14500m^3. Thus, at the current utilization rates, the kilns are operating at approximately 50% capacity.

From the data collected, the annual consumption of kiln dried lumber in Kosovo is approximately 24000m^3. This implies that about 60% of the kiln dried wood used in Kosovo is kiln dried in country, while the remainder is imported from other countries in the region.

The main species of lumber dried is beech accounting for 78% of the volume; fir with approximately 12% of the volume; spruce, oak and other minor species accounting for the remaining volume of 10%.

Key words: *beech; kiln drying; oak; wood.*

INTRODUCTION

The in-use performance, life expectancy and value of secondary wood products such as flooring, furniture and interior wood work depends a great deal on the quality of the drying process used. During the manufacturing process, the drying process takes most of its time (Rice et al. 1994). For each combination of wood species and lumber thickness; temperature, humidity and air speed through the lumber stacks is manipulated in order dry the lumber as rapidly as possible while minimizing the amount of degrade caused by the drying process.

1. Proper control of temperature during wood drying is essential for quality drying. In short, higher drying temperatures promote more rapid drying, which if not properly controlled, results in the wood shrinking rapidly in conjunction with the wood becoming weaker at higher temperatures, thus increasing the risk of degrading to the lumber through checking, cracking, honeycombing, collapse, warp, and color change. On the positive side increased temperatures, above 54^{o}C, tend to destroy insects, insect eggs, and fungus.

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2. The air surrounding the lumber must be capable of receiving moisture from the wood surface. That is, the relative humidity of the air surrounding the lumber must be below 100%. Proper control of humidity during drying is also essential for quality drying. The lower the relative humidity (RH), the faster the drying, resulting in flatter, brighter colored lumber. On the other hand, low RH values at the beginning of the drying process can result in excessively fast drying that may cause cracks, splits, and honeycomb in some species and lumber thicknesses (Denig et al. 2000).
3. During drying, air movement through a stack of lumber must be adequate to bring energy into the stack, and to remove evaporated moisture. Proper airflow speed ensures that the load of lumber in a kiln is exposed to relatively uniform drying conditions (Denig et al. 2000).

Prior to kiln drying the lumber is often air dried to remove some moisture from it, thus decreasing the amount of time the lumber has to be in a dry kiln. The air temperatures in Kosovo are favorable for this natural drying process of the wood. The highest average values are recorded in Prizren (+16,9℃). The monthly average temperatures are positive for all months apart from January. The number of days with temperatures higher than 25℃ is high for the whole territory of Kosovo. This means that Kosovo has temperatures to be applied for a natural wood-drying process (Bajraktari et al. 2016).

Theoretical and practical data show that wood humidity for indoor environments In Kosovo should be 8-12% (Osmani 2001). Wood usage in outdoors varies depending on the relative humidity and temperature of the region where it will be exposed. In Kosovo, the humidity of outdoor wood varies depending on the region and the seasons of the year, ranging from 10.5% during the summer to 19.1% during the winter (Sejdiu et al. 2012).

OBJECTIVE OF THE STUDY

The objective of this study was to quantify the commercial lumber dry kiln capacity in country, identify the additional types of wood processing that are used at the firms kiln drying lumber, to find the subjects' requirements for wood moisture according to their requirements.

MATERIALS AND METHODS OF THE STUDY

For the realization of this study, the subjects of the sawn material were initially identified. Data on wood drying were then collected, which were further analyzed to generate the following results. The lumber dry kiln operations in Kosovo were initially identified through interviewing firms that utilized kiln dried lumber in their manufacturing process. The study included all companies that were identified as being involved in kiln drying lumber in the Republic of Kosova. Companies were divided into categories based on their services (firms that kiln dry lumber only, those that saw green lumber and kiln dry it, and those that are involved in sawing, kiln drying lumber and further processing lumber), and cross categorized by region (Fig. 1.).

Fig. 1.
Regional distribution of kiln drying in Kosovo.

Table 1 shows that the distribution of kiln dryers is almost proportional to the number of entities in the region. However, some regions do not use dry timber even though they have a large number of enterprises. To estimate the volume of kiln dried lumber annual consumed in Kosovo, 121 companies were randomly selected to be interviewed by face to face and by telephone from a data base of 494 companies of the known companies that utilized kiln dried lumber in their manufacturing process.

RESULTS

CONSUMPTION OF DRY TIMBER IN KOSOVO

According to the data issued for each region they are also processed data for all of Kosovo. Republic of Kosovo has 1544 wood processing subjects that operate.

Table 1

Consumption of dry timber by region is provided below**

Regions		Total Firms	Samples	Used dry material	Don't use dry material	No answer	In m^3/%	Consumption of dry timber m^3					Origin		Total
								Fagus	Fir	Spruce	Oak	Pinus	Kosova	Import	
Prishtinë	No	337	81	120	217	0	m^3	2553	387	489	1138	80	2069,5	2730,2	4800
	%	21,8	21,3	24,3	20,7	0,0	%	20,3	15,6	10,1	40,5	15,0	43,4	56,9	20
Ferizaj	No	345	89	107	238	0	m^3	4700	162	575	374	7	4998	875	5873
	%	22,3	23,4	21,7	22,7	0,0	%	37,3	6,5	11,9	13,3	1,3	85,1	14,9	25
Gjakovë	No	219	59	68	151	0	m^3	2450	244	826	327	294	3256	885	4140
	%	14,2	15,5	13,8	14,4	0,0	%	19,4%	9,8	17,1	11,7	55,4	73,3	26,7	18
Pejë	No	200	50	49	152	0	m^3	710	105	2418	51	68	1740	1606	3345
	%	100,0	24,0	24,3	75,7	0,0	%	5,6	4,2	50,0	1,8	11,6	52,0	48,0	14
Prizrenit	No	212	46	76	135	1	m^3	535	1243	392	666	67	893	2161	3053
	%	13,7	12,1	15,3	12,9	33,3	%	4,2	50,1	8,1	23,7	12,7	29,2	70,8	13
Gjilan	No	99	23	26	72	1	m^3	1280	82	47	116	0	1237	289	1525
	%	6,4	6,0	5,3	6,9	33,3	%	10,2	3,3	1,0	4,1	0,0	81,1	18,9	7
Mitrovicë	No	132	33	49	82	1	m^3	373	256	91	138	21	672	207	879
	%	8,5	8,7	9,9	7,8	33,3	%	3,0	10,3	1,9	4,9	4,0	76,4	23,6	4
Total	No	1544	381	494	1047	3	m^3	12600	2478	4838	2810	530	14863	8752	23,615
	%	100,0	24,7	32,0	67,8	0,2	%	53,4	10,5	20,5	11,9	2,2	62,9%	37,1%	100,0

According to the Table 1 approximately 23600m^3 dry timber consumed in Kosovo, 14800m^3 (62.9%) is provided by country and about 8750m^3 (37.1%) from imports. The types of wood mostly imported from abroad are oaks, while from coniferous are spruce and fir. The data show that the coniferous trees like fir and spruce imported is because the largest amount where it lies has been declared as a national park and cuts are very limited.

* Other minor species (Chestnut, Walnut, Poplar, Ash, Mahagony) were those that hand less than 2% utilization.

** *Sejdiu R. Study on artificial drying capacities in the territory of the Republic of Kosovo, PhD. Thesis, Agricultural University of Tirana, Albania*

Table 2

Wood moisture requirements for kiln dried lumber based upon respondents and the volume of kiln dried lumber consume annually (this data was based upon a previous survey by the author of kiln dried lumber users, 121 participants

Required moisture %	Respondents		Quantity of wood represented	
	No	%	m^3	%
7-10	198	40,1	9760	41,3
>10-12	143	28,9	8290	35,1
>12	89	18,0	4120	17,5
Not declared	64	13,0	1450	6,1
Total	494	100,0	23620	100,0

Table 3

Perceived quality of kiln dried lumber according to users

The quality of dry material	Subjects		Quantity							
	No	%	Import		Place		Total			
			m^3	%	m^3	%	m^3	% of the amount	% of the import	% of the place
Excellent	159	34,1	3493	46,5	4700	48,8	8193	47,8	42,6	57,4
Acceptable	270	58,2	4022	53,5	4587	47,7	8610	50,2	46,7	53,3
Poor	36	7,7	0,0	0,0	336	3,5	335	2,0	0,0	100,0
Total	465	100	7515	100,0	9623	100	17138	100	43,8	56,2

Respondents were asked about the quality of the kiln dried lumber the received. They were asked to rate the quality using excellent, acceptable and poor based upon their experience. Table 3 shows that 159 (34%) of respondents from 465, which consumed represents 48% of the kiln dried lumber, rated the kiln dried lumber that they use as excellent quality; 270 (58%) respondents, which represents 8,610m^3 (50%) of the kiln dried lumber consumed, rated the kiln dried lumber that they use as acceptable; and 36 (or 7.7%) respondents, which represents 335 (2%) of the kiln dried lumber consumed, rated the quality of the kiln dried lumber that they use as poor.

Table 4

Categorizing firms that produce kiln dried lumber for sale and or internal use

Firms that kiln dry lumber		
Respondents that:	No	%
Only kiln dry	3	8,6
Kiln dry and further mechanically processing	24	68,6
Saw lumber and kiln dry	3	8,6
Saw lumber, kiln dry and further mechanically process	5	14,3
Total	35	100,0

Table 4 indicates only 8,6% of the respondents only kiln dry lumber, 68,6% of them kiln dry and further mechanically process the lumber, 8,6% of the respondents reported that they saw the lumber and kiln dry it and 14,3% of the respondents saw the lumber, kiln dry it and further mechanically process the lumber.

Table 5

Annual dryer capacity, lumber dried, unused kiln capacity and the amount of kiln dried lumber consumed by region and the whole country

Regions	Annual dryer capacity m^3 region (country)		Annual amount of lumber dried in region (country)		Unused capacity region (country)		Annual quantity that is consumed region (country)	
	m^3	%	m^3	%	m^3	%	m^3	%
Prishtinë	2525	9,0	565	22,4	1960	77,6	4800	20,3
Ferizaj	8290	29,5	4998	60,3	3292	39,7	5873	24,9
Pejë	3100	11,0	1525	49,2	1575	50,8	4140	17,5
Gjakovë	9190	32,7	4645	50,5	4545	49,5	3345	14,2
Prizren	960	3,4	0	0,0	960	100,0	3054	12,9
Gjilan	3200	11,4	2600	81,3	600	18,8	1525	6,5
Mitrovicë	860	3,1	70	8,1	790	91,9	879	3,7
Total	28125	100,0	14403	51,2	13722	48,8	23616	100,0

While the total amount of timber consumed (23,616m^3) shows that our subjects drain about of total volume which consumed from wood industry 61% (14,400m^3).

Table 6

Domestic and imported wood for drying in Kosova

Annually																		
Types of wood	Beech		Oak		Pine		Spruce		Chestnut		Poplar		Walnut		Fir		Total	
	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%	m^3	%
Domestic	10299	91,3	224	51,6	277	91,7	295	52,0	16	100,0	20	100,0	19	100,0	663	37,1	11812	81,9
Imported	983	8,7	210^3	48,4	25	8,3	273	48,0	0	0,0%	0	0,0	0	0,0	1125	62,9	2615	18,1
Total	11282	100	434	100	302	100	568	100	16	100	20	100	19	100	1788	100	14427	100

Table 6 indicates that that 82% of the green lumber dried in Kosovo is from domestic sources and 18% of green lumber is imported. Beech is by far the most common species dried in Kosovo and is found in great abundance in the country.

Table 7

Field observations of kiln systems evaluated during data collection

Type of dryer			
	No	m^3	%
Conventional kiln	34	13110	91,0
Electric dryer (specialty dryer)	1	1293	9,0
Total	35	14403	100,0
Estimated serviceability of the kilns			
Excellent	15	7833	54,4
Acceptable	15	6077	42,2
Poor	5	493	3,4
False ceilings used to circulate the air through the lumber			
Yes	19	10600	73,6
No	16	3803	26,4
Air circulation fans are reversed periodically to promote more uniform			
Yes	16	10191	70,8
No	19	4212	29,2

Kilns had a humidification system to control the humidy			
Yes	16	10211	70,9
No	19	4192	29,1
Kilns used an electronic controller to control the conditions inside the kiln (heat,			
Yes	13	9789	68,0
No	22	4614	32,0
Kiln used lumber moisture probes to monitor and or control the lumber drying			
Yes	13	9789	68,0
No	22	4614	32,0
Kiln loading process			
Mechanical	24	11865	82,4
Manual	11	2538	17,6
Final stated target moisture content at the each drying facility humidity of			
Target moisture	No	m^3	%
7-10	18	8527	59,2
10-12	13	5176	35,9
>12	4	700	4,9
Firms that had defined kiln loading procedures			
Yes	11	7459	51,8
No	14	3291	22,8
Quite	10	3653	25,4

Air drying is sometimes used as a predrying method to initially remove moisture from the lumber, this reduces kiln residence time and thus can increase kiln productivity. The drying conditions cannot be controlled during air drying, so this practice can damage lumber. From the firms interviewed, 26 respondents air dried (representing 10300m^3 of lumber), while 9 respondents did not air dry (representing 4100m^3 of lumber). From visite in terrain there are seen bad condition of air drying (Fig. 2.).

Fig. 2.
Air drying lumber in Kosova.

One problem that was noted during the field interviewing process was the wide range of dry lumber storage practices after kiln drying in order to protect the lumber from damage through rewetting the surface. Lumber storage practices were documented in Trable 8.

Table 8

Dry lumber storage at facilities with lumber dry kilns

Ways of protecting dry lumber	Subjects	Quantity	
	No	m^3	%
Enclosed sheds with method of controlling the temperature and or humidly inside the shed.	2	1893	13,1
In factory buildings where the machining was done	21	6729	46,7
Under shed roofs	10	5293	36,7
Enclosed sheds with no moisture control	1	259	1,8
Not declared	1	230	1,6
Total	35	14404	100,0

Table 9

Dry lumber storage facilities at manufacturing facilities that do not have dry kilns

The way of maintaining dry timber	Subjects		Quantity	
	No	%	m^3	%
In factory areas where the machining is done	428	92,0	14700	85,7
Under shed roofs	14	3,0	1260	7,4
Enclosed sheds with no moisture control	23	5,0	1190	6,9
Total	465	100,0	17150	100,0

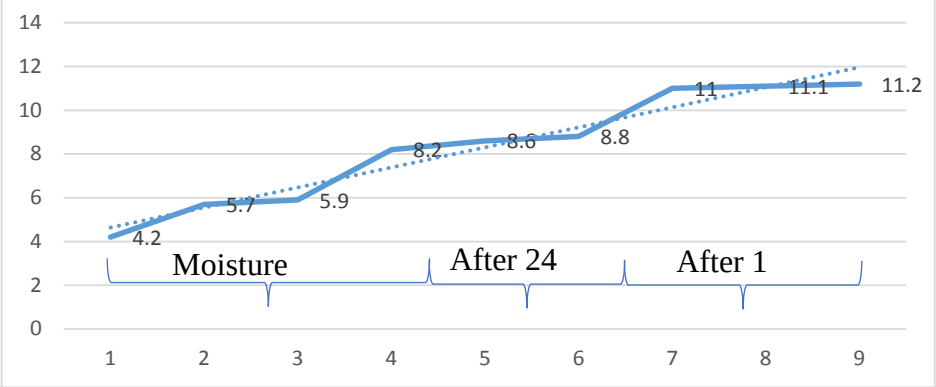

Fig. 3.
Moisture absorbtion of dry boards after storage in factory.

Fig. 3, shows dry wood storage inside production factory premises is not suitable as it absorbs moisture, rendering wood drying under 10% moisture useless (Data were collected during spring season).

CONCLUSIONS AND RECOMMENDATIONS

- In Kosovo, there are 35 firms that dry timber and have an annual dryer capacity of 28125m^3, however they only dry about 14400m^3 on an annual basis of approximately 23600m^3 of dried lumber that is consumed in country.
- Of the total amount of timber that is dried in Kosovo, approximately 11800m^3 is sourced in Kosovo, while approximately 2600m^3 of the lumber dried in country is imported.
- The majority of dry kiln operations (68.6%) use air drying to reduce the starting moisture content of the lumber prior to entering the dry kiln. An interesting future study would be to evaluate the drying defects caused by air drying. Would it be more economical to reduce the amount of air drying by utilizing the excess kiln capacity, and thus reducing the amount of lumber yield losses due to uncontrolled air drying.

- The data show that only 37.1% of the subjects report they have automated processes in their dryers, but they do not know if they can intervene in changing the drying conditions if this is needed.
- The data on the field show that only 3 of the 35 subjects keep the dry timber in closed silos while the rest of them keep in warehouses where the mechanical process is done or outdoors with roof as cover and without walls.

RECOMMENDATION FOR SUBJECTS THAT DRY TIMBER

- Since the percentage of using dryers is 51.2%, while capacities of dryers are greater than consumption of dry timber for 19.1% it is recommended to invest only in quality of drying as a necessity of growth demand of dry timber from the country.
- Regarding the wood products which have contact with the environment, such as doors and windows, the wood humidity should be consistent with the equilibrium moisture in the regions where they are placed.
- The report of 20 subjects that dry the timber below 10% is not justified, because according to their reports, dry timber stored outdoors covered by roof. To reduce the discard and humidity changes, the subjects that drain should take care for the preservation of dry material.
- The improvement of drying quality would be a very important factor in the use of timber in the country because the majority of subjects which report are satisfied with the quality of drying provide that from import. Since 58.2% of subjects report on acceptable drying quality, it is concluded that have to do a lot to improve the quality of drying.
- Subjects that do not use natural pre drying, should study specific opportunities for it.

Subjects that dry should cooperate with other subjects that use dry wood to determine the appropriate moisture of dry material.

CONCLUSION FOR SUBJECTS THAT CONSUME DRY TIMBER

The processed data obtained from subjects who consume dry timber are the following conclusions:

- Subjects of wood processing industry in Kosovo consume about 23600m^3 dry timber. From the total amount of dry wood, beech wood takes the highest percentage with 53.4%, fir with 20.5%, oak 11.9%, spruce 10.5% and others with 3,7 %. Beech wood is used the most in Kosovo because of the volume found in the forests, the low price and the customer demand.
- About 14600m^3 (62%) of dry timber is provided by the country and around 8970m^3 (38%) from imports. This statistics shows that the subjects of the wood processing industry in Kosovo are also partially dependent on imports.
- Data on consumer demand for humidity of dry timber show that a large numbers of subjects (86 subjects) reported they did not know the humidity of timber they use.
- As regards only 34% of the subjects report that they are very satisfied with the quality of dry timber. It is worth mentioning that subjects which provide it from import are satisfied.

RECOMMENDATION FOR SUBJECTS THAT CONSUME DRY TIMBER

It is recommended that:

- Subjects should improve the quality of stacking and storage of dry timber.
- To increase cooperation between subjects and those that dry up and those which process to determine exactly the necessary humidity of dry timber depending on conditions of use.

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