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Study on efficiency of sawing coniferous trees in theMitrovica region

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Abstract

Mitrovica is known as the region in which the first saws of timber were set there. Today this region supplies a very large part of Kosovo with sawn timber (coniferous). The trunks of coniferous species in this region are: pine, fir and spruce which mainly are imported from Montenegro. In this study, we tried to bring interesting data on the subjects of this region for sawing trunks and production efficiency of sawn timber, as well as field losses or form of waste, wood residue and sawdust.

To conduct the study, there were taken a number of conifers, were sawn and measured to determine the efficiency of sawing trunks. Results of the study are provided below:

The volume of sawing logs 23.071 m^3

Boards 16.268 m^3

Wood residue 3.941 m^3

Sawdust 2.548 m^3

Others 0.313 m^3

The study shows that, by sawing trunks were produced 70.52% boards, 17.08% wood residue, 11.04% sawdust, and 1.36% others.

If worked with better technical measures, by performing division of trunks according to diameters and by calculation of models by maximum sawing for each trunk diameter, sawing trunks efficiency would be higher.

Keywords: trunks, sawn timber, wood residue, sawdust, conifer.

Introduction

Mitrovica lies on alluvial rivers of Ibër, Sitnica and Lushta and the slopes of the hills that surround them. The geographical location is favourable because of the terrain. The corridor of north-south through Ibër-Sitnica Valleys has economic and cultural importance since it connects with many different countries. The city borders Kreshbardhës (Kopaonik), Rogozna, Mokna and Qyqavica slopes. The entire territory of Mitrovica outskirt has an important position, especially for bypass. Mitrovica lies in 42.53 ° northern latitude and at 25, 52 ° eastern latitude at an altitude 508-510m. In East, Mitrovica borders Lisi Hill (665m), in the south with Shkemzet Hill (formerly Cerrnusha 1010m), and west with Zmiq (822m) and Gërrmova Hill (782m). Dominant morphological characteristics of Mitrovica territory are hilly mountainous. In the wider Mitrovica dominates the mountain landscape [4].

The timber industry in this region is highly developed and has about 90 sawmills registered in the ministry of commerce, where 35 of them deal with sawing of trunks. According to the data from previous studies show that the majority of firms produce timber from coniferous wood types [5].

The aim of study

The aim of this study is to determine the efficiency of sawing coniferous trees during the production of sawing timber, the determination of the waste amount (in the form of wood residue, slats,

pieces and sawdust), and are given recommendations to the sawmills of timber in Mitrovica region to increase the efficiency of production.

Material and Methods

To conduct this study, there were visited some sawmills in Mitrovica region and 21 questionnaires were completed, and there were also made sawing and measurements in 5 different sawmills, where were sawn by 5 trunks in each.

Materials used

- Saw logs,
- Band saw,
- Circular saw,
- Metre stick,
- Calibre,

Methodology used

To determine the efficiency of sawing coniferous trees in Mitrovica region, ground measurements were used.

For quantitative evaluation of products that result from sawing trunks are recognized three methods: the volumetric method, by weighing and combined method [2]. In this study, it was used the combined method.

After completing the questionnaires in sawmills, we have begun the measurement of trunks, where trunks were measured in three parts, by two transverse measurements with each other. Trunks were measured at the top, middle and bottom, and then we drew the average diameter of the trunk. After finding the average diameter, the trunk is measured in length and then its volume is derived based on the equation 1 [1].

$$Q = \frac{D^2 \times \pi}{4} \times l \ldots . (m^3) \ldots\ldots\ldots\ldots (1)$$

Where:

D - average trunk diameter in m.

l – trunk length, in m.

Then we started to saw the trunks. Boards after sawing were measured by meter in length, width and thickness. Based on the size, was calculated its volume according to equation 2.

$$V = a \times b \times l \ldots . . (m^3) \ldots\ldots\ldots\ldots (2)$$

Where:

a - board width in m.

b - board thickness in m.

l - board length in m.

Then, wood residue and sawdust are collected and weighed. Reason why weighting the wood residue

$$V_l = \frac{P}{¥_u} \ldots\ldots\ldots \left(m^3\right) \ldots\ldots\ldots\ldots (3)$$

and saw dust was because these materials do not have regular geometric shapes and it is difficult to calculate with other methods. For their calculation, it was used equation 3 [3].

Where:

P – sawn timber weight in kg.

$¥_u$ - specific wood weight in kg/m^3.

For the return weighed timber materials by weight to volume, have to be found the specific timber weight, which is calculated by the formula (4):

$$¥_u = \frac{P_u}{V_u} \ldots\ldots\ldots \left(gr / cm^3\right) \ldots\ldots\ldots\ldots (4)$$

Where:

P_u – wet weight sample in gr.

V_u – wet volume sample in cm^3.

To do it, are taken samples sized 2x2x2cm from sawn timber. The samples were measured by a micrometer in order to find exact size or volume. Then the samples were weighed with scales precisely 0.01gr. Sawn material moisture is measured by moisture meter after sawing trunks. After measuring the sawn material, the humidity was 38%.

Table 1. Dimension, volume, weight, and percentage of sample moisture

Nr.	Sample dimensions mm.			Volume cm^3	Sample weight gm.	Nr.	Sample dimension mm.			Volume cm^3	Sample weight gm.	Nr.	Sample dimension mm..			Volume cm^3	Sample weight gm.
1	19,80	18,25	19,23	6,95	4,20	34	19,87	19,29	19,21	7,36	4,40	67	19,97	19,27	19,24	7,40	4,50
2	19,84	19,31	19,25	7,37	4,40	35	19,85	19,21	19,21	7,32	4,40	68	19,96	19,30	19,22	7,40	4,50
3	19,83	19,28	19,21	7,34	4,40	36	19,86	19,19	19,25	7,33	4,40	69	19,86	19,24	19,24	7,35	4,40
4	19,84	19,27	19,20	7,34	4,40	37	19,84	19,18	19,05	7,25	4,30	70	19,69	19,34	19,20	7,31	4,40
5	19,90	19,15	19,05	7,26	4,30	38	19,90	19,21	19,23	7,35	4,40	71	19,95	19,21	19,32	7,40	4,40
6	19,90	19,22	19,16	7,32	4,40	39	19,85	19,21	19,22	7,33	4,40	72	20,06	19,22	19,29	7,44	4,50
7	19,87	19,29	19,21	7,36	4,40	40	19,81	19,27	19,21	7,33	4,40	73	19,95	19,15	19,19	7,33	4,40
8	19,85	19,21	19,21	7,32	4,40	41	19,81	19,13	19,18	7,26	4,30	74	19,96	19,25	19,28	7,40	4,40
9	19,86	19,19	19,25	7,33	4,40	42	19,79	19,25	19,29	7,35	4,40	75	19,92	19,22	19,27	7,38	4,40
10	19,84	19,18	19,05	7,25	4,30	43	19,96	19,18	19,03	7,28	4,30	76	20,07	19,29	19,28	7,46	4,50
11	19,90	19,21	19,23	7,35	4,40	44	19,82	19,16	19,27	7,32	4,40	77	19,88	19,28	19,29	7,39	4,40
12	19,85	19,21	19,22	7,33	4,40	45	19,95	19,26	19,25	7,39	4,40	78	19,92	19,22	19,23	7,36	4,40
13	19,81	19,27	19,21	7,33	4,40	46	19,86	19,19	19,25	7,33	4,40	79	19,87	19,22	19,22	7,34	4,40
14	19,81	19,30	19,32	7,38	4,40	47	19,92	19,26	19,27	7,39	4,40	80	19,93	19,18	19,15	7,32	4,40
15	19,85	19,12	19,28	7,31	4,40	48	19,90	19,17	19,11	7,29	4,30	81	19,90	19,21	19,13	7,31	4,40
16	19,90	19,17	20,17	7,69	4,60	49	19,77	19,26	19,28	7,34	4,40	82	20,01	19,23	19,31	7,43	4,50
17	19,92	19,23	19,29	7,38	4,40	50	19,77	19,17	19,28	7,31	4,40	83	19,90	19,25	19,20	7,35	4,40
18	19,83	19,33	19,28	7,39	4,40	51	19,81	19,31	19,24	7,36	4,40	84	19,70	19,20	19,25	7,28	4,30
19	19,76	19,29	19,31	7,36	4,40	52	19,84	19,18	19,05	7,25	4,30	85	19,96	19,24	19,21	7,38	4,40
20	19,85	19,35	19,28	7,40	4,40	53	19,90	19,21	19,23	7,35	4,40	86	19,93	19,81	19,23	7,59	4,50
21	19,72	19,29	19,27	7,33	4,40	54	19,85	19,21	19,22	7,33	4,40	87	19,88	19,25	19,19	7,34	4,40
22	19,83	19,30	19,27	7,37	4,40	55	19,81	19,27	19,21	7,33	4,40	88	19,84	19,31	19,25	7,37	4,40
23	19,84	19,24	19,23	7,34	4,40	56	19,81	19,13	19,18	7,26	4,30	89	19,83	19,28	19,21	7,34	4,40
24	20,00	19,13	19,91	7,62	4,60	57	19,79	19,25	19,29	7,35	4,40	90	19,84	19,27	19,20	7,34	4,40
25	19,84	19,26	19,31	7,38	4,40	58	19,96	19,18	19,03	7,28	4,30	91	19,90	19,15	19,05	7,26	4,30
26	20,42	19,24	19,24	7,56	4,60	59	19,82	19,16	19,27	7,32	4,40	92	19,90	19,22	19,16	7,32	4,40
27	19,84	19,26	19,33	7,38	4,40	60	19,95	19,26	19,25	7,39	4,50	93	19,87	19,29	19,21	7,36	4,40
28	19,88	19,81	19,31	7,60	4,60	61	19,79	19,21	19,21	7,30	4,40	94	19,85	19,21	19,21	7,32	4,40
29	19,78	19,27	19,25	7,34	4,40	62	19,87	19,25	19,16	7,32	4,40	95	19,86	19,19	19,25	7,33	4,40
30	19,80	19,28	19,30	7,37	4,40	63	19,85	19,20	19,27	7,34	4,40	96	19,84	19,18	19,05	7,25	4,30
31	19,80	19,28	19,26	7,35	4,40	64	19,83	19,26	19,22	7,34	4,40	97	19,90	19,21	19,23	7,35	4,40
32	19,81	19,38	19,30	7,41	4,50	65	19,87	19,25	19,19	7,34	4,40	98	19,85	19,21	19,22	7,33	4,40
33	19,81	19,25	19,28	7,35	4,40	66	19,79	19,25	19,29	7,35	4,30	99	19,81	19,27	19,21	7,33	4,40
Average				**7,37**	**4,42**	**Average**				**7,33**	**4,38**	100	19,81	19,13	19,18	7,26	4,30
												Average				**7,35**	**4,40**

According to the table, it turns out that the average sample weight is 4.40 gr, and sample volume is 7.35cm^3. By these data, we calculate specific wood weight and it is:

$$¥_u = \frac{P_u}{V_u} = \frac{4.40}{7.35} = 0.59861\left(gr/cm^3\right)$$

So, 1 cm^3 weighs 0.59861, or 1 m^3 weighs 598,61kg.

Results and discussions

The amount of sawn material: According to the data made in 21 sawmills show that, the number of sawn trunks is 9870 m^3 per year. Data about the number of trunks that are sawn in these sawmills are given in table 2.

Table 2. The number of trunks for sawing.

Sawmills	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	**Total**
Amount m^3	600	400	700	300	500	360	400	450	700	400	360	550	800	300	200	400	300	700	500	550	400	**9870**

Types and size of sawn material that are sawn in Mitrovica region are different. In this region, main produced timber is coniferous tree which is shown in figure 3. This raw material (trunks) is mainly imported from Montenegro (95%). Sawn timber which is produced here is used mainly for construction, roof, and a small part for doors and windows. The dimensions differ a lot by form of raw materials, customers' demand, exploitation, etc. Dimensions which are mostly produced for sawn material in length, in this region, are shown in table 4

Table 3. The amount of sawn material by type of sawing wood

Type	Pine	Spruce	Picea excelsa	Beech	Others	Total
Amount m^3	4000	1850	1790	1900	330	9870
%	40,5%	18,7%	18,1%	19,3%	3,3%	100,0%

Table 4 Length dimensions of sawn material.

Total in m.	3	4	5	6	7	8	Custom-made
Sawmills	5	21	18	18	8	2	21

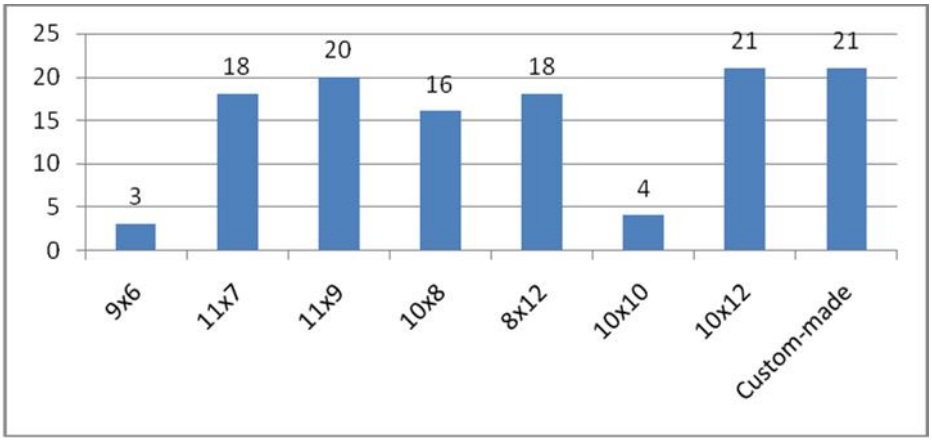

Figure 1. The number of sawmills that saw prisms.

Even the width of sawn material that is traded in this region fits according to the requirements of clients; this material is sold in two forms, the prism and boards. Boards in width are cut depending on the thickness of the trunk, only the boards that come from sawing width over 30 cm are divided into two or more parts. Prisms (beams) are produced with dimensions shown in figure 1. According to the thickness, the requirements for board are shown in table 5.

Table 5. The most frequent board thickness.

Thickness mm	20	25	30	40	50	Custom -made
Sawmills	17	21	21	15	21	21

4.1. The measurement results of trunks.

In 5 sawmills were sawn by 5 trunks, which means a total of 25 trunks have been sawn. In two sawmills were sawn trunks in length by 5m, and in 3 sawmills trunks by 4 m. Details of sawn trunks are shown in table 6. After the measurement, the trunks were sawn and manufactured one by one.

4.2. Measuring results of sawn timber.

Sawn timber products are measured in length, width and thickness. After the measurement, we have the volume of sawn timber. Wood residue, slats, and sawdust are weighed and their weights are returned into volume, table 7.

As seen from table 7, the volume of trunks was 23.071m^3. From this amount, after sawing have been issued boards fully manufactured by 16.269m^3 volumes, and the percentage of use was 64.49-74.55%, average data 70.52% are seen graphically in figure 2.

Wood residue and slats arising from sawing trunks and manufactured material were weighed and convert in m^3. As shown in table 7, wood residue and slats quantity is 3.941m^3, expressed in percentage 17.08%.

Even the sawdust was put in plastic bags and weighed and converted in volume. Its volume was 2.548 m^3, expressed in percentage 11.4%, and 0.313 m^3 or 1.36% is other materials that could not be measured because of wind, dust, etc.

Table 6. Here it is the diameter, length and volume of trunks.

Nr.	Diameter in m.						Average diameter m	Length m	Volume m^3
	Measurement I		Measurement II		Measurement III				
1	0,27	0,28	0,26	0,26	0,25	0,25	0,26	4	0,430
2	0,31	0,30	0,28	0,27	0,26	0,26	0,28	4	0,492
3	0,29	0,28	0,26	0,26	0,24	0,24	0,26	4	0,430
4	0,34	0,33	0,31	0,30	0,29	0,28	0,31	4	0,597
5	0,33	0,33	0,31	0,30	0,28	0,27	0,30	4	0,578
6	0,38	0,39	0,37	0,37	0,35	0,36	0,37	4	0,860
7	0,40	0,41	0,38	0,39	0,37	0,37	0,39	4	0,939
8	0,38	0,37	0,36	0,35	0,34	0,33	0,36	4	0,791
9	0,42	0,42	0,4	0,4	0,38	0,37	0,40	4	0,996
10	0,42	0,41	0,39	0,38	0,36	0,36	0,39	4	0,939
11	0,44	0,42	0,41	0,4	0,38	0,38	0,41	5	1,288
12	0,42	0,42	0,39	0,39	0,36	0,35	0,39	5	1,184
13	0,43	0,42	0,41	0,4	0,37	0,37	0,40	5	1,256
14	0,4	0,41	0,37	0,36	0,34	0,33	0,37	5	1,065
15	0,39	0,39	0,37	0,36	0,35	0,35	0,37	5	1,065
16	0,3	0,31	0,28	0,29	0,27	0,27	0,29	4	0,516
17	0,29	0,28	0,26	0,26	0,24	0,24	0,26	4	0,430
18	0,34	0,33	0,31	0,30	0,29	0,28	0,31	4	0,597
19	0,38	0,39	0,37	0,37	0,35	0,35	0,37	4	0,852
20	0,38	0,38	0,37	0,37	0,36	0,35	0,37	4	0,852
21	0,45	0,45	0,42	0,42	0,4	0,39	0,42	5	1,396
22	0,4	0,39	0,37	0,37	0,35	0,34	0,37	5	1,075
23	0,42	0,41	0,39	0,38	0,36	0,36	0,39	5	1,174
24	0,51	0,5	0,48	0,47	0,46	0,45	0,48	5	1,796
25	0,46	0,45	0,44	0,43	0,41	0,41	0,43	5	1,474
						Total volume of 25 trunks			**23,071**

Table 7. The sawing results of 25 trunks.

		Sawn timber		Wood residue and slats			Sawdust			Others	
Nr.	Trunk volume	Volume	%	Weight	Volume	%	Weight	Volume	%	Volume	%
1	0,430	0,310	72,09	35	0,080	18,50	13	0,030	6,87	0,011	2,54
2	0,492	0,340	69,11	37	0,084	17,09	27	0,061	12,47	0,007	1,33
3	0,430	0,310	72,09	34	0,077	17,97	18	0,041	9,51	0,002	0,42
4	0,597	0,430	72,09	41	0,093	15,62	25	0,057	9,53	0,017	2,77
5	0,578	0,424	73,42	45	0,102	17,71	21	0,048	8,26	0,003	0,61
6	0,860	0,620	72,09	60	0,136	15,86	40	0,091	10,57	0,013	1,48
7	0,939	0,680	72,42	63	0,143	15,25	41	0,093	9,92	0,023	2,41
8	0,791	0,560	70,80	60	0,136	17,24	39	0,089	11,21	0,006	0,76
9	0,996	0,710	71,29	71	0,161	16,20	52	0,118	11,87	0,006	0,65
10	0,939	0,700	74,55	62	0,141	15,01	43	0,098	10,41	0,000	0,04
11	1,288	0,890	69,10	101	0,230	17,82	65	0,148	11,47	0,021	1,61
12	1,184	0,820	69,26	85	0,193	16,32	70	0,159	13,44	0,012	0,99
13	1,256	0,810	64,49	99	0,225	17,91	80	0,182	14,48	0,039	3,12
14	1,065	0,730	68,54	97	0,220	20,70	50	0,114	10,67	0,001	0,09
15	1,065	0,750	70,42	90	0,205	19,21	48	0,109	10,24	0,001	0,13
16	0,516	0,380	73,64	40	0,091	17,62	19	0,043	8,37	0,002	0,37
17	0,430	0,315	73,26	28	0,064	14,80	21	0,048	11,10	0,004	0,85
18	0,597	0,440	73,70	48	0,109	18,27	21	0,048	7,99	0,000	0,03
19	0,852	0,600	70,42	60	0,136	16,01	45	0,102	12,00	0,013	1,57
20	0,852	0,620	72,77	62	0,141	16,54	40	0,091	10,67	0,000	0,02
21	1,396	0,990	70,92	94	0,214	15,30	65	0,148	10,58	0,045	3,20
22	1,075	0,710	66,05	88	0,200	18,60	65	0,148	13,74	0,017	1,61
23	1,174	0,825	70,27	97	0,220	18,78	53	0,120	10,26	0,008	0,69
24	1,796	1,283	71,44	125	0,284	15,82	82	0,186	10,38	0,043	2,37
25	1,474	1,022	69,34	112	0,255	17,27	78	0,177	12,03	0,020	1,37
Total	**23,071**	**16,269**	**70,52**	**1734**	**3,941**	**17,08**	**1121**	**2,548**	**11,04**	**0,313**	**1,36**

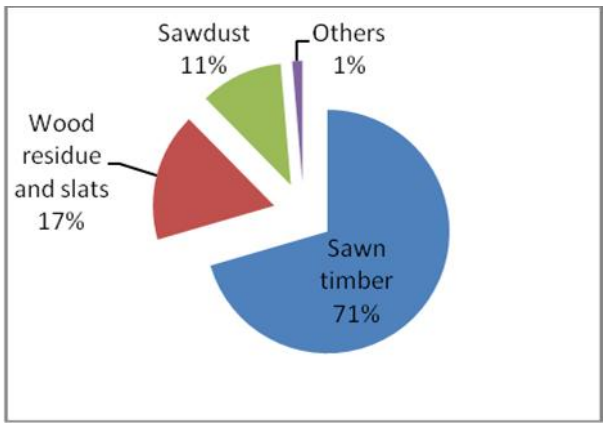

Figure 2. The percentage of sawn timber, wood residue and sawdust.

Conclusions

- According to the study we have these conclusions:
- In this region, the most sawn timber is pine tree with 41%,
- The most sawing trunks are 4m length,
- The widths of the boards are 20 and 25 cm,
- The thicknesses of boards are 25, 30 and 50 mm,

- The most requested prism sizes are 11x9 and 10x12,
- From 23.071 m^3 exploitation of sawn material is manufactured 16,269 m^3 or 70,52%.
- Wood residue is 17.08%.
- Sawdust is 11.04%,
- Others are about 1.36%.

Recommendation

- To increase the efficiency of sawn material it is recommended:
- To divide the trunks in diametric groups,
- To make sawing models and calculate maximum models for each diametric category for a better use.
- To take care for a better use of waste resulting during the sawing trunks (wood residue, slats, and sawdust), in order to be used for other products.
- To be careful of sawn timber quality in order to have a good quality and production efficiency.

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