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## Process analysis of sawmill timber transport in medium and small enterprises

Selected Aspects of Wood Delivery in the Polish Sawmill Industry

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**Abstract:** *Process analysis of sawmill timber transport in medium and small enterprises.*

The article analyses the process of large-scale road transport of softwood. Research conducted on medium and small enterprises resulted in the formulation of technical and operational indicators of the transport unit. The indicators enabled the determination of the transport organization efficiency. The researchers verified the influence of the size of processing enterprises and their raw material purchasing structure on the rationale of deliveries and costs related to their implementation.

*Keywords:* sawmill, supply of raw material, costs

### INTRODUCTION

The analysis of wood deliveries is characterised both by the concentration of resources understood as the forest cover in Poland and by considerable concentration of processing plants. The production of wood-based boards or the manufacturing process in paper mills needs to take place in large enterprises, whereas the sawmill market (about 7,300 companies according to estimates made by the Central Statistical Office in 2017) is characterised by the share of considerably dispersed small production plants [Ratajczak 2017].

This specific character of this branch of the wood industry is reflected by division into the types of transport. According to data of the Central Statistical Office (2017), the rate of rail transport in the total transport of wood and wood products is decreasing. It dropped from 3.2 million tonnes in 2004 to 1.1 million tonnes in 2011. On the other hand, the share of road transport of wood is systematically increasing. Between 2004 and 2013 it increased from 27.5 million tonnes to about 80 million tons, but it dropped to 66 million tons in 2016.

**Table 1.** The rail and road transport of wood and wood products between 2004 and 2016

Years		2004	2005	2006	2007	2008	2009	2010	2011	2013	2016
Rail transport	million km	1,023.2	1,312.7	1,312.8	1,442.5	566.9	360.1	446.5	351.9	501.2	460.9
	million tonnes	3.2	4.1	4.0	4.1	1.4	1.1	1.4	1.1	1.6	2.1
Road transport	million km	3,761	4,718	4,676	6,260	15,599	16,800	21,016	19,762	24,259	26,635
	million tonnes	27.5	33.5	31.8	37.9	51.3	49.9	64.3	63.7	79.9	65.9

Source: The authors' compilation based on yearbooks published the Central Statistical Office

The reception of wood by enterprises is the stage when the transport from the place of storage to the consignee is an additional element of logistic aspects of the company's activity, which is correlated with the lowest cost possible. The transport of raw material is specific and according to applicable legal regulations [Official Journal 2018 Pos. 36]), it is characterised by different aspects such as:

- seasonality, resulting from wood acquisition requirements,

- transport of loads with specific dimensions (maximum length and weight),
- loads with a variable form of transport,
- dispersion of places of reception and regionalisation within one purchase,
- fragmentation of the raw material purchase structure.

Wood transport services in Poland are mostly provided by transport companies or by wood companies which have their own fleet of cars. In general, road transport is the most common in the sawmill sector. The transport of raw material often generates a significant percentage of the company's costs. It is logistically connected with the rules ensuring the maintenance of appropriate inventory. The inventory level translates into production continuity. Many factors affect the range of deliveries. These are costs which are borne both by entrepreneurs and the State Forests Holding, which is responsible for organization [Lewaszkiewicz et al. 2012, Kurowski 2017]. Timely execution of production orders depends on the facilities for raw wood material. Therefore, it is necessary to apply adequate logistics to prepare wood for export and to have efficient procedures for raw material receptions and deliveries. In view of the cost of wood transport, it is risky to transport it over long distances [Jednoralski 2000, Sielwanowski 2008].

The research showed that it was possible to estimate the effective range of wood export in the companies under study, allowing for the specificity of processing, and to make organisational arrangements which were directly related to the delivery criteria.

The aim of the study was to indicate the structure of quantitative and value-related changes in the flow of raw wood material deliveries from the State Forests Holding. The researchers allowed for the type and form of wood and the costs included in the raw material as well as elements in the wood supply chain based on road transport. The scope of the research included the current state of knowledge on the management of raw material supplies in a selected part of Poland. The research allowed for solutions involving the use of cars for road deliveries. On the other hand, the analysis of costs and justifications for making decisions on the supply of wood from state forests were based solely on the cost index.

#### RESEARCH METHODOLOGY

The research was based on the analysis of the range of deliveries in sawmill enterprises. The range of raw wood deliveries was based on external means of road transport. This enabled both the definition of unit costs of transport and precise specification of the travelling distance to collect roundwood. The distribution of wood species also influences the range of deliveries and their rationality. The companies which mostly processed pinewood were verified in the research as it is the most common type of wood processed in sawmills. The location of the company is also an important factor affecting of the cost of raw material deliveries. Enterprises located in southwestern Poland have considerable wood resources in the form of trees for lumbering. Both the enterprises located in areas with considerable forest cover and those with lesser abundance of raw wood were included in the research so as to ensure the comparability of indicators. The enterprises which mostly process large-sized wood receive raw material in the form of logs. This form of wood is processed, depending on the technological development of enterprises. Large-size wood is classified as long wood, usually in the form of long logs (at least 9 m long) or medium-length logs (3-6 m). The size of wood affects the mechanisation of export of this raw material. Companies in Poland usually have portal agreements with the State Forests Holding and use them to purchase wood. Raw wood is acquired on the basis of species specificity in some of the seventeen Regional Directorates of the State Forests Holding.

Most enterprises do not have their own vehicles for wood transport. They cooperate with companies which have a fleet of vehicles to ensure wood delivery and processing continuity. The research covered transport areas related with the purchase of softwood, raw

pinewood being the predominant species. The maximum volume of wood transported ranged from 25 to 30m<sup>3</sup>, depending on the construction of the vehicle. The maximum permissible load of a transport vehicle is 40 tonnes. According to the conversion table for individual wood types provided in the Wood Density Regulation issued by the Minister of the Environment and the Minister of Economy on 2 May 2012, the raw pinewood density is 740 kg/m<sup>3</sup>.

The annual period of verified deliveries of raw material to enterprises was assumed as a full cycle of deliveries. The researchers decided to verify only the range of transport referring to domestic deliveries of wood to companies, without possible individual wood sawing orders. Small and medium enterprises which processed 10,000-30,000 m<sup>3</sup> of wood in 2016 were analysed. The volume of wood transported, the travelling distance and the costs of transport were determined in the study. The following indicators of the transport process were determined upon the research results [Kubiak 1990, Official Journal of 17 May 2012, Official Journal of 25 January 2018, Pos. 36]:

- the size and structure of the type of wood purchased by enterprises,
- the number of wood suppliers and their location,
- the average transport distance for wood to be delivered to an enterprise,
- the average cost of wood delivery to an enterprise,
- the influence of variation in the wood transport distance on the unit cost of wood delivery.

The verification of the transport distance to deliver raw material and the costs of its transport enabled the calculation of unit costs of purchasing raw materials for individual deliveries in the enterprises. The percentage of wood volume referring to specific transport distances was calculated.

The average distance for transport of selected type of pinewood to individual enterprises was calculated as the ratio between the transport distance and the volume of wood transported.

#### RESEARCH RESULTS

Table 1 lists the data obtained in the research on pinewood deliveries to sawmills. As can be seen, the amount of deliveries involving transport over a distance of 60 km was higher than average – it amounted to 78% of all deliveries. In some of the enterprises the average transport distance was 65 km – it amounted to 38% of the total transport distance.



Figure 1. The share of the wood volume vs the transport distance

The measurements of deliveries shown in Fig. 1 enabled the calculation of value-related indicators shown in Fig. 2. The dependence between the raw material purchase cost and the transport distance was characterised by high variability. The largest share of the raw

material purchase costs within the range of 85% refers to a distance up to 60 km. The share of the roundwood purchase cost decreased significantly in the other transport distance intervals. There was a slight increase in deliveries over a distance of 81-150 km.

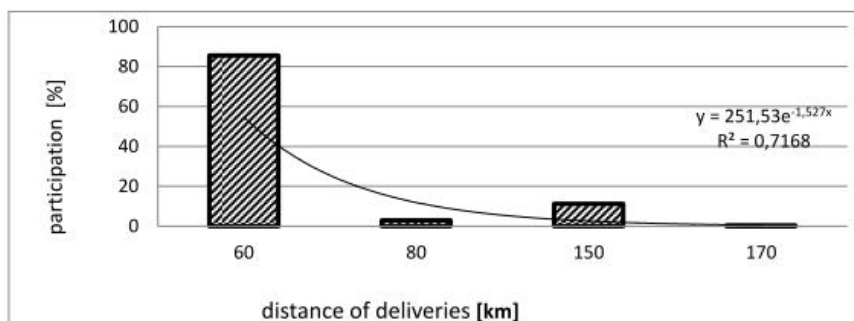


Figure 2. The share of the total raw material costs in the transport distance

Fig. 3. shows detailed measurements of the structure of the unit cost of deliveries with division into transport distance intervals up to 60km, 61-80 km, 81-150 km and 151-170 km in actual transport cycles. Between 2016 and 2017 the actual net cost of transport ranged from 15 to 28 zlotys per m<sup>3</sup> of wood transported. It dominated in the interval of 61-80 km and reached the maximum cost per one m<sup>3</sup> of pine wood transported.

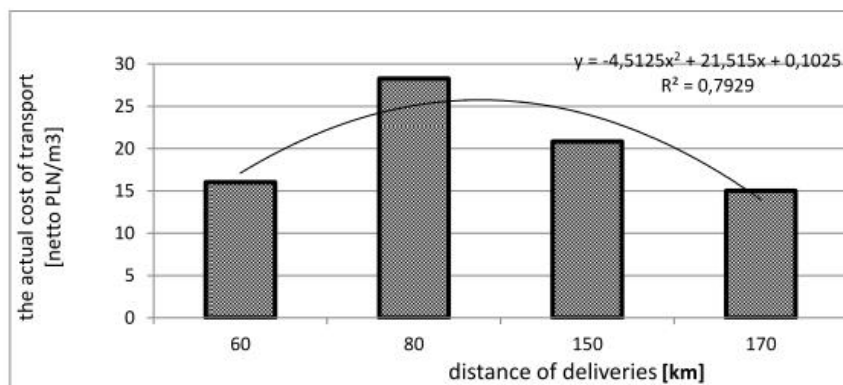


Figure 3. The actual net cost of transport of 1 m<sup>3</sup> of pine wood in the enterprises under study

The percentage share of individual deliveries in the study indicates that the enterprises tried to acquire sawmill wood within the minimum range of transport distance. The diagrams clearly show that the highest costs in this cycle were generated within the transport distance of 61-80 km, which amounted to nearly 40% of the distance in the total transport cycle. The transport distance in the cycle under study was limited to 170 km. The cost of the raw material dropped noticeably as the distance of wood deliveries increased. It was reflected by the purchasing policy, where it accounted for nearly 35% of the cycle.

## CONCLUSIONS

The analyses of the results of the research on the wood transport process led to the following conclusions:

1. The average distance required to deliver raw pinewood to sawmills was 65 km. It indicated good use of available resources. According to the current data, the maximum distance assumed for the transport of softwood to sawmills was 170 km. The distance in more than a half of the cycles under study was close to average. It shows that the organisation of deliveries to sawmills was good.
2. The coefficient of the share of raw material costs was largely related to the enterprise location and transport costs. The amount of planned costs of transport is affected by the distance from the location of raw material resources. Difficult conditions resulting from the frequent diversification of round wood suppliers and the specific character of wood transport cause the need to search for a compromise ensuring both successive deliveries and limiting the cumulative costs of raw material and transport.
3. The level of raw material costs generated in relation to the transport distance up to 60 km amounted to over 80%. During the period under study the low value of deliveries made over longer distances was caused by an increase in the costs of transport and sustainable raw materials.
4. The average net cost of transport of one m<sup>3</sup> of wood was 20 zlotys. As the export distance increased up to 80 km, the net cost of transport reached an average value of 28 zlotys per m<sup>3</sup> of wood. Sawmills were usually located in regions with considerable forest cover. However, wood was transported over long distances to ensure sufficient amounts of raw material and to maintain production continuity.
5. The cost of loading and unloading in relation to the transport distance also had considerable influence on the cost of wood deliveries. The form of wood: the length of logs and wood concentration had considerable influence on the duration of this activity and the cost of loading and unloading.
6. The efficiency of stacked wood export depends on adequate logistics. The organisation of wood reception by the State Forests Holding is of key importance. The condition of forest roads, the quality of raw material, storage places and their dispersion are the main factors affecting this efficiency. On the other hand, the availability and good technical condition of adequate equipment as well as its operators' experience are responsibilities of the wood industry.

The research enabled analysis of stacked wood delivery costs. The results enabled assessment of pinewood transport in sawmills. The research showed that it was rational to transport pinewood to sawmill enterprises up to a distance of 60 km, where the maximum distance should not exceed 200 km. Softwood can also be transported at longer distances but it is not cost-effective due to the considerable increase in the costs of transport. Sawmill enterprises rarely have their own fleet of vehicles because it is necessary to maintain and repair them regularly.

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