

## Transport as a Factor in the Location Selection Process of Timber Firms

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**Abstract:** The article *Transport as a Factor in the Location Selection Process of Timber Firms* examines the important role of transport in the location process of timber firms. The authors emphasise that the efficiency of transport infrastructure and sustainable transport practices are crucial to the success of companies in this industry. The article also raises the issue of access to both domestic and international markets as an important factor influencing the location process of wood businesses. The conclusions presented highlight the importance of including transport aspects in the location analysis and point to the need to support the development of transport infrastructure in order to further develop the industry.

*Keywords:* timber transportation, location of production facilities, location factors

### INTRODUCTION

In today's world of rapidly developing technologies - IT automation, robotics and the market for various types of plastics - wood still remains an extremely important and necessary raw material. As you can read on the website of the Polish State Forests:

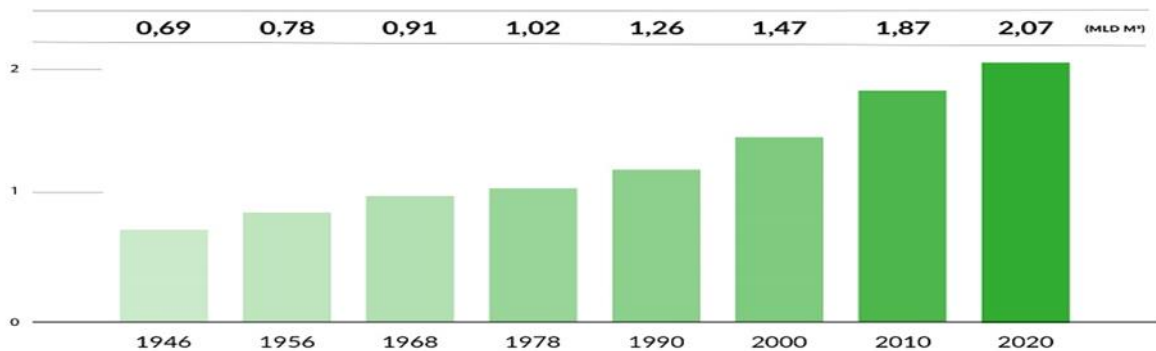
The timber industry still plays a very important role in the economy of the countries concerned. The extent of this role depends, of course, on the natural conditions of the region - climatic conditions, degree of afforestation, etc., but wood is a very commonly used building material, which has advantages such as ease of harvesting (reproducibility), physical properties and - as has been highlighted in recent years in particular - environmental friendliness. As you can read on the aforementioned website of the State Forests, in the last two decades the consumption of wood in our country has increased two and a half times. For example, in 1990, a Pole consumed on average the equivalent of 0.4 m<sup>3</sup> of roundwood per year, while today it is more than 1 m<sup>3</sup>. An analogous situation was previously observed in other European countries (e.g. a contemporary German consumes on average 1.7 m<sup>3</sup> of wood per year, the Czech Republic almost 1.5 m<sup>3</sup>, and Italy 1.1 m<sup>3</sup>).

The main supplier of the discussed raw material in Poland is the State Forests (90% of resources), which, taking advantage of the fact that timber resources have significantly increased over the last half-century (Fig. 1), have gradually increased their sales over subsequent decades. Although this trend was somewhat halted in 2018 - 2022 (the phenomenon in question is illustrated in Fig. 2), the volume of raw material sold still makes the wood industry in Poland grow

Poland is the sixth largest producer and third largest exporter of furniture in the world. The value of furniture production in 2018 exceeded PLN 49 billion and the value of exports approached PLN 47 billion annually. A measure of the key role of the forest and wood sector in the Polish economy is that it generates around 2 per cent of GDP. Not only does it provide work for hundreds of thousands of people, it is also an engine for investment and the development of innovative technologies. Since the beginning of the transformation, it has also attracted foreign capital worth more than PLN 30 billion.



**Figure 1: TIMBER SALES BY STATE FORESTS.** Thanks to increasing abundance, the State Forests are able to harvest and sell more timber, without worrying about the sustainability of the forests.  
Source: <https://www.lasy.gov.pl/pl/drewno/skad-sie-bierze-drewno>



**Figure 2: TIMBER RESOURCES IN STATE FORESTS** Increase in resources, that is, the amount of timber present in the forests, means that there are more and bigger trees.  
Source: <https://www.lasy.gov.pl/pl/drewno/skad-sie-bierze-drewno>

## MATERIAL AND METHODS

The methodology of the work consisted in a systematic search and analysis of available sources of information in order to gain a fuller understanding of a given topic. The key element of the research process was the selection, critical analysis and synthesis of information from various sources in order to draw conclusions and summarize knowledge on a given topic.

The aim of the work was an attempt to conduct a comprehensive analysis of the role of transport in decisions regarding the location of enterprises related to the processing of wood raw materials and the production of wood industry products. The study aimed to understand how transport-related factors such as transport infrastructure availability, logistics costs, sustainable transport practices and access to markets influence the location selection process by companies in this industry. By analyzing these aspects, the work was aimed at providing guidelines and recommendations that can support effective location decisions and contribute to the sustainable development of wood industry enterprises.

## RESULTS

### **The influence of transport on location decisions in the timber industry**

Transport plays an important role in location decisions in the timber industry. It affects many aspects such as access to raw materials, production costs, logistical efficiency and environmental sustainability.

The first important factor is access to wood raw materials. Businesses in the timber industry, such as sawmills or wood processing plants, need to be located in areas where there is sufficient access to adequate wood quality. This means that the location must be convenient in terms of transporting wood from the forest to the processing plant. Where timber transport is costly or difficult due to distance or inadequate road infrastructure, companies may have to locate closer to timber resource areas, which affects location decisions (Ballou, 2004)

Another aspect is the cost of transport. The timber industry is often dependent on road transport for both the delivery of raw materials and the distribution of products. Transport costs, such as fuel, road tolls or drivers' wages, can be a significant component of production costs. Therefore, companies may choose locations where transport costs are lower, for example near good quality roads, ports or other important transport hubs.

Logistical efficiency is another aspect that influences location decisions in the timber industry. The optimal location of a production plant can enable efficient supply chain management, minimising transport time and costs. Locating the plant in a place where there is easy access to customers, suppliers, as well as transport services, can allow for better logistical organisation and increase the competitiveness of the company in the market (Coyle and Bardi, 2002).

Finally, environmental sustainability is an increasingly important factor influencing location decisions in the timber industry. Companies need to take into account environmental aspects such as CO<sub>2</sub> emissions, energy consumption or waste generation. Locating a plant in a place where negative environmental impacts related to transport are minimised, such as proximity to timber resource areas or the possibility to use more sustainable modes of transport, for example rail or waterways, can be a key factor in location decisions (Matulewski et al., 2008).

In summary, transport has a significant impact on location decisions in the timber industry. Access to wood raw materials, transport costs, logistical efficiency and environmental sustainability are all important factors for companies to consider when selecting the location of their plants. Optimal location can contribute to efficient supply chain management, minimised production costs, environmental protection and increased competitiveness in the wood industry market.

### **Analysis of transport accessibility for wood businesses**

As mentioned in the introduction, transport plays an important role in the process of locating timber enterprises, as it is an industry that usually operates with forest resources located in different parts of the country. Some of the key factors influencing the location decisions of timber enterprises are (Fertsh, 2006):

1. availability of forest resources - timber enterprises need access to forest resources in order to harvest timber and other forest raw materials. It is therefore important that they are located near areas with sufficient forest resources,

2. transport infrastructure - transport is crucial for the timber industry, as forest raw materials need to be transported from the forest to processing plants and finished products need to be delivered to customers. It is therefore important for companies to be located in a place where adequate transport infrastructure such as roads, rail network, ports or airports are available, which is also related to another aspect covered in the following section,

3. transport costs - these can significantly affect a company's profitability. Thus, if the company is located in the right place, e.g. close to the sourcing of raw materials or distribution warehouses, transport costs will be lower. It is also important to use efficient transport strategies, such as multimodal transport and the use of return loads,

4. availability of labour - the timber industry typically employs a large number of workers, including forestry workers, machine operators, drivers and processing workers. This

also has an impact on the location of the business, as if a business locates in an area where adequate labour is available, it will be easier to ensure adequate production and service.

5. Policies and regulations - these factors can also have a significant impact on the location of enterprises, because if, for example, a particular country or region has appropriate laws and regulations to facilitate business activity, then undoubtedly entrepreneurs will choose those countries or regions (Dembińska-Cyran and Gubała, 2003).

The following factors are worth considering in an accessibility analysis (Fertsh, 2006):

1. accessibility of transport routes - timber companies should carefully examine whether roads leading to forestry, sawmills and other production sites are in good condition and allow for safe and efficient transport of goods,

2. availability of means of transport: the same companies should also assess whether they have easy access to different means of transport, such as trucks, trains, ships and planes. If there are difficulties in accessing them, there is a risk of, for example, delays in production or delivery or additional transport costs,

3. port and terminal infrastructure: the woodworking industry often uses maritime transport and it is therefore worth examining whether the ports and terminals used by the company are adequately equipped for the rapid and safe loading and unloading of goods,

4. availability of logistic services: timber companies should also carefully examine whether there are logistic companies in their region that are able to provide adequate transport and warehousing services,

5. climatic and geographical conditions: companies in the sector should also take into account difficult climatic and geographical conditions in their analysis of transport accessibility, which can affect transport costs and delivery times (Deng et al., 2013)

According to another classification, the factors shaping transport accessibility are:

1. the transport network (e.g. road, rail);
2. transport nodal points (e.g. airports, distribution and logistics points).

In a further classification, the factors discussed can also be divided into:

1. spatial - spatial transport accessibility is based on the transport development of an area and its provision of transport infrastructure - linear and points. The level of transport accessibility is determined by the number of transport points and the density of the transport road network,

2. temporal - temporal accessibility depends on the actual time of travel to a given location, which in turn depends on both the density of the transport network (linear, point) and its quality (e.g. speed of the means of transport, time of passenger service),

3. economic - economic transport accessibility is shaped by the price level of transport services. Thus, it depends on the purchasing power of the population living in a given area and on the type of transport needs reported,

4. informational - informational accessibility is based on the possibility to obtain information on the transport services provided in a given area and on the characteristics of the service (such as price, timetable or duration of travel, etc.).

Nowadays, the role of information and information systems is increasingly emphasised, but in the case of the wood industry they are not as important as in other fields of logistics (Witkowski, 2015)

**Table 3** Industry location factors

Natural factors	Non-natural factors: techno-economic	Non-natural factors: socio-political
raw material base energy base access to water environmental quality and environmental barriers	technical infrastructure outlet benefits of agglomeration workforce scientific and technical facilities	state policy social factors strategic factors

Source: own elaboration

In conclusion, it should be stated that the analysis of transport availability for wood enterprises is important in order to plan the business strategy accordingly, as well as to minimise the costs of transport and storage of wood raw materials and wood products.

**Transport costs in the timber industry**

Transport costs in the timber industry depend on several factors, such as the distance between the place of cultivation (plantation) and the place of processing, the type and quantity of timber transported and the type of means of transport used.

The main cost is the fuel surcharge, which can cover up to 50% of the total transport costs. Vehicle operating costs - depreciation, insurance, repairs and maintenance - are also significant.

Transport costs can also depend on the type of timber being transported. That which is heavy and large undoubtedly requires larger - and thus more expensive - vehicles and special (also expensive) loading and unloading equipment (COM, 2011).

Another factor is the distance between the logging site and the processing site. There is a simple relationship here: the longer the route, the higher the transport costs, but in addition to this, attention must also be paid to road quality and terrain, which is very important in the timber industry, as transport is often used in areas where access may be difficult due to location (forests, mountains, sodden ground, etc.). There are also generally no high quality roads in such areas. All of the above-mentioned factors undoubtedly increase costs, affecting, among other things, increased fuel consumption, higher vehicle operating loads, slower transport, etc. (Ficoń K. 2001)

The last important element is the choice of transport mode. The most common mode of transport used in the timber industry is by road, but in some cases it may be cheaper and more efficient to use rail or water.

In summary, transport costs in the timber industry are a complex issue, depending on many factors.

**Transport and logistics in the raw material supply of the wood industry**

From the issues described in the previous section, it can be concluded that more than one factor usually determines the location. In the case of the timber industry, these will mainly be the raw material base (in this case: transport of forest resources, which may not be profitable due to the high weight of the raw material, which is why some plants are located in the area of its occurrence and extraction), technical infrastructure (mainly equipping the area with a communication network, such as roads, railways), strategic factors (e.g. legal regulations, creation of economic zones, application of tax concessions, limiting or abolishing duties, subsidising domestic production) and social factors (fashion, traditions,

financial possibilities of the inhabitants generate demand for certain goods. The influence of social organisations - e.g. environmental organisations - can be important).

For the efficient delivery of raw materials and shipping of manufactured goods, wood processing plants are located close to road, rail or river/sea transport. The latter two provide high loading capacity and relatively low costs for transporting raw materials and can be used bi-directionally - also for the distribution of goods, especially when the goods are large or bulk. When discussing transport issues in the timber industry, it is important to start with the haulage of timber from the forest. It can be mechanical (e.g. using cars or narrow-gauge railways), water, rail, horse (occurs over short distances and in difficult terrain or when transporting firewood) and - much less frequently - overhead.

The most common form of transport in question is by road, which uses semi-trailers and trailers with a system of steel stanchions (sliding or removable) to support and secure the material (these vehicles may additionally have a floor). These platforms have special hooks for strapping down the load, and climbing onto the trailer is facilitated by a three-step ladder. In turn, a steel beam is used to pull the trailer out in difficult conditions.

Another form is rail transport. Long timber is transported using platform stanchion wagons (Roos) or open wagons, or coal wagons (for transporting short timber bales). In rail transport, either the goods are transshipped onto trucks (usually) or the goods travel directly by rail to their destination.

Over longer distances, timber is transported by ship and barge. The most common types of wood transported in this way are plywood, boards, coppice (round logs) and pulpwood (used to make cellulose) and sawn timber (planks, logs, strips, laths, edges, beams). The means of transport used for this purpose - so-called timber carriers - have appropriately designed holds and large hatches to allow them to be loaded. As timber is relatively light, part of the cargo is placed in the hold of the vessel and part on deck (usually along the side of the vessel). As a rule of thumb, heavy and damp timber is stored below and light and dried timber higher up. A popular method of so-called timber stowage is to secure bundles of timber with chain ties or by using clamps and chains to secure round timber to the deck or chassis. Large logs, on the other hand, are transported in the holds of so-called general cargo ships below their decks.

Some timber products are sensitive to moisture and susceptible to damage, so special care and diligence must be taken when transporting them. Such cargo is usually transported in parcels or bundled units.

Related to the above issues is the question of how to load, the consequence of which will be safe transport. In such loading, the following equipment plays the most important role:

1. a forestry trailer crane (essential for efficient loading),
2. rotator (attached to the crane, allows the grapple to turn freely),
3. hoists (help with both the loading itself and during transport).

Thus, the transport of timber and wood products is usually carried out by various means of transport, such as trucks, trains, ships and planes. The choice of the appropriate means of transport depends on a number of factors, such as the distance between the production site and the reception site, the amount of goods to be transported, their weight and dimensions, as well as road and weather conditions.

The timber industry also often uses intermodal transport, which involves transporting goods by different modes of transport, such as containers, making more efficient use of sea and rail transport.

Storage and warehousing of raw materials and products is also an important part of logistics in the wood industry. Warehouses should be well protected against moisture and other atmospheric factors, and equipped with appropriate facilities for loading and unloading goods. Transport and logistics costs are a significant component of production costs in the timber industry, so companies often employ various strategies to minimise them. Examples include

developing distribution networks in key markets and using modern information technology to manage transport and storage of goods.

The specificity of wood logistics is also reflected in the terminology used here. Its most important concepts are:

**Just In Time (JIT)** - this term means like just-in-time delivery, or more precisely one of the techniques that is used in management by quality. It involves supplying as much of the materials necessary to produce products or services as the company needs and in the time required. Thanks to this technique, the company can reduce inventories to the minimum possible, optimise delivery times and also reduce the costs of the production process,

**kW** - this abbreviation stands, of course, for kilowatts and is a term used primarily to indicate the power of internal combustion engines. However, it is often used for cars in logistics and to indicate the power of equipment in the timber industry,

**Delivered Duty Unpaid (DDU)** - literally translated, this means "duty unpaid", and in timber industry logistics it is a delivery formula for goods for which the seller takes responsibility (insurance and risk of damage or loss). The role of the buyer is to take care of customs and border duties and to unload the purchased goods (DDU therefore differs from another formula used in transport - DDP, or Delivered Duty Paid, responsibility and payment for customs issues),

**Delivered At Place (DAP)** this term literally means 'delivery at place' and is related to Incoterms 2010, one of the International Trade Rules. It refers to the sellers' obligation to deliver the goods ordered by the recipient to the designated place. DAP excludes the obligation to unload the goods, which is already the responsibility of the buyer himself,

**LOCO** - this term is Latin for "place" and expresses a formula whereby the seller delivers the goods to the carrier, and the carrier is substituted by the buyer at the appointed place at the appointed time - usually the seller's warehouse,

**IPPC** - is a certificate awarded to manufacturers of wooden pallets. It is a document which confirms that the technical and organisational conditions of heat treatment of the wood from which the batch was made comply with the sanitary requirements of the European Union. Buyers of IPPC-certified pallets can be sure that technology complying with the required standards was used in their production (e.g. that, in addition, bark-free wood was used in their production, that the equipment which took part in the process of drying the wood kept the humidity in the wood to twenty per cent, that during the drying process itself a temperature of at least fifty-six degrees Celsius was achieved, and that the heating did not last longer than half an hour),

**Knocked Down (KD)** From the English language, these terms can be translated as "to haggle, lower, lower" - for example prices.

**Hors Taxes (HT)** - literally from English means 'on taxes' and applies to all businesses - including, of course, transport and logistics. The rules are regulated in Chapter 3 of Section V of the Value Added Tax Act of 11 March 2004. The scope of logistics services includes numerous smaller services that could - otherwise - be taxed on their own. These are, for example, forwarding services, transport services or warehousing services.

### **Environmental aspects of transport in the timber industry**

Transport in the timber industry has a major impact on the environment. One of the main problems associated with this form of activity is the emission of greenhouse gases such as carbon dioxide, nitrogen oxides and dust. These emissions come mainly from the vehicles used to transport the wood, but also from its storage and processing.

The following are environmental aspects of transport in the timber industry that are worth considering:

- reducing CO2 emissions by using alternative energy sources: timber companies should consider introducing vehicles powered by electricity, hydrogen or biofuels. These alternative energy sources reduce CO2 emissions and other pollutants,
- optimising transport routes: routes should be planned in such a way as to minimise transport distance and time and reduce greenhouse gas emissions,
- implementing recycling and material recovery programmes: recycling and material recovery reduce waste, as well as the emissions of the gases already mentioned,
- use of maritime transport: this is one of the most environmentally friendly ways of transporting goods, so timber companies should consider using it,
- investment in rail transport: this type of transport is certainly more environmentally friendly than road transport and therefore worthy of investment in the industry. It is also worth noting that it allows for the movement of goods on a much larger scale (similar to sea transport) than that by car. This also reduces the environmental impact.

So, timber companies should act in an environmentally sustainable way, incorporating the ecological aspects of transport into their business strategy. Implementation of alternative energy sources, optimisation of transport routes, implementation of recycling and material recovery programmes, use of sea and rail transport are good ways to reduce the negative environmental impact of this form of business.

### **Transport infrastructure as a factor in attracting investment in the wood industry**

Transport infrastructure is a very important factor in attracting investment in the timber industry. Investors look for locations where they have easy access to wood raw materials and markets for their products, and the right infrastructure then allows for faster and more efficient transport of goods, which in turn affects a company's competitiveness and attractiveness as an investment.

The following summary covers the main elements of transport infrastructure that are important for attracting investment in the timber industry:

- roads and motorways: accessibility is crucial for the timber industry, as the transport of timber and processed products is mostly done by road. The right road infrastructure allows for faster and more efficient transport, which in turn affects the competitiveness of the business,
- seaports: these allow easy export of wood products to foreign markets, which is very important for the industry. Their accessibility allows for faster transport, which is an advantage already highlighted many times in this work,
- rail: this is one of the most efficient ways of transporting timber. Like the maritime transport outlined above, it allows cargo to be moved to foreign markets. It also allows for a large scale of this transport, which significantly speeds up delivery, reduces costs and is more environmentally friendly,
- warehouses and depots: it is important to have warehouses and depots in the vicinity of the wood business where wood raw materials and processed products can be stored. The availability of such locations optimises the logistics process and influences the competitiveness of the enterprise,

As far as the transport infrastructure in Poland is concerned, it is dominated by roads and motorways, with a total length of 429816 km. In turn, the railways in operation cover 19326 km and the inland waterways 3768 km (Fig. 3)

As far as marine terminals are concerned, it should be noted that the length of transshipment wharves at marine terminals in 2021 totalled 5.5 km, of which 85.2% were wharves for handling



cargo units. The parking and manoeuvring area occupied 6.1 ha and the total storage area of the terminals - 183.0 ha, of which 80.4% of the area was for containerised units. The capacity of the storage yards was 100,700 TEUs. The maritime terminals had a total of 17 km of normal-gauge rail track, of which 70.8% was dedicated directly to the loading or unloading of intermodal units. The average yard length (number of wagons) handled simultaneously at a marine terminal was 71 units. On the other hand, the parking and manoeuvring area of the inland terminals covered a total of 24.9 ha and the total storage area of the terminals was 96.5 ha, 82.7% of which was dedicated to containerised units. The capacity of the storage yards amounted to 133,400 TEUs. They had a total of 83.2 km of normal-gauge rail track, of which 41.7% was dedicated directly to the loading/unloading of intermodal units. The average train length (number of wagons) handled simultaneously at the overland terminal was 31 units.

According to the 2021 data, there are 39 active terminals in Poland, whose activities are distributed as follows: (shown in figure 4)

- 4 handle sea-rail, sea-road shipments (marine terminals),
- 35 handle rail-road shipments (land terminals).

09.02.2021



**Figure 3.** Transport network of Poland (as at 09.02.2021)



**Figure 4.:** Distribution of intermodal terminals in 2021

Source: Intermodal transport in Poland. Signal information

**Table 5** Handling equipment at intermodal terminals in 2021.

Specification	Marine Terminals	Land terminals
	In pieces	
cranes	109	13
wharf	28	–
Container gates	5	9
Container roadway	76	4
Mobile and offshore cranes	7	2
Carts	27	123
Front booms	18	90
Other wagons	9	33
Tech tractors	163	8
Low-semi trailers (rolltrailer)	55	–
The remaining	46	1

Source: Intermodal transport in Poland. Signal information

The total annual handling capacity of the intermodal transport terminals was 8.1 million TEU and was distributed as follows:

1. marine terminals - 4.9 million TEU,
2. and at in land terminals - 3.2 million TEU.

31.1 million tonnes were transported to and from terminals by sea (accounting for 37.9% of the total cargo handled at sea and land terminals), 26.4 million tonnes (32.2%) by road and

24.6 million tonnes (29.9%) by rail.

In 2021, intermodal road transport carried more than 26 million tonnes of containerised cargo. The share of domestic transport amounted to 98.7%, with most cargo transported to and from the provinces of Łódź (24.6%), Pomerania (18.1%) and Silesia (15.3%).

On the other hand, in 2021, domestic freight transport by rail averaged 193 km, with almost 53% of freight transported up to 150 km. This placed Polish transport in second place among the 27 EU countries behind Germany and ahead of France

In conclusion, it should be noted that most of the data given in this subsection relates to transport infrastructure in Poland in general, but this is also the infrastructure serving transport in the timber industry. This infrastructure is of key importance for attracting investment in the industry in question and is still at an unsatisfactory level for entrepreneurs. It is known, after all, that the availability of roads and motorways, seaports, railways and warehouses and depots allows for faster and more efficient transport of goods, which in turn affects the competitiveness of the enterprise and its attractiveness as an investment. (Woźniak H. 1993)

### **Logistics and organisation of transport within woodworking companies**

A properly organised intra-enterprise transport process allows for a faster and more efficient flow of wood raw materials and processed products, thus reducing delivery times and minimising costs.

The most important aspects to take into account when organising intra-enterprise transport in the wood industry are :

1. transport route planning: it is important to always plan the transport route taking into account the most efficient and shortest routes. It is also important to take into account road constraints such as weight restrictions, height restrictions, etc,

2. appropriate choice of means of transport: an appropriate means of transport should be chosen depending on the type and volume of goods to be transported. For the transport of larger quantities of timber, trucks are most often used, while vans can be used for smaller quantities,

3. organisation of the loading and unloading process: this process must be well organised so that the stopping time of the vehicles is kept to a minimum. Appropriate machinery and tools such as loaders, cranes, forklifts etc. can be used for this purpose,

4. Transport scheduling: transport should always be planned in advance and take into account the production schedule and customer requirements. This avoids delays and ensures on-time delivery,

5. supervision of the transport process: it is important that such supervision is carried out by a suitably qualified person. Fuel consumption and transport-related costs should also be monitored so that the process can be optimised and costs minimised.

The organisation of transport within a woodworking company is therefore crucial to ensure the efficiency and competitiveness of the business. Elements such as proper planning of the transport route, selection of means of transport, organisation of the loading and unloading process, planning of the transport schedule and supervision of the transport process are key factors influencing the efficiency and costs of intra-company transport in the industry.

### **Innovations in the transport sector of the wood industry**

Innovations are constantly emerging in the transport sector of the timber industry in order to improve transport efficiency and safety, as well as to reduce the negative impact on the environment. Some of such innovations - the most relevant to the interests of the industry in question - are outlined below (Elliason and Proost, 2015):

1. the use of GPS and IoT (Internet of Things) technologies - these allow vehicles to be tracked, as well as monitoring their fuel consumption and condition. This allows timber

companies to better plan the transport route, minimising costs and delivery times and controlling the correct route,

2. use of electric vehicles - these vehicles are becoming increasingly popular in transport, so they will probably also appear in the timber industry due to their lower environmental impact. This will also enable companies to avoid costs associated with the purchase and operation of fuel (Wiesenthal, 2015),

3. use of IT solutions - more and more transport and logistics management applications and software are being used in the timber industry. These enable companies to better plan transport routes, control stock levels and monitor fuel consumption (Lakshmann and Anderson, 2015),

4. use of eco-friendly materials - biodegradable materials are increasingly being used in the production of packaging and pallets, thus reducing the environmental impact of the timber industry.

These innovations allow timber companies to increase efficiency and improve transport safety, as well as reduce their environmental impact. However, in order to fully exploit the potential of these innovations, companies need to invest in appropriate training for their employees and adapt their processes and procedures to the new developments.

### **Transport policy and regulations in the timber industry**

In Poland, the timber industry is subject to various transport regulations and legislation, the most important of which are:

- The Public Roads Act, which defines the rules for the use of public roads, including standards for loads carried by vehicles,

- The Road Transport Act, which regulates road transport regulations, including the requirements for obtaining a licence to transport passengers and goods,

- Regulation of the Minister of Infrastructure and Construction of 12 January 2016 on the technical conditions of vehicles and the scope of their necessary equipment defining the technical requirements for vehicles that transport timber,

- Order of the Minister of the Environment of 17 November 2014 on the conditions to be met when generating waste from forestry activities defining the rules for handling waste from forestry activities, including wood waste,

- Regulation of the Minister of the Environment of 1 April 2014 on the conditions to be met when generating industrial waste and how to deal with it concerning the handling of waste generated in the process of wood production and wood processing,

- DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (EU) 2020/1057 of 15 July 2020 laying down specific provisions with regard to Directive 96/71/EC and Directive 2014/67/EU concerning the posting of drivers in the road transport sector and amending Directive 2006/22/EC as regards enforcement requirements and Regulation (EU) No 1024/2012

In addition, there are also regulations in Poland concerning the transport of timber during the protection period and requirements for the transport of timber abroad.

In general, under Polish law there are two categories of timber cargo - logs and sawn timber. The transport of logs, i.e. round timber, requires both specialised equipment and qualified professionals. This is due to laws that require the carrier to, among other things:

1. to rest the load against a headboard or similar barrier,
2. use of chain or webbing lashings,
3. tensioning the lashings by means of a tensioning device,
4. Checking the cargo and lashings before driving on public roads,
5. Regularly inspect the load and lashings during transport.

It is also forbidden to transport timber stacked transversely against the headboard and

rear bracket. Timber should be a maximum of 2.55 m long and in the longitudinal direction must be sectioned by means of rigid baffles or stanchions. Each load must also be secured at the top with at least two web lashings.

When timber is transported longitudinally, the outer logs must either be supported by at least two stanchions (with a minimum of 30 cm overhang) or be secured with chains to prevent them being pulled apart. Any piece shorter than the distance between two stanchions must be placed in the middle of the load, and the axis of any log must not be higher than a stanchion, but the top middle piece of timber should be placed higher than the outermost pieces.

Still another category is the carriage of a longitudinally stacked load by means of a combination of vehicles with a headboard in the vehicle pulling each section. It will then be necessary to use:

1. one top-over lashing if the timber is unbarked and the length does not exceed 3.3 metres,
2. Two top-over lashings if the timber is debarked or exceeds 3.3 m in length.

In contrast, the rules for transporting sawn timber should undoubtedly be easier for traders to understand and enforce. Sawn timber is produced by sawing on saws and takes the form of battens, boards, logs, slats, beams or bevels. Consequently, it is possible to transport it in standardised packages that comply with ISO 4472 and related standards. They include, among others:

1. timber supports under the complete load,
2. a strap around the complete cargo,
3. cover around the complete load,
4. wood protector,
5. corner protector.

The lumber bundles are usually tied with straps or wire at both ends and transported on flat platforms equipped with central stanchions or side walls, using top-over webbing lashings. For safety reasons, the transport of timber is therefore governed by a number of restrictive regulations. It is not only safety that is a source of regulation here, but also climate policy issues or international transport regulations. In order to comply with these requirements, an entrepreneur needs above all up-to-date data, the right equipment and qualified employees. This will allow to perform activities in accordance with the applicable legal standards, but will undoubtedly also increase costs (as mentioned in an earlier section on costs).

### **Managing reverse logistics in the wood industry.a**

The aim of reverse logistics (reverse logistics) is to create added value from the management of waste generated at each stage of the value creation chain value creation chain. Tasks are therefore carried out within reverse supply chains, where different actors are involved than in traditional chains and different activities are carried out (Szołtysek, 2009; Carrus et al., 2015).

Thus, reverse logistics management in the timber industry involves processes and systems that allow for the efficient collection, transport and processing of waste from forestry operations, such as branches, bark, sawdust and other wood waste. A few key aspects of these processes are:

1. planning and coordination - planning the transport of wood waste requires coordination between the various actors in the supply chain, including foresters, transport companies and processing plants. It is also important to ensure that adequate resources and equipment, such as transport vehicles and waste processing machinery, are available,
2. processing technologies - processing wood waste can be expensive and requires specialised machinery. Therefore, it becomes necessary to use the latest technologies and equipment that allow for efficient processing and recovery of valuable raw materials,

3. tracking and monitoring - this will ensure that waste is collected and transported in accordance with environmental requirements. Using technology such as GPS systems and telematics, vehicle movements and waste flows can be tracked,

4. treatment for energy purposes - wood waste can be used to produce electricity, heat or biofuels, thus reducing greenhouse gas emissions and reducing the consumption of electricity from traditional sources. It is important to ensure that appropriate facilities and technologies are in place to process waste for energy purposes,

5. cooperation with external parties - in the wood industry there are many opportunities for such cooperation - e.g. with recycling companies and processing plants. These collaborations can contribute to better waste utilisation and improved transport efficiency (Dobrowolska, 2017).

The benefits of reverse logistics are defined as follows (Szoltysek, 2009):

- cost reduction - reuse of materials and management of packaging returnable can provide revenues that stimulate new initiatives and efforts in developing and improving reverse logistics processes. In some industries, such as the aluminium industry, where valuable raw materials are the subject of returns, processing costs are significantly lower than, for example, re-manufacturing a product from bauxite (the industry's primary raw material).
- Environmental impact - raising awareness of environmental protection is not a temporary trend. This factor results in a long-term reorientation of production and consumption towards sustainability. In this context, logistics must strive to minimise the detrimental environmental impact of not only production and post-consumption residues. It is very important to reduce the negative impact of products at every stage of their life cycle.
- Competitive advantage - one way to gain a competitive advantage in the market is to introduce a liberal return policy (strategy of minimising return barriers during product exchange), which allows customer loyalty. In this way, companies that manage return logistics in the right way are able to succeed in the market. What is more, it is easier for them to reach their customers, gauge their expectations and, on this basis, differentiate themselves from their competitors....
- Company image differentiation - a lot of companies use reverse logistics for strategic purposes, positioning themselves as a 'citizen company', engaging socially and helping the less privileged.

The management of reverse logistics in the timber industry is therefore important for environmental protection and allows for the efficient use of waste from forestry operations. Appropriate planning, processing technologies and monitoring of logistics processes are key to achieving sustainable waste management.

## CONCLUSIONS

1. Transport is a key factor in the location of woodworking companies.

When analysing the role of transport in the process of locating timber companies, it is clear that the efficiency and availability of transport infrastructure have a huge impact on the success of companies in this area. Both the transport of forestry raw materials to processing plants and the transport of finished products to customers are key elements of operations. It is worth investing in the development of transport infrastructure in the relevant regions to support the growth of timber companies.

2. Sustainable transport is becoming an increasingly important location factor.

With a growing awareness of the environment and sustainability, timber companies are increasingly considering environmental aspects in the location process. Choosing a location

that allows efficient and environmentally friendly transport of raw materials and finished products can benefit both the company and the environment.

### 3. Location and transport are closely linked to access to markets.

With the globalisation of markets, the location choice of a wood enterprise must take into account access to both domestic and international markets. Transport plays a key role in getting products to market and can affect a company's competitiveness. Therefore, it is important to carefully analyse transport aspects in the localisation process, taking into account both costs and potential benefits.

In conclusion, the role of transport in the localisation process of woodworking companies is crucial to their success. Efficient transport of raw materials, sustainable transport and access to markets are key aspects to consider when analysing the localisation process. By supporting the development of transport infrastructure and ensuring sustainable transport practices, we can support the further development of this important industry.

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**STRESZCZENIE:** W artykule *Transport jako czynnik w procesie doboru lokalizacji przedsiębiorstw branży drzewnej* analizowana jest istotna rola transportu w procesie lokalizacji przedsiębiorstw branży drzewnej. Autorzy podkreślają, że efektywność infrastruktury transportowej oraz zrównoważone praktyki transportowe mają kluczowe znaczenie dla sukcesu firm w tej branży. Artykuł podnosi również kwestię dostępu do rynków zarówno krajowych, jak i międzynarodowych jako istotny czynnik wpływający na proces lokalizacji przedsiębiorstw drzewnych. Przedstawione wnioski podkreślają znaczenie uwzględnienia aspektów transportowych w analizie lokalizacyjnej i wskazują na potrzebę wsparcia rozwoju infrastruktury transportowej w celu dalszego rozwoju tej branży.

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