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Impacts of using larger and heavier vehicles on operations and profitability of timber transportation: The case of Finnish operating environment

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Abstract This study was set up to find out how Finnish timber transport entrepreneurs perceive their operating environment in terms of using larger and heavier vehicles (LHVs and HCVs), with the main aim of providing guidance for developing sustainable policies that would improve timber transportation. A total of 100 entrepreneurs responded to a questionnaire survey which contained three sections administrated by an online service. Five-point Likert scales were used to collect perceptions and, in addition to statistical descriptors, the Kruskal Wallis and Mann-Whitney U test was used to compare the responses of entrepreneurs. They felt that the 76 t vehicle combination is best suited for transporting timber when transport starts from the forest. When the analysis considered transport from terminals, 76 t combinations remained the most popular, but the popularity of >76 t combinations increased substantially. The farther the LHVs operate from the highways, the less suitable the road network was perceived for timber transport. The results also show that driving and rest time regulations as parts of the working time legislation were perceived as the most disruptive. Further, the availability, responsiveness of technical support, and long delays in solving the queries of drivers were critical problems for the efficient use of in-vehicle ICT-applications. The profitability over the 2014–2018 period has declined more for entrepreneurs using <76 t vehicle combinations. When looking at the development of profitability over the 2020–2024 period, the responses changed in a more positive direction. However, the current skilled workers are retiring and there are too few educated ones to replace them. This is expected to increase wages, which may be reflected in a decreased profitability in the timber transport sector in the future.

Keywords: transport, regulations, operating environment, measures, support, road network, driver education, profitability.

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Introduction

In 2020, the export value of Finnish forest industry products was 10.5 billion euros, covering 18% of Finland's exports (Finnish Statistical Yearbook of Forestry 2021). Since 2010, the use of industrial wood has been accounting for more than 60 million m^3 per year, and in the peak year 2018, the use was estimated at 73.6 million m^3. Of this amount, the pulp industry used 54% and the saw and board industry 46%. In the same year, heating and power plants used 4.8 million m^3 of energy wood (Finnish Statistical Yearbook of Forestry 2021). However, the growth of forests (107 $m^3 \times ha^{-1}$) was found to be greater, therefore the industry should use more wood in order to preserve the functionality of forests in sinking carbon (Palander et al. 2020a). The results of the forest inventories run by the National Natural Resources Agency (Korhonen et al. 2021) show that, due to decades of too low wood extraction, the forests have aged, and their growth has decreased (103 $m^3 \times ha^{-1}$), which threatens their carbon binding capacity and the future of forestry (Luke 2022). Without logging, the forests eventually die and become harmful to the climate when they release the carbon dioxide bound to the trees into the atmosphere (Olsson 2011). The risk of forest fire also increases because wood remains in the forests as a flammable fuel (Moriz et al. 2005, Urbieta et al. 2019, Parisien et al. 2020). Altogether, wood procurement seems to be the only sustainable option for recycling the wood energy and carbon (Palander et al. 2020a).

Finnish forest industry directly employs approximately 63,000 people, of which approximately 11,000 are entrepreneurs in the logistics of wood procurement or persons belonging to their families (Finnish Statistical Yearbook of Forestry, 2021). In this regard, logistics includes wood harvesting and long-distance transportation (Soirinsuo 2012). Wood harvested from the forest can be transported to production facilities by trains, ships or trucks. The share of these transportation modes remained the same during the last decade (Palander 2016), but recently, the amount of ship transportation has increased in the country, since fuel has become more expensive (Yle 2022). In all long-distance transportation modes, at some point, the wood is transported on roads i.e., by a vehicle combination composed of a truck and trailer equipped to transport timber. The companies that transport timber by trucks have traditionally been small, one-truck family businesses, which have been replaced by larger logistics companies in recent decades (Soirinsuo & Mäkinen 2011, Palander et al. 2012). These companies hold several vehicle combinations and play a central role in the logistics of wood procurement (Palander 2022). As of 2019, 75% of the road transports were done as direct transports from the forest to the factory, accounting for an average transport distance of 116 km (Strandström 2021); however, the average transport distance was 91 km, when the calculations included road transport to other transportation modes or terminals (Strandström 2021).

Currently, timber transport companies hold around 1,400 vehicle combinations; these are combinations of a truck and a semi-trailer, a truck and an actual trailer, or a truck and several trailers (Natural Resources Institute Finland 2020, Lahti 2021). As of 2019, the maximum permitted length of a vehicle combination is 34.5 m and its total mass is 76 t (VNA 31/2019). This is a significant increment in transportation capacity, termed hereafter as larger and heavier vehicles (LHVs). In the EU, dimensions are of 16.5 m in length (18.75 m for road trains), 2.6 m in width, 4 m in height and 40 t in weight (EUR-Lex 31996L0053). The regulations of the Road Traffic Act (VNA 31/2019) also define the rules regarding the maximum permissible mass of vehicle combinations and their load. According to legislation, the most important factor controlling the total mass is the number of axles in a vehicle combination. In practice, the axle configuration of 60 t vehicle combinations is 3+4, i.e., the truck has 3 axles and the trailer has 4 axles. The 76 t vehicle combination is configured to have 9 axles. In addition, at least 65% of the trailer's mass must be discharged on the two-wheeled axle, which needs to have two tires next to each other on each axle hub. Commonly used axle solutions for 76 t combinations are 4+5 and 5+4.

For a total mass exceeding 76 t, a legal exemption is required; for such cases, the exception permit is issued by the Finnish Transport and Communications Agency (Lahti 2021). Such vehicle combinations, which are longer or heavier than the general legislation permits, are called HCT (High-Capacity Transport) combinations in Finland and Sweden (Korpilahti & Koskinen 2013, Venäläinen & Korpilahti 2015, Traficom 2022). They are also called an HCT system (Korpinen et al. 2017). However, the use of the HCT abbreviation can be confusing as it also refers to planning systems and multimodal transport systems (Leurent 2011, Ye et al. 2014, Alonso-Mora et al. 2017, Lindqvist et al. 2020). Therefore, Lindqvist et al. (2020) also called these vehicle combinations as HCV (High-Capacity Vehicles), a term that was used in this study. In the international literature, these vehicles are generally called LHVs (McKinnon 2005). The use of HCVs is aimed at increasing the transportation capacity, i.e., payload, therefore lowering fuel consumption and increasing energy efficiency (Palander et al. 2020b, Lahti 2021, Kärhä et al. 2023). A general goal of the forest industry is also to minimize transport unit costs.

Operating environment commonly refers to the operational work environment, in which stakeholders located outside a given transport company may influence the company's profitability (Marsden 2000, Kotaja 2008). Influencing the operating environment is, therefore, not only in the portfolio of the transport companies. The most common challenges of the operating environment that have emerged lately are those related to the availability of labour, the level of competence of the labour force, and the requirements of road maintenance; in addition, information systems supporting transport were found to require further development as they are still incompatible to each other (Malinen et al. 2014). That is why several (computer) programs used by the forest industry are still needed in vehicles and in the offices of transport companies (Palander 2022).

From the point of view of timber transport, and especially the utilization of LHVs, the road network is an important element of the operating environment (Finland's State of Logistics 2012). In this regard, the current state-owned road network enables comprehensive traffic throughout the entire country. The road administration is responsible for the development and maintenance of this road network, which operates under the Ministry of Transport and Communications (Traficom 2020). In practice, public roads are either completely managed by the state or jointly maintained by municipalities and the state (Road Network 2022, Palander et al. 2021). Accordingly, the road network is divided based on its size, importance and maintenance category into national, base, regional and connecting roads; at their most basic level, connecting roads are further divided into actual connecting roads and less significant local connecting roads (Viitala et al. 2004). Typically, the forest roads are local connecting roads or private roads. The private roads owned and maintained by private road management associations are important in the operating environment of transport companies because more than 90% of the harvested timber is transported on them (Anon 2017, Private Forest Roads 2022). In addition to roads, transport companies are also concerned about the condition of bridges (Palander et al. 2021), since at least at the level of connecting roads, they make it difficult for LHVs to carry out transport operations.

Furthermore, the operations of transport companies have expanded from traditional wood transport to the operation of a multi-sector enterprise. The expansion of their operating environment requires them to hold a considerable business expertise in order to maintain their profitability at a good level (Soirinsuo & Mäkinen 2011, Palander et al. 2012). In this regard, the contracting relationships between the forest industry and entrepreneurs have changed in the 2010s towards a broader responsibility model, where the contractor itself is responsible for the planning, organization, supervision and implementation of the transports (Palander 2022), whereas in the traditional model, the forest industry as the transport customer was responsible for all the wood supply processes (Mäkinen 1993, Palander 1998). As an effect of these changes, an entrepreneur may be responsible for the wood procurement operations of a certain geographical area, where these operations may include the entire wood supply chain, except wood purchasing. Such operations may include harvesting, transport and, if necessary, forest regeneration operations, or they can be limited to one of these operations. However, a fairly common practice is still that small different companies are responsible for harvesting and transportation contracting; they may also have joint business arrangements and customer relationships (Palander 2022).

Regulations and support of the road timber transport are strategic measures to be implemented by parties outside the transport company, which in turn will affect their operating environment (Mäkinen 1993, 1997, 2001). Both aim at developing transport logistics and at increasing the cost efficiency in transport operations. In this regard, the unit costs of long-distance timber transport have remained almost at the same level since 2010 (Strandström 2021). On the other hand, starting from 2022, the costs have started to rise due to the war in Ukraine (SKAL 2022). The cost efficiency is primarily affected by the regulations on the dimensions and transport masses (Anon 2013, Finlex 407/2013). For instance, studies by Palander (2016, 2017) have shown that increasing the maximum size and mass of vehicle combinations in the right working environments saves significant amounts of fuel, which is the most significant cost factor of transport companies (Lindström & Fjeld 2014, Svenson & Fjeld 2016, 2017). Therefore, as a general rule of the Road Traffic Act (Lahti 2021), allowing larger vehicles to operate can be seen as a support measure, and the regulations can also grant temporary transport permits for HCV combinations over 76 t (Lahti 2021, VNA 31/2019). However, it has not been asked directly from entrepreneurs how the regulations affect their profitability in a new operating environment.

The cost efficiency of transportation can also be supported by information systems, i.e., routing and control systems (Palander et al. 2012, Lindström & Fjeld 2014, Malinen et al. 2014). These support measures have become an essential part of timber transport management. In the forest industry's wood procurement logistics, programs developed by several software companies are used so far, though they are based on similar operating principles. They enable the management in giving to the vehicle combination the information required to drive to destinations and to carry on the wood order. At the end of the wood order, a notification is returned from the vehicle when the job is completed. With this approach, the inventory records of the forest industry and transport companies are kept connected in real-time. Under the expanded responsibility model, the forest industry as a customer provides the entrepreneur with the necessary data from its own information system as a support function (Palander 2022). This is enabled by linked software (LogForce 2022) that retrieves and hands over information from the customer's information system to the transport company's system. In addition to entrepreneurs' work, the reliability and ease of use of these information systems may affect the drivers' work, which should be explored in the current, changing working environment.

Society's support measures may affect the availability of skilled drivers in the labour market. This is often seen as a future success factor for a transport company, which is influenced by the remuneration level and attractiveness of the industry, on the one hand, and by the level of education organized by society, on the other hand (Paajanen et al. 2008, Soirinsuo 2012, Pajuoja 2013). Therefore, the availability of skilled drivers can be positively influenced by developing cooperation between schools and transport practice. It is assumed in this study, that this can be achieved by offering work opportunities to the students and to those undergoing training internships in large transport companies that use advanced technology both in terms of equipment and data transfer technology.

Regulations create the conditions for a safe and functional society. Although the regulation of timber transport generally aims at the same positive effects in the form of support measures, in some circumstances they may be perceived as burdensome and they may have opposite effects on the operating environment. Before the weight limit regulation of the vehicle combinations came into force (Finlex 407/2013), it was common for the vehicles to be overloaded, i.e., the total weight of the vehicle combination could be more than 60 t (Palander 2016, 2017). The overload increased cost efficiency and the profitability of transport companies. Nowadays, in 76 t vehicles, overloads are rare but possible. For example, the high humidity of timber may cause an excessively heavy load in the wet weather conditions of autumn. The forest industry has set sanctions for exceeding the weight limits, and police authorities also monitor excessively the practice of transporting heavy loads. Overloading monitoring is just one example of regulation and control, but let's say that, generally, this regulation is a positive manifestation of developed society and it is necessary as a common rule of the operating environment. So far, Nordic studies have considered old operating and working environments (Mäkinen 1993, 2001, Soirinsuo & Mäkinen 2011, Lindström & Fjeld 2014). However, it is equally important to broadly open up the regulations' multiple effects by asking transport entrepreneurs' opinions about them in the current operating environment (VNA 31/2019).

Soirinsuo and Mäkinen (2011) pointed out that the profitability of timber transport is not related to the economy of scale, but it is resource-oriented. In this study, information was collected from transport entrepreneurs with the aim of developing the operating environment of road transport by considering the point of view of the companies' operational activities and profitability. Primarily, the results describe how the entrepreneurs' responses differ in relation to LHVs (≤ 76 t) and HCVs (> 76 t). Inside the LHVs group, the best vehicle combinations were also selected. In addition, the development needs of the road network, regulation and support functions are considered for both groups. To a small extent, the future of the Finnish transport sector is also examined. The conclusions tap into the actions, measures and policies required to improve timber transportation.

Materials and Methods

Survey

The research was carried out by a questionnaire survey aimed at timber transport entrepreneurs. The survey collected information about the situation in the operating environment of transport companies in 2019. We especially focused on events between 2014 and 2018. The survey was carried out by an online, e-form service, which is a form software used with an internet browser. The respondents accessed the survey via a URL link without any requirement to log in while the survey was open. Entrepreneurs were sent a link to the survey by email on March 6, 2019. The response period for the survey ended on March 24, 2019. Entrepreneurs invited to the survey were sent a reminder about the survey on March 18, 2019, when there was a week left to respond. In the e-mail containing the link, it was emphasized that the responses are processed in such a way that the respondent is anonymous in the study.

The questionnaire contained three sections: Background information (A), Transport vehicle combinations (B), and Operating environment (C). It was designed to enable the responses to given questions without any prerequisite in completing the answers to previous questions, and it received a total of 103 responses. In other words, it was possible to omit some responses in the questionnaire, which is why the number of observations on some items varied. The questionnaire was developed to hold several free text fields where the respondents had the opportunity to justify or elaborate on the answers they gave to certain questions. In addition, feedback was asked at the end of the sections, which the respondents could give freely by writing.

In section A, the company's background information was asked, such as the entrepreneur's age, domain, the vehicle combinations owned and the main customer. These were used for grouping the data collected in sections B and C during the analysis.

Sections B and C had five-point Likert scale statements, from which the respondent could choose the option that best fitted his/her own experience. The polarity of the scale was arranged from negative to positive in such a way that the most negative answer was the one on the left and the most positive answer was the one on the right (Salkin 2010). In section B, the respondent was introduced to various timber transport situations, in relation to which a choice of the vehicle combination that best suited the situation was asked from among the alternatives. The combinations were presented by the number of axles and the maximum mass. The included options were 3+4 (60 t), 3+5 (68 t), 4+4 (68 t), 4+5 (76 t), 5+4 (76 t), 5+5 (84 t) and "I can't say". These were included into two groups (≤68 t and >68 t) in the profitability analysis, and the answers given to the option "I can't say" were left out of the analysis, which included only those responses in which a position was taken on the choice of vehicle combination. Transport situations were described to start either from the forest or from a terminal. When loading from the forest, the vehicle combination was assumed to operate with a loader.

Section C related to the operating environment was divided into several subsections, such as the road network, regulation of road transport, support functions and the future. First, experiences in use were asked about the suitability of the road network for vehicle combinations ≤76 and >76 t. After that, experiences were asked about the use of forest information systems and on-board vehicle computer programs. Claims were not targeted at a single information system, but the smoothness of use and their effect on operations were investigated on a general level. As the last issue, the entrepreneurs' opinions were asked about training and labour issues in the transport sector, without forgetting the entrepreneur's future plans.

Data analysis

Microsoft Excel spreadsheet program and IBM SPSS Statistics 29 statistical program were used for data processing, calculation and analysis (SPSS Inc. 1988).

First, the data were transferred from the e-form software to an Excel file and an SPSS file.

When inspecting the data, two cases were found in which two consecutive answer lines were completely identical. One of the lines was deleted, assuming that this was caused by technical problems in filling out or saving the form. In addition, the first answer line was the test line of the authors of the study. These three lines were removed from the processed data. Consequently, a database containing 100 answer lines was used for data processing.

SPSS software was used for the description of the data in the form of mean, median, mode and standard deviation values. Then Spearman's (1904) correlation coefficients were estimated for nine factors (X) that influence the financial profitability of timber transport: X1 = Fuel price, X2 = Renewal of vehicles, X3 = Work staff, X4 = Road condition and maintenance, X5 = Seasonal variation, X6 = Storage conditions, X7 = Number of partial loads, X8 = Information systems and X9 = Transport rates.

The Kruskal-Wallis test was used when comparing the distributions of two answer groups and the Mann-Whitney U-test was used when comparing the paired responses of the answer groups on the ordinal scale (Graziano & Raulin 1993, Kruskal & Wallis 1952, Mann & Whitney 1947).

In the implementation of the tests, the null hypothesis was that the distributions or responses were the same.

The significance levels used in the analysis were $p < 0.05$; $p < 0.01$ and $p < 0.001$. If the p-value given by the test was less than the assumed level of confidence, the null hypothesis was rejected (Fisher 1966, Heikkilä 2010).

Results

Background data

This section reports background information on transport entrepreneurs and their companies. The entrepreneurs were elderly, as 74% were 45 years of age or older (Table 1). 3% of the respondents were under the age of 35. The respondents were mainly experienced transport entrepreneurs, as 89.9% of them had worked in the field for at least 10 years. 1% of the respondents worked as a transport entrepreneur for less than 5 years.

The transport companies of the respondents were found to operate in different parts of Finland. Most responses came from the Eastern Finland region. The survey did not specify the boundaries of the operational areas, but the entrepreneurs were allowed to define the area they felt they belonged to. The majority of entrepreneurs owned 1 or 2 combinations of vehicles (66.7%), and there was an 8.1% share of large companies (more than 6 vehicle combinations) in the responses. Several entrepreneurs delivered wood simultaneously to several forest industry customers (Figure 1).

The most common customer was Metsä Group, for which 21.9% of transport companies

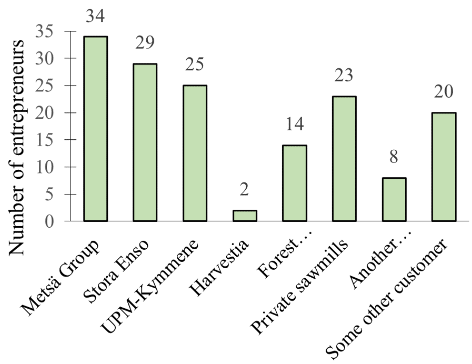

Figure 1 Customers of the surveyed transport companies in the forest industry.

Table 1 Background information of the entrepreneurs and their transport companies.

Age group (years)	Frequency of age groups	Experience (years)	Frequency of experience	Main operating area	Frequency of main operation area	Vehicle combi-nations	Frequency of vehicle combi-nations
No answer	2	<5	1	Northern	24	1–2	66
25–35	3	5–10	9	Western	26	3–4	18
35–45	21	10–15	12	Eastern	35	5–6	7
45–55	32	>15	77	Southern	15	>6	8
>55	42	-	-	-	-	-	-
Total	100	-	99	-	100	-	99

delivered wood. Stora Enso was the second, with a share of 18.7%, and UPM-Kymmene was the third most common customer (16.1%). Private sawmills were also found to be important customers (14.8%).

Transport vehicles

Best vehicle combinations for transporting from the forest

The differences between the vehicle combinations of forest transport (FT) and terminal transport (TT) were tested in terms of suitability characteristics for wood transport (Figures 2 and 3). The distributions of the FT and TT were different (K-W, p = 0.001, t = 14.108).

First, comparisons were made to find the best vehicle combinations when loading from the forest (FT) (Figure 2). From the point of view of transportation costs (€×tkm^{-1}), the most popular vehicle combination in terms of truck and trailer axles turned out to be the 4+5; that was the 76 t combination, which was chosen by 63.6% of respondents (e.g., 76 vs. 68 t, M-W, p = 0.016, t = -12.452). The second most popular combination was 3+5, chosen by 21.6% of respondents.

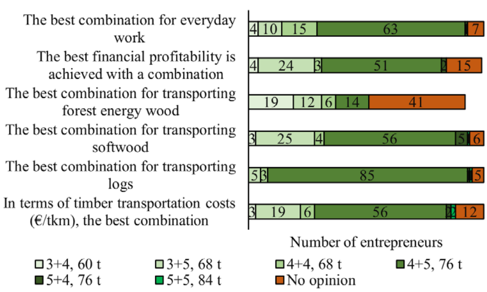

Figure 2 Axle solution and vehicle combination for transporting timber when loading from forest.

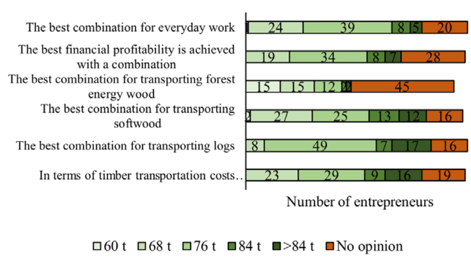

Figure 3 The vehicle combination for transporting timber from terminal.

Roughly 90% of the respondents believed that the 4+5 axle solution is the best suited for transporting logs, and none of the respondents considered the combination of 3+4 as the best for transporting logs (e.g., 76 vs. 68 t, M-W, p = 0.045, t = -45.500). The median and mode of the responses characterized the combination of 4+5, and the standard deviation of the responses was 0.5. The combination of 4+5 was also the most popular for transporting soft pulpwood. It was chosen by 59.6% of respondents, while 26.6% of the respondents felt that the 3+5 combination was the best. Mann Whitney's test indicates that these combinations were perceived as different (e.g., 76 vs. 68 t, M-W, p = 0.000, t = -22.462). In addition, 60.7% of the respondents had the opinion that the best economic profitability is achieved with the combination of 4+5 (e.g., 76 vs. 68 t, M-W, p = 0.000, t = -19.375). The second most popular was the combination of 3+5, which was supported by 28.6% of the respondents. The mode and median of the responses was the combination of 4+5, with a standard deviation of 1.1. The combination of 4+5 was also considered the most popular for daily work since 67.7% of respondents thought it was the best (e.g., 76 vs. 68 t, M-W, p = 0.000, t = -19.376). The second and third most popular combinations were those of 4+4 and 3+5, as indicated by 16.1 and 10.8% of respondents.

Best vehicle combinations in transporting from the terminals

Figure 3 shows the results describing the perceptions of the best vehicle combinations in transporting wood from the terminals (TT). As shown, 37.7% of the respondents considered the 76 t combination to be the best in terms of transport costs (€×tkm^{-1}) (e.g., 76 vs. >84 t, M-W, p = 0.044, t = -4.051). The next three important combinations were: 68 (29.9%), >84 (20.8%) and 84 t (11.7%). The 76 t combination (60.5%) was considered to be the most suitable for transporting logs (e.g., 76 vs. 84 t, M-W, p = 0.034, t = -45.500). The second most popular was the >84 t combination, chosen by 21.0% of the respondents. The mode and median of the responses were 3 (76 t combination), and the standard deviation was 0.9. The 68 t combination (34.2%) was considered the most suitable combination for softwood pulpwood transport (e.g., 68 vs. >84 t, M-W, p = 0.014, t = -16.375), and it was more popular than the 76 t combination which was chosen by 31.6% of the respondents. HCV combinations were preferred in the following order: 84 t (16.5%) and >84 t (15.2%).

From the point of view of financial profitability, the 76 t combination was considered the best (e.g., 76 vs. 84 t, M-W, p = 0.004, t = -17.813). This is based on the 50.0% of the respondents who had this opinion, while 27.9% chose the 68 t combination as the best. The most preferred HCV combinations were 84 t (11.8%) and >84 t (10.3%). The mode and median of the responses were found for the combination of 76 t, with the standard deviation of 0.9. The 76 t combination (50.6%) was considered the best for operative work, whilst 31.2% of the respondents preferred the 68 t combination.

Effects of age and company size on the preference of vehicle groups

The transport fleet was divided into combination groups weighing ≤68 t and >68 t. Using the age of the entrepreneur in the analysis of these two groups, we noticed that older entrepreneurs preferred lighter combinations (≤68 t). The younger the entrepreneur, the more popular was a larger vehicle combination (>68 t) (Figure 4). Response distributions between groups were almost statistically different from each other (K-W, p = 0.065).

The companies were divided into four groups in terms of company size. When entrepreneurs owning 3–4 and 5–6 vehicle combinations were used in the analysis, it was noticed that they believed that combinations >68 t were better (Figure 5). In companies holding more than 6 vehicle combinations, the preferences regarding the vehicle combinations were more or less the same.

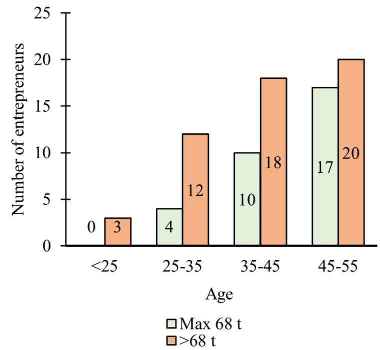

Figure 4 The effect of entrepreneur's age on the preference of vehicle combinations (≤68 t and >68 t).

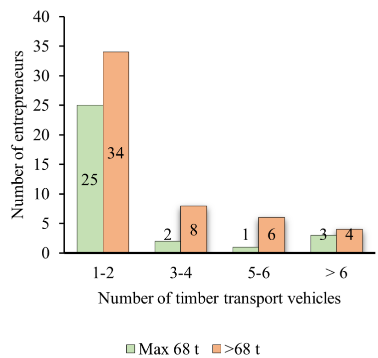

Figure 5 The effect of company size (number of vehicle combinations) on the preference for the group of vehicle combinations (≤68 t and >68 t).

Financial profitability

Profitability in general

All respondents rated financial profitability for the years 2014–2018. Accordingly, 45% of the respondents felt that profitability has weakened slightly or remarkably in the last five years. In contrast, 27% of the respondents felt that profitability has improved slightly or remarkably. The median response was that profitability has remained unchanged for the past five years. On the other hand, 30.2% of the respondents predicted that profitability will decrease slightly or remarkably during the next five years (2020–2024). However, 42.7% of respondents anticipate that profitability will remain the same, and 28.1% of respondents estimate that profitability will improve slightly or substantially over the next five years.

Profitability in two-vehicle groups

The responses to the statement on the best financial profitability achieved with a vehicle combination when timber is transported from the forest were divided into two groups, namely those in favour of combinations weighing ≤68 t, and those in favour of combinations weighing >68 t. The former group received a total of 31 responses and the latter group received 53 responses. When comparing the responses given by these two groups to the claim put to them about the development of profitability during the five years 2014–2018, the responses were very much in the same direction. Both groups felt that, on average, financial profitability has remained unchanged or decreased slightly (Figure 6). The K-W test performed between the distributions indicated no statistically significant differences between the vehicle combination groups ($p = 0.677$, $t = 2.321$).

These groups see the financial profitability of the next five years (2020-2024) as very similar (Figure 7). However, the distributions of the groups (2014-2018 vs. 2020-2024) were different according to the K-W test ($p = 0.003$, $t = 16.140$). Although the profitability was believed to remain unchanged, the responses were slightly more positive than the results of the previous five years (2014-2018).

Factors affecting financial profitability

Table 2 describes the correlations among the factors that may affect the financial profitability of the transportation companies. Seven of these factors correlated statistically significantly ($p < 0.01$) with either the "Transport rates" or "Renewal of vehicles". However, the factors X4-X7 formed a group in which the value p of statistically significant correlation was ≥ 0.01 or it occurred only with one of them. It is also important to notice that forest "Storage conditions" correlated with all other factors as opposed to "Fuel price".

Based on the results, 53.1% of the

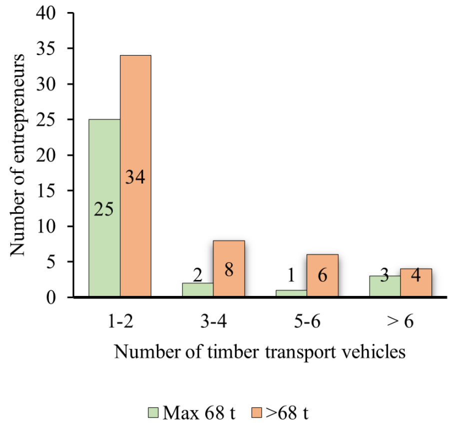

Figure 6 Financial profitability of vehicle combination groups (≤68 t and >68 t) in the period of 2014–2018. A = Substantially weakened, B = Weakened slightly, C = Remained unchanged, D = Increased slightly, E = Substantially improved.

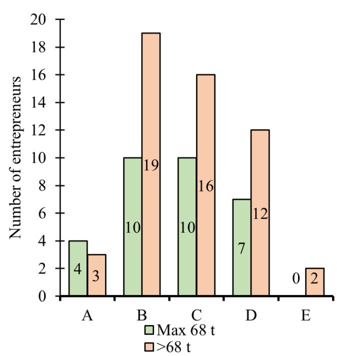

Figure 7 Financial profitability of vehicle combination groups (≤68 t and >68 t) for 2020–2024. A = Weakens substantially, B = Weakens slightly, C = Remains unchanged, D = Improves slightly, E = Improves substantially.

Table 2 The correlation of factors that influence on financial profitability of timber transport. X1 = Fuel price, X2 = Renewal of vehicles, X3 = Work staff, X4 = Road condition and maintenance, X5 = Seasonal variation, X6 = Storage conditions, X7 = Number of partial loads, X8 = Information systems, X9 = Transport rates.

	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	1	0.474**	0.374**	0.109	0.113	0.083	0.077	0.147	0.419**
X2	0.474**	1	0.444**	0.268**	0.12	0.246*	0.175	0.276**	0.509**
X3	0.374**	0.444**	1	0.111	0.069	0.209*	0.15	0.066	0.354**
X4	0.109	0.268**	0.111	1	0.118	0.233*	0.163	-0.061	0.128
X5	0.113	0.12	0.069	0.118	1	0.404**	0.343**	0.259*	0.149
X6	0.083	0.246*	0.209*	0.233*	0.404**	1	0.634**	0.321**	0.231*
X7	0.077	0.175	0.15	0.163	0.343**	0.634**	1	0.283**	0.377**
X8	0.147	0.276**	0.066	-0.061	0.259*	0.321**	0.283**	1	0.344**
X9	0.419**	0.509**	0.354**	0.128	0.149	0.231*	0.377**	0.344**	1

* = p< 0.05; ** = p< 0.01

respondents felt that the fuel price weakened financial profitability slightly or substantially, and 40.8% of the respondents felt that the effect remained unchanged (Figure 8). The renewal of the vehicle combinations weakened the profitability slightly or substantially (47.9%), while 20.4% thought that it improved the profitability slightly or substantially. Of the respondents, 52.5% felt that labour-related factors weakened profitability slightly or substantially, while 11.1% felt that the effect had slightly or substantially improved financial profitability. 52.5% of the respondents felt that the impact of transport rates has slightly or substantially weakened profitability, while 21.2% of the respondents felt that the rate levels slightly or substantially improved profitability. The distributions of "Road condition and maintenance" and "Transport rates" were different (K-W, p = 0.002, t = 17.552). Accordingly, 78.8% of the respondents felt that the road condition and maintenance impact the financial profitability by slightly or greatly weakening it; 25.3% of the respondents felt that the effect of storage conditions on profitability was slightly or substantially reduced, and 26.3% of the respondents felt that it improved profitability slightly or substantially. The median of responses indicated that the effect of storage conditions on financial profitability has remained unchanged. Of the respondents,

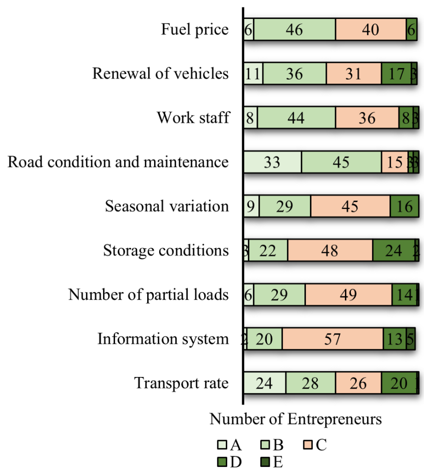

Figure 8 The importance of factors that influence financial profitability for timber transport. A = greatly reduced, B = slightly reduced, C = unchanged, D = slightly improved, E = greatly improved.

35.4% felt that the number of collected loads reduced profitability slightly or significantly, while 15.2% of the respondents estimated that the effect was slightly or substantially improving economic profitability. In addition to the factor "Road condition and maintenance", "Seasonal variation" was the factor that did not correlated with the "Transport rate". Accordingly, 38.4% of the respondents felt that the effect of seasonality slightly or greatly weakened profitability, while 16.2% felt that the effect of seasonality improved slightly the profitability. Furthermore, 22.7% of the respondents felt that the information systems decreased the profitability of transport slightly or essentially, but most of the respondents felt that the profitability would remain unchanged as related to the three previous factors.

Road network as an operating environment

Usability of the road network for ≤76 t vehicle combinations

Respondents evaluated how the road network's road classes and bridges are suitable for the ≤76 t transport fleet (LHVs) currently in use (Figure 9). The distributions of the response groups were statistically different according to the Kruskal-Wallis tests. Of the respondents, 67.3% slightly or completely agreed that highways and national roads are suitable for ≤76 t combinations. 21.4% of the respondents disagreed somewhat or completely with the statement. According to the mode and median of the responses, the respondents' opinion was "slightly agree", with a standard deviation of 1.3; 33.7% of the respondents agreed somewhat or completely with the statement that regional roads are suitable for the combinations of ≤76 t, while 50.0% disagreed somewhat or completely with the statement. The mode and median of the responses were "slightly disagree", with a standard deviation of 1.4.

A share of 19.4% of the respondents slightly or completely agreed with the statement that "forest roads are suitable for the current combinations". The majority of the respondents (73.5%) were slightly or completely disagreeing with the statement. To the statement "bridges are suitable for ≤76 t combinations", 24.0% of entrepreneurs responded that they somewhat or completely agreed, while 58.3% of them slightly or completely disagreed with the statement.

Usability of the road network for >76 t vehicle combinations

In this part of the questionnaire, respondents were asked to rate how suitable existing roads and bridges are for the use of vehicle combinations of >76 t (HCV). The situation was even worse in these response groups as compared to that described for the ≤76 t transport fleet. 44.4% of the respondents slightly or completely agreed that highways and national roads are suitable for HCVs, while 39.4% of the respondents slightly or completely disagreed with the statement (Figure 10). The distributions of the response groups were statistically different according to the Kruskal-Wallis tests. 12.1% of the respondents slightly or completely agreed with the statement "regional roads are suitable

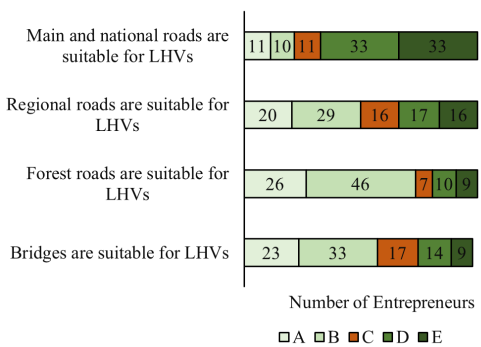

Figure 9 Usability of the road network for vehicle combinations of ≤76 t. A = Completely disagree, B = Slightly disagree, C = Neutral, D = Slightly agree, E = Completely agree.

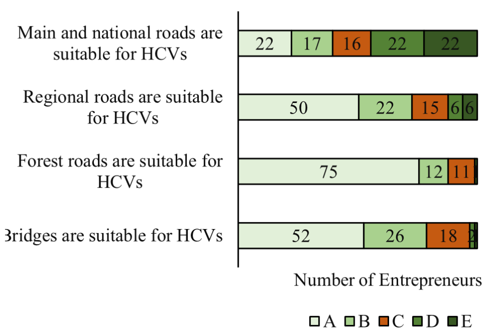

Figure 10 Usability of the road network for >76 t vehicle combinations. A = Completely disagree, B = Slightly disagree, C = Neutral, D = Slightly agree, E = Completely agree.

for HCVs", while 72.7% of the respondents slightly or completely disagreed with the statement. 87.9% of the respondents slightly or completely disagreed with the statement "forest roads are suitable for HCV combinations", and a clear majority (78.8%) responded similarly to the statement "bridges are suitable for HCV combinations".

Timber transport regulation and support functions for the future

Regulation of the operating environment

51.5% of the respondents completely or slightly agreed that "the transport of timber is regulated too precisely", while 13.1% slightly or completely disagreed (Table 3). In the same way, 42.4% of the respondents completely or slightly agreed with the claim that "the transportation of timber is monitored too closely", whilst 25.3% of the respondents either slightly or completely disagreed. 68.7% of the respondents slightly or completely agreed with the statement "working hours legislation makes it difficult to transport timber", whilst 18.2% of the respondents slightly or completely disagreed. To the claim "the driving and rest time regulation makes it difficult to transport timber", most of the responses were slightly or completely in agreement (64.6%), while 19.2% slightly or completely disagreed.

To the claim "The overloaded vehicle law is interpreted and enforced too closely", the responses were most evenly distributed. 38.4% of respondents slightly or completely agreed, while 30.3% slightly or completely disagreed. 55.6% of the respondents slightly or completely agreed with the statement "There are too many occupational safety and other training associated with transporting", while 15.1% slightly or completely disagreed.

Forest information systems and vehicle applications as a support function

73.2% of the respondents slightly or completely agreed with the statement "Vehicle applications have made it easier to plan and implement transportation", while 21.6% of the respondents neither agreed nor disagreed (Table 4).

Furthermore, 48.5% of the respondents slightly or completely agreed with the statement "Training has been available for vehicle applications", while 25.8% of the respondents slightly or completely disagreed with the statement. 45.4% of the respondents slightly or completely agreed with the statement "With the vehicle application, you can work with several customers", while 22.7% slightly or completely disagreed. 67.0% of the respondents slightly or completely agreed with the statement "A well-built vehicle application improves the economic profitability of timber transport", while 22.7% neither agreed nor disagreed. 38.1% of the respondents slightly or completely agreed with the statement "The technical support of the vehicle application knows how to solve problems", while 25.8%

Table 3 The impact of regulation on the operational performance of transport.

Average number	A	B	C	D	E	F
Average	3.57	3.24	3.82	3.77	3.14	3.62
Median	4	3	4	3	3	4
Mode	3	3	5	5	3	4
Standard dev.	1.061	1.153	1.232	1.276	1.237	1.01

A	The transport of timber is regulated too precisely
B	The transportation of timber is monitored too closely
C	Working hours legislation makes it difficult to transport timber
D	The driving and rest time regulation makes it difficult to transport timber
E	The Overload Act is interpreted and enforced too closely
F	There are too many occupational safety and other training associated with transporting

slightly or completely disagreed with the statement. 21.6% of the respondents slightly or completely agreed with the statement "Technical support for the vehicle application is easy to reach", while 38.1% slightly or completely disagreed with the statement. 43.8% of the respondents slightly or completely agreed with the statement "Poorly functioning connections make it difficult to use the vehicle application", while 30.2% slightly or completely disagreed with this statement. Last but not least, 13.4% of the respondents slightly or completely agreed with the statement "The vehicle application is incomplete or faulty", while 39.2% of respondents slightly or completely disagreed with this statement.

Labour factors and education

A share of 39.2% of the respondents slightly or completely agreed that increasing "The efficiency of operations will ease the labour shortage" in the transport sector, while 27.8% of respondents slightly or completely disagreed (Table 5).

12.2% of the respondents slightly or completely agreed that "Timber transport sector is of interest to young people", but 73.5% slightly or completely disagreed. 7.1% of the respondents slightly or completely agreed with the claim "The cooperation between

Table 4 Views on the future of timber transport.

Average number	A	B	C	D	E	F	G	H	J
Average	3.94	3.25	3.62	3.28	3.75	3.09	2.72	3.21	2.73
Median	4	3	4	3	4	3	3	3	3
Mode	4	4	4	3	4	3	3	4	3
Standard dev.	0.933	1.118	1.103	1.205	1.011	1.022	1.058	1.169	0.896

A	Vehicle applications have made it easier to plan and implement transportation
B	Training has been available for vehicle applications
C	The use of vehicle applications has brought considerable additional work to the company
D	With the vehicle application, you can work with several customers
E	A well-built vehicle application improves the economic profitability of timber transport
F	The technical support of the vehicle application knows how to solve problems
G	Technical support for the vehicle application is easy to reach
H	Poorly functioning connections make it difficult to use the vehicle application
J	The vehicle application is incomplete or faulty

Table 5 Views on the future of timber transport.

Average number	A	B	C	D	E	F	G	H	I	J
Average	3.16	2.05	2.03	3.14	3.39	4.24	4.33	2.59	3.08	3.65
Median	3	2	2	3	4	4,5	5	2	3	4
Mode	3	2	2	3	4	5	5	1	3	5
Standard dev.	1.115	1.019	0.936	1.045	1.056	0.981	0.847	1.539	1.10	1.378

A	The efficiency of operations will ease the labour shortage
B	Timber transport sector is of interest to young people
C	The cooperation between companies and educational institutions is close and the skills of new drivers are at a good level
D	Work orientation is a planned process in your transport company
E	Employees are committed to the company and industry
F	Many of the current experts will retire in the next few years
G	A possible shortage of drivers will increase the wage level and thus transport costs
H	Generational change will be topical in your company in the next few years
I	I am aware of the implementation of generation change
J	We intend to continue as entrepreneurs for another five years

companies and educational institutions is close and the skills of new drivers are at a good level", while 72.4% slightly or completely disagreed. 36.7% of the respondents slightly or completely agreed that "Work orientation is a planned process in your transport company", while 24.5% slightly or completely disagreed. 57.7% of the respondents slightly or completely agreed with the statement, "Employees are committed to the company and industry", while 21.6% slightly or completely disagreed. The opinion of the respondents (83.3%) was slightly or completely agreeing with the claim "Many of the current experts will retire in the next few years", while 6.3% slightly or completely disagreed. Also, the responses to the claim "A possible shortage of drivers will increase the wage level in the future and thereby transport costs" were slightly or completely agreeing (85.7%), while 2.0% of the respondents disagreed completely. 31.6% of the respondents slightly or completely agreed with the statement "Generation change will be relevant in your company during the next few years", while 54.1% slightly or completely disagreed. To the claim "I am aware of the implementation of generation change" the responses given were evenly distributed, and 35.8% of respondents slightly or completely agreed with the statement. Regarding the claim "We intend to continue being an entrepreneur in another five years" most of the responses were slightly or completely on the side of agreement (56.1%), while 18.4% of respondents slightly or completely disagreed with the statement.

Discussion

There were three result goals in this work, to which responses were received directly from entrepreneurs in the road transport sector. Based on the results, conclusions are made about the usability of the vehicle combinations in various operational situations. Profitability can be affected by choosing the right vehicle combination. The discussion is extended to the operating environment because the combined effects of the road network and the vehicle combination are important for both profitability and operational activities. New research data can highlight the development needs of the road network. Thirdly, we discuss the importance of regulation by external parties and various support functions such as information systems, workforce and education, in the same context. In the entrepreneurs' responses, one can find guiding success factors driving the growth of transport companies for a better common future. According to Soirinsuo and Mäkinen (2011) and Soirinsuo (2012), it is surprisingly difficult to find a success model which focuses explicitly on small business growth and profitability. However, the growth of transport companies is necessary due to decades of too-low wood extraction. The Finnish forests have aged, and their growth has decreased, which threatens their carbon-binding capacity and the future of forestry (Palander et al. 2020a, Korhonen et al. 2021, Luke 2022).

Currently, the most common option in timber transport is the 76 t vehicle combination, which can be used to transport the maximum amount of wood permitted by the law (VNA 31/2019). The most commonly used axle solution of the 76 t combination is 4+5. Entrepreneurs feel that this vehicle combination is best suited for transporting both logs and pulpwood when the vehicle is loaded from the forest storage. When transporting saw logs, it was clearly the most popular, and for pulpwood, more than half of respondents preferred this combination. Consequently, this combination is also perceived as the best from the point of view of financial profitability. When the analysis considered the vehicles loaded from the terminals, the 76 t combinations were still the most popular. The profitability of 84 t combinations increased in these transports, which is understandable from a practical point of view. It is difficult or even impossible for

HCVs to operate on regional or private forest roads, although, in theory, they are more profitable than LHVs (Palander et al. 2020b).

In order to determine factors affecting profitability more accurately for small and large combinations, the transport fleet of LHV was divided into two groups (≤68 and >68 t). When looking at the development of profitability over the last five years (2014-2018), the results show that the profitability of ≤68 t combinations weakened more than the profitability of >68 t combinations. There was no statistical difference between the distributions of the groups, but relatively more entrepreneurs felt that profitability substantially weakened if ≤68 t combinations were used. At the same time, everyone who felt that profitability has improved substantially, belonged to the group of >68 t. With these extremes emphasized it can be concluded that ≤68 t combinations are a determining factor for profitability because those who use them experienced the past five years (2014-2018) as economically worse than users of >68 t combinations. When looking at the responses about the development of profitability for the next five years (2020-2024), the responses in these two groups even out. For both groups, the responses have moved in a more positive direction compared to the 2014-2018 period. In both groups, a larger proportion of respondents felt that profitability would improve slightly or substantially. This looks a little bit strange because respondents seem to feel the future is brighter than the past five years. The fuel price increase of the spring (2022) is not included in the survey's analysis, which may explain this situation.

When looking at the impact of individual factors on financial profitability (Figure 8), the condition and maintenance of roads and the contract rates paid by the forest industry come to our attention, which have weakened profitability the most. There has been a strong campaign in the forest industry to increase cost efficiency in Finland (Venäläinen & Korpilahti 2015, Venäläinen & Poikela 2020), which may cause short-term overkill and back recoil in the transport sector. On the other hand, the most positive effect on profitability is the improvement of forest and terminal storage conditions, which affect the loading operation of the LHVs.

When examining the operating environment, the focus is on the effects of the road network. In particular, we investigated its suitability for the current vehicle combinations ≤76 t, but we also looked over its suitability for combinations weighing >76 t. This is new information because previous studies have focused on 60 t vehicle combinations (Svenson & Fjeld 2017). In addition, some recent studies have focused on working environments instead of profitable operating environments (Anttila et al. 2022). Nowadays, the majority of vehicles are 76 t LHV combinations (approx. 90%), so the importance of the survey is related to these combinations. On the other hand, the results found for >76 t HCV combinations are also useful and accurate, because all the vehicles in use were operated by the study respondents.

When looking at the group of ≤76 t vehicle combinations and how the entrepreneurs have experienced the suitability of different levels of the road network for them, it was noticed that the lower the level of road category, the less suitable was it perceived. Highways and national roads are still considered very suitable. In the case of regional roads, however, almost half of the respondents felt that they were not suitable for the use of ≤76 t vehicle combinations. When we go further to the forest roads, almost three out of four respondents think that they are not suitable for the use of ≤76 t vehicle combinations. Regarding bridges, the responses are also grouped on the negative side. Looking at the group of >76 t vehicle combinations (HCVs) the responses are in the same direction as for the ≤76 t vehicle group. However, the responses are even more sharply negative for the regional roads, forest roads and bridges than in the ≤76 t group. From a practical point of view, it seems that at least the HCV combinations are so large in terms of their physical dimensions that their use is not possible on lower levels of the road network, particularly on private roads.

Legislation has guided the transition of heavy traffic to LHV vehicle combinations. The entrepreneurs, as contractors, have been compelled to acquire equipment and vehicle combinations. At the same time, the operating environment especially the road network has remained unchanged (Anon 2007, Traficom 2022b) and the lower road network of Finland is deteriorating at an alarming rate (Ministry of Transport and Communications 2021). Every citizen who has travelled on these roads knows that. When heavy transport equipment, changing weather conditions, rush and fatigue are brought into this equation, we are in a dangerous operating environment. The law stipulates that the transport fleet must be in a condition for safe operation and the driver must be fit and competent to transport his vehicle combination (Finlex 407/2013, VNA 31/2019, Finlex 320/2017). Should it also be written into the law that the road should be in a condition worthy of these top professionals and first-class vehicle combinations? Forests are located all over Finland and have always been cultivated by restoration tree planting and harvesting, which will not change in the future by changing the tradition. They are not the so-called natural forests' carbon sinks (Anon 2022). To process the wood, it should be transported efficiently and safely on all levels of the road network (Anon 2007), which is a prerequisite for an efficient forest industry that can continue to bring prosperity to society and enable the vital carbon sink in Finland.

Regulation and its control are positive manifestations of a developed society. In some industries, regulation significantly affects daily operations, including operational work, of which the road transport of timber is a good example. Therefore, the rest of this study discusses the effects of regulation on the development of operational activities. Another important cornerstone of operational activities is digital competence. Drivers and entrepreneurs use forest information systems and vehicle applications, which in this work were classified as a support function because their use is possible with the consent of the forest industry. Another support function in this category of labour and training factors, which were also seen as the most important factors for the company's short-term success in the current labour shortage. The discussion therefore includes a small amount of future analysis in addition to the operational analysis that examines the present.

Based on the results, it was noticed that the entrepreneurs feel that the regulation of operations is excessive. More than half of the respondents feel that the transport of timber is regulated too precisely. Especially the working time legislation and the driving and rest time regulation were perceived as factors that make transportation inefficient. In general, the trend for poorer profitability at high working time utilization has also been reported by Lindström and Fjeld (2014). Their results show that profitability decreased with increasing annual operating hours per truck. Somewhat surprisingly, the responses related to supervision are not quite as sharp, i.e., supervision as a regulation was not perceived as excessive. However, a significant proportion of respondents feel that there is too much supervision. These responses can be interpreted as the fact that the laws and regulations are perceived as too strict, but the activities of the supervising authority are nevertheless accepted as based on the laws and regulations. This would reflect well the honest character quality of the respondents.

A vehicle combination transporting standard goods operates on a long route. In this case, the driver would need a very long continuous driving performance, which needs to be broken up with statutory rest breaks. In timber transport, such a situation, where a single driving performance would take several hours, is rare. As in Sweden, the high proportion of wood from non-industrial private forests, and the distribution of saw and pulp mills require the coordination of several assortments from scattered harvesting sites to multiple mills (Lindström & Fjeld 2014). During the working day, the drivers visit several storage locations and get out of the cab to load the vehicles or to visit the measuring station of the receiving production plant. In this case, the drivers will have natural breaks in their numbing driving work; in addition to this, they will get some exercise, which will get the blood circulating comfortably. It seems that in the Nordic countries, it is not correct to put timber transport in the same category as other heavy traffic transports. Further, the regulations could be designed in such a way that drivers do not have to knowingly break them. Therefore, road transport of timber should be considered as its own transport sector in the driving and rest time regulations.

Next, the impact of support measures on the timber transport activity is considered. It was reported in the survey that the vehicle applications of forest information systems are perceived to have facilitated the planning and implementation of transports, but at the same time they are perceived to be incomplete (Table 4). The training and system support available for the applications divide opinions strongly, although the responses are slightly on the positive side. The impact of poorly functioning communication connections during the use of vehicle applications also divided the opinions. Although vehicle applications are perceived to have made operations more efficient, their use is also perceived to have brought significant additional work. Despite negative experiences, entrepreneurs are aware that a well-built vehicle application could improve the financial profitability of transportation. The vehicle application of the forest information system has brought with it real-time wood inventory monitoring, which benefits both the wood procurement organization and the transport entrepreneur in outsourcing of operations (Palander 2022). Despite the difficult and nerve-wracking problems in daily work, it is a fact that real-time inventory management and reliable storage location-specific balance information improve operations at different stages of the wood procurement chain, and transportation is one of the biggest beneficiaries. However, a clear problem is the issues related to the accessibility and responsiveness of the technical support of the applications, as well as the long delay in fixing non-critical problems. In many places, the world is not ready, and the same also applies to forest information systems and their vehicle applications. Software companies are currently struggling with a labour shortage to a significant extent because there is a global shortage of coders. Because of this, human resources have to be used for critical repair and maintenance work, and lower-priority developments and improvements are delayed or not done. This is annoying for users of information systems which get constantly small errors in the user interface.

Finally, hints were found about the labour situation and training in the wood road transport. It was noticed that the entrepreneurs had a unanimous view on many labour-related issues. A strong majority was of the opinion that young people are not interested in the timber transport sector and that the cooperation of educational institutions with companies is not sufficient; in addition, the skill level of new drivers is not sufficient. It seems that labour will be the success factor in the current growth of the timber transport companies as it has been for the 60 t vehicle combinations (Soirinsuo & Mäkinen 2012). Further, the current experts committed to the sector will soon retire and there are not enough new and well-trained professionals entering the sector. This is believed to increase wage costs in the future, which will be reflected in increased transport costs. Within road transport, timber transport will probably face an even more challenging future which would need the support function of education. The transport of timber is known to be the most difficult task of road transport because wood is delivered all year round from challenging environments. Further, the vehicles are to be driven in severe frost, on slippery roads or in an operating environment saturated by water. Drivers also operate on tight schedules, making and tying the loads themselves. All this, and much more, is done in addition to driving a vehicle 40 times heavier than a passenger car. To generalize, based on the entrepreneurs' responses (Table 5), the labour situation is the most important success factor for the transport companies in LHVs for a near future.

Conclusions

Legislation has set limits on the operating environment for the road transport of timber, and profitability has guided the entrepreneurs to use the LHV as 76 t with a 4+5 axle construction. From the point of view of financial profitability, this has happened, but from the point of view of the operative environment, the choice of the best vehicle combination might be different. Considerations like this are based also on the change in transport contract rate structure, which has taken place in favour of combinations according to the current legislation. Actually, entrepreneurs were concerned about the following factors of the operating environment: road maintenance, driving and rest time regulations, forest information systems and labour situation, which should also be considered by support measures of customers and society. The entrepreneurs suggested the following policy and support functions:

i) funding must be increased for the maintenance and improvement projects of both the regional road network and forest roads,

ii) road transport of timber should be considered as own transport sector on the regulations,

iii) transport entrepreneurs' valuable experience and development ideas should be used for the development of systems, and

iv) the forest industry, entrepreneurs, educational institutions and organizations should cooperate more visibly in education matters and invest in the forest industry's image in order to attract young people to apply for the driver's profession.

If society wants to move to LHVs or HCVs on a larger scale than the current one, the maintenance and construction rates of highways and other national basic roads must also be increased. This requires long-term cooperation between the government, administration and companies operating in the forest sector.

Abroad, Finnish experiences with timber transportation provide alternative information to the forest industry on how to expand the efficiency of timber harvesting and advance the functioning of the European carbon sink.

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