Report on summertime High Capacity Transport (HCT)

2015

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Summary

General information

As the summer season (April-September) 2015 began, there were four permit holders operating with a total of seven HCT combinations. In July, the HCT combination of one new permit holder began running, operating for half of the summer season.

HCT combinations transported raw timber, LVL beams, long shipping containers and retail goods. The combinations covered around 650,000 km of road in total, with the main routes being the Vantaa-Kempele and Espoo-Lahti legs of national road 4 for retail goods; and the Helsinki-Tampere leg of national road 3, national road 6, and the Kotka-Imatra leg of national roads 15 and 26 for shipping containers. Raw timber was transported in the Saimaa region on national roads 5, 6, 13 and 15.

The Vantaa-Lahti and Kouvola-Lappeenranta legs saw most HCT combination traffic, at 3 to 5 loads a day.

Experience

HCT transport has been a success, and the combinations have worked without major problems. The loaded combinations have been stable, agile and safe in traffic. The most frequent challenges were posed by unusual situations or traffic arrangements, such as accidents, road repairs and the related detour arrangements. Overweight combinations, in particular, may even be forced to halt and wait until the situation is over, or a suitable alternative route is found. Traffic controllers are not necessarily able to determine the kind of route onto which they should redirect the combination. Indeed, the authorities should develop a clear procedure for providing notifications of exceptional situations at a sufficiently early stage.

One HCT combination was involved in an accident. The rearmost trailer of the HCT combination fell over into a ditch as a result of a corrective steering manoeuvre by the driver. There were no other parties to the accident, and no injuries occurred. It has been ascertained that the accident was caused by a low level of alertness in the driver. The fact that the combination was an HCT combination probably played no role in the accident. The rearmost trailer of a regular modular combination would probably have suffered the same fate.

Preliminary results

The HCT trials are still in their initial phase, and the results are only indicative. Reporting is still being developed to better assist in arriving at the final conclusions. In addition to the permit holders' own studies, information will be obtained from several university-level studies that are currently ongoing at institutions such as Aalto University and the universities of Lappeenranta and Oulu.

It appears that increasing the length of the combinations will improve transport efficiency more than increasing their weight. In addition, this will require no significant changes to the transport environment, which means that it will not impose costs on society.

Reducing fuel consumption per transported unit is more challenging in the transport of large weights than lightweight goods. If the transported number of units is doubled and the transport is not overweight, HCT is very energy efficient.

1. Introduction

The Finnish Transport Safety Agency Trafi has been able to grant permits of exception for High Capacity Transport (HCT) combinations exceeding the maximum allowed dimension and/or weight limit values since 2013, when authority to grant permits of exception was expanded to cover modular combinations. The purpose of the trials made possible with these permits is to develop technology related to larger-than-usual vehicle combinations and collect data on the suitability of vehicles – which are larger than before – for the Finnish transport system.

In the summer of 2013, Trafi and the Finnish Transport Agency established an HCT steering group with the purpose of steering and coordinate trials including the permit process, and drawing conclusions on the development of legislation based on the trial results. The steering group comprises representatives from Trafi and the Finnish Transport Agency, and a consultant serving as the secretary of the working group.

One of the tasks of the HCT steering group has been to make the permit process as smooth as possible. Determining the eligibility of the transport routes proposed by the permit applicant has taken most time, since several public authorities have issued statements in each case. The Finnish Transport Agency checks the load-bearing capacity of the bridges on the route, local ELY Centres and municipalities examine the suitability of their roads, including all traffic arrangements, and municipalities check the bridges of their own street networks.

In the autumn of 2015, Trafi adopted a new, simpler route assessment method, alongside the parties responsible for road maintenance. This method was carefully reviewed alongside representatives of the ELY Centres before it was adopted. However, the authorities should continue to focus on the rapid determination of route eligibility so that permit applicants receive a decision on the matter in a reasonable time and trials can begin.

The HCT steering group requires monthly traffic reports from all permit holders, who must also report biannually, or separately for the summer and winter seasons, in accordance with the permit-specific study plan. For the summer season, the permit holders were particularly requested to report on the fuel savings achieved by HCT combinations per transported unit compared to reference combinations.

This report primarily discusses transport operations during the summer season, limited to the time period between April and September. The next report, which will discuss the winter season, will be published next summer.

2. Combinations that operated during the summer season

As the summer season (April-September) began, there were four permit holders operating with a total of seven HCT combinations. In July, the HCT combination of one new permit holder began running and remained in operation for half of the summer season. An additional HCT combination began operating at the very end of August, but this had so few transport operations during the observation period that it is not included in this report.

2.1 Speed Group Oy

Speed holds permits of exception for four 11-axle Duo2 combinations with lengths between 32 and 33.5 metres and maximum allowed weights between 68 and 90 tonnes. These combinations are used to transport two long shipping containers instead of the one that fits a normal semi-trailer combination. The combinations transport containers from the Vuosaari Harbour in Helsinki to the Tampere, Lahti and Heinola regions, and from the Mussalo Harbour in Kotka to the Kouvola, Lappeenranta and Imatra regions. Transports have also begun on the Helsinki-Oulu route.

2.2 Orpe Oy

Orpe holds a permit of exception for a 12-axle Duo2 combination that is 31 metres long and has a maximum allowed weight of 94 tonnes. The large combination transported timber in the Saimaa region on the Lappeenranta–Savonlinna–Mikkeli–Lappeenranta and Lappeenranta–Kouvola–Kotka routes.

UPM and Orpe are jointly developing more efficient methods for the large-volume trunk line transport of timber. This combination is able to transport one third more timber than a traditional timber combination. The vehicle is specifically designed for driving on main roads. Different combinations are used for picking up timber from alongside forest roads and transports between plants.

2.3 Keslog Oy/Mikko Niskala Oy

Kuljetusliike Mikko Niskala Oy holds a permit of exception for an 11-axle Duo2 combination with a maximum allowed weight of 90 tonnes and a maximum allowed length of 34 metres. Mikko Niskala Oy operates as a contractor for Keslog Oy, which handles daily transports for K-food stores.

The two double deck trailers of this combination developed jointly by Volvo and VAK hold double the number of rolltainers compared to a regular modular combination. This large combination operated on national road 4 between Vantaa and Kempele, completing six round trips per week.

2.4 Kuljetusliike Kalevi Huhtala Oy

Kuljetusliike Kalevi Huhtala has a permit of exception for a semi-trailer combination with a maximum length of 22 metres and a maximum weight of 60 tonnes. The combination transports long LVL beams from manufacturing plants to harbours, and miscellaneous cargo as the return load. This HCT combination travels along a route with a total distance of 1,320 km. Such beams were previously transported by rail, but VR discontinued the service due to the low number of transports. Without the HCT permit,

the beams would have had to be transported as special transports without a return load.

2.5 Kilon Osuus-Auto KOA

Kilon Osuus-Auto holds a permit of exception for an 11-axle Duo2 combination. The combination's maximum allowed length is 32 metres and maximum allowed weight 68 tonnes. The combination transports S-Group deliveries between Kilo in Espoo and Lahti. It operated for only half of the summer season, or three months. Compared to a regular modular combination, this combination has the benefit of high transport efficiency combined with a reasonably affordable vehicle.

3. Summertime transport operations

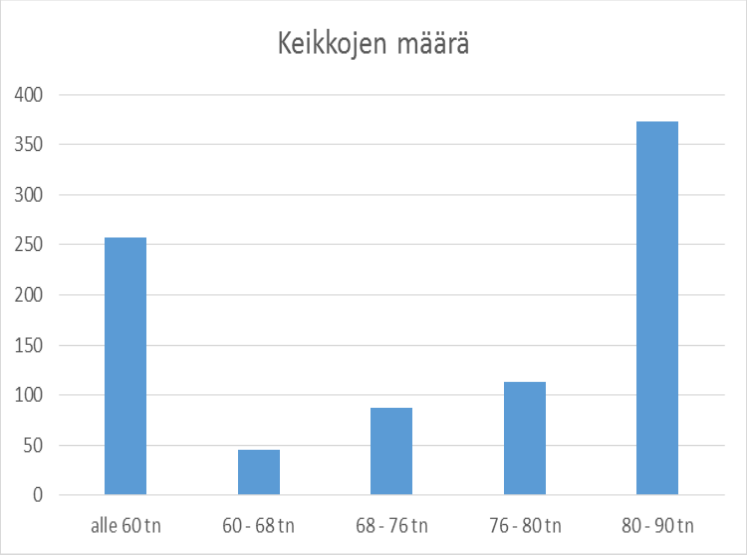
3.1 Traffic volumes

HCT combinations have been operating for a total of two years. Overall, the combinations have driven over 1.1 million km, of which over half, around 650,000 km, was driven during the last summer season, from the beginning of April to the end of September.

Of the permit holders, the most HCT kilometres were driven by the four HCT combinations of Speed, totalling over 260,000 km. Of individual combinations, Keslog's Duo2 combination amassed the most kilometres, almost 170,000 in six months. Huhtala's semi-trailer combination also covered over 120,000 km of road during the summer season. The timber transports of Orpe's Duo2 combination saw the greatest variation in monthly traffic volumes, which is typical, due to the seasonal variations of plants using timber.

3.2 Transport weights of the HCT combinations

Shipping container transport – during the summer season, there were a total of four permits, one of which was for 68 tonnes and three for 80-90 tonnes of weight. The total weight of around half of the container transports exceeded 76 tonnes. In the case of the forest industry's export containers, the total weight of the combination was 78-88 tonnes. In the case of other container transport, the weights were clearly lower as a rule. Somewhat over one quarter of the transports had a total weight of less than 60 tonnes.



	Number of trips

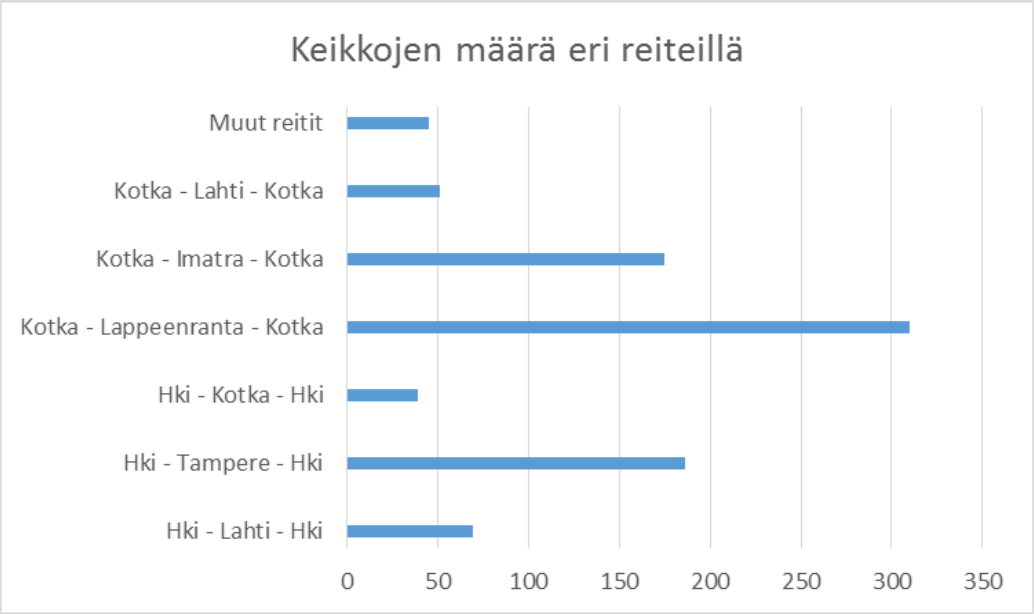
An HCT combination loaded with **timber** had a weight of 90–94 tonnes. However, the share of unloaded driving during the summer season was 33%.

During the summer season, **retail goods** were transported in almost full loads (90 tonnes), while both the fill rate and weight of return loads were significantly lower. The lighter (68 tonnes) combination was used to transport full loads in one direction, while the return loads were relatively empty. In the trunk line transport of groceries,

the sizing of HCT combination loads was successful with regard to transport efficiency. HCT combinations were almost always full with regard to capacity and rolltainer slots.

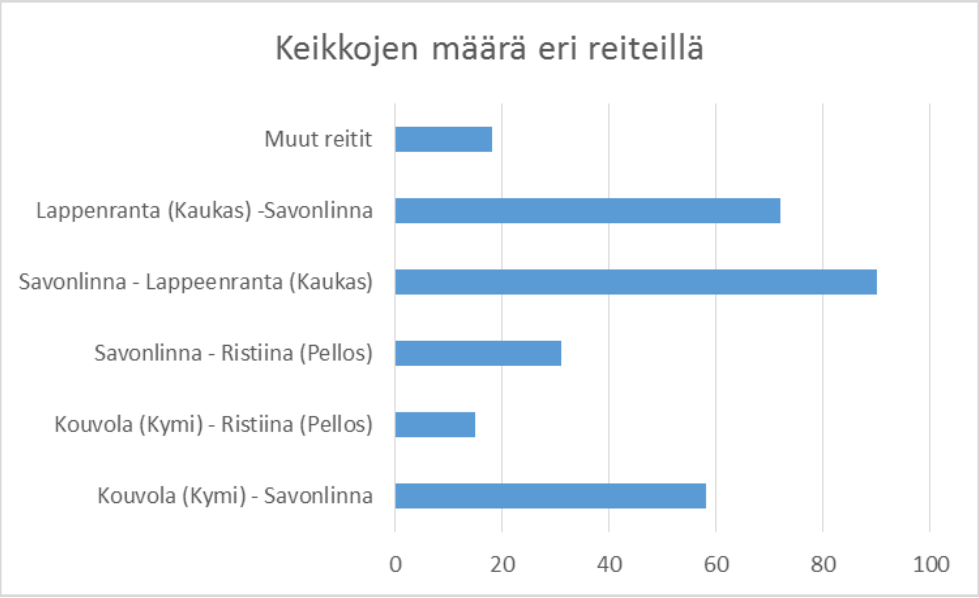
3.3 Transport routes

During the summer season, the largest number of **shipping containers** was transported on national road 6 between Kotka and Lappeenranta, a total of around 500 round trips. The total number of trips on all routes was 875.



	Number of trips on different routes

Most **timber** was transported between Savonlinna and Lappeenranta (NR 6), totalling around 160 one-way trips. The total number of trips during the summer season was around 300.



	Number of trips on different routes

Retail goods were transported between Vantaa and Kempele (NR 4) on around six round trips per week, and between Espoo and Lahti (NR 4) for up to around 12 trips per week.

With all transports totalled, HCT combinations accounted for the most traffic between Vantaa and Lahti, and Kouvola and Lappeenranta during the summer season. These legs saw three to five transports a day.

3.4 Experiences on the road

The permit holders' experiences on the road were mainly positive. According to the drivers, fully loaded HCT combinations were more stable to drive than regular combinations. They were also praised for their agility. The steering axles and axle weight reduction functions of the trailers have allowed the construction of combinations that move smoothly in traffic, despite their length. However, there is still much room for improvement in the combination of various technical solutions, the settings of the automatics, and the forced steering functions of the trailers used by the drivers. The drivers are already highly aware of the necessity of these functions and the importance of using them correctly.

The combinations were out of operation for some days, mainly due to the repair of minor defects or maintenance. Other road users did not react unusually to the HCT vehicles.

The uphill deceleration of an HCT combination was compared to the deceleration of a regular combination with both an almost full load and a smaller return load. Speed loss on large hills depends on the ratio between engine power and mass. The HCT combinations meet the minimum statutory requirements by a clear margin. There was no significant difference in their speed compared to other fully loaded combinations. Many drivers have reported that this is in line with their own experiences.

3.5 Unusual traffic situations

In summer traffic, unusual traffic arrangements on HCT routes, such as roadwork and accidents requiring temporary arrangements and detours, posed the greatest challenges. Unexpected obstacles along the permit routes pose a major challenge to overweight combinations in particular. The combination may even have to halt and wait until the situation is over, or a suitable alternative route is found. Information on exceptional arrangements should be made available as early as possible, so that the detour's suitability for overweight HCT combinations can be ascertained.

The detour caused by the repairs of the Simpele bridge on national road 6 caused problems for the August transports of an HCT combination. The permit holder was unaware of the detour and was not initially included on the Finnish Transport Agency's disruption map. However, the detour was soon found to be suitable for an HCT combination. The intersections and one steep hill on the detour did not pose particular challenges for a larger-than-normal combination in summer conditions, once permission was given to use the route.

On national road 4 in Pulkkila, information on the detour arrangements was obtained just a week before traffic on the main road was stopped. The operators and the Finnish Transport Agency cooperated well, taking a couple of days to determine a suitable alternative route. The procedures followed in such situations will be developed in the future.

Two other detour arrangements were made during the summer season, one of which was ideal for an HCT combination, while a route through the parking lot of a store had to be used as part of the other. In addition, a couple of detour arrangements had to be made due to traffic accidents. Traffic controllers were present at both locations.

3.6 Traffic accidents

During the summer season, one of the HCT combinations was involved in a traffic accident, in August. The combination was driving along a national road early in the morning on its way to Kotka Harbour. The combination was loaded with two 45' shipping containers full of paper rolls. The total weight of the combinations was around 84 tonnes, of which the paper rolls accounted for around 50 tonnes.

The vehicle drifted to the right on a straight road section and, as the driver steered the vehicle back onto the road from a gently sloping embankment, the rearmost trailer fell over onto its side. It also toppled the dolly. The combination had almost completely stopped by the time the trailer fell over. There were no personal injuries and no other parties were involved in the accident.

The conditions during the time of the accident were good: the sun was shining and the road was dry. The combination had no technical malfunctions. It has been ascertained that the cause of the accident was the driver's rather low level of alertness. The driver had taken the proper breaks. It is unlikely that the fact that an HCT combination was in question played any role in the accident. The rearmost trailer of a regular modular combination would probably have suffered the same fate.

4. Fuel savings of the transports

4.1 Shipping container transports

The permit holders were asked to report fuel consumption per transported unit, particularly for HCT combinations, and to compare this to the reference combinations.

In the case of the shipping container transports, an HCT combination transporting two long and light shipping containers consumed 40% less fuel per container at a total weight of less than 68 tonnes, compared to two regular semi-trailer combinations transporting one container. The relative difference in consumption was slightly smaller for heavier containers.

According to the permit holder, because one leg of shipping container transports is almost always driven with empty containers, in the case of empty containers in particular fuel would be saved by vehicles with tandem bogie lifts, since the rearmost wheels of such vehicles are in the air.

4.2 Retail goods transports

The fuel consumption per rolltainer of heavy (90 tonnes) HCT combinations transporting retail goods was up to 25% lower than that of regular modular combinations (64 tonnes). Compared to the best double deck transports of rolltainers, the advantage was clearly lower, but a minimum of 10% savings in fuel consumption per rolltainer was still achieved.

4.3 Timber transports

The fuel consumption of a long semi-trailer combination (60 tonnes) transporting **LVL beams** was compared to that of two regular semi-trailer combinations (48 tonnes). In such a case, the estimated fuel savings would be around 36%. In reality, making such a comparison would be more difficult, because a special transport would be used as the actual reference. After all, special transport vehicles have major limitations with regard to the return load.

Only indicative results could be obtained for the combination **transporting raw timber**. Metsäteho is just beginning its actual studies.

According to studies of preliminary samples, a loaded HCT combination (94 tonnes) consumed roughly the same amount of fuel per net payload tonne as the reference combination (semi-trailer-centre-axle trailer combination 76 tonnes). Combinations intended for timber transport are well optimised for large weights and are energy-efficient, due to which it is difficult for HCT combinations to achieve significantly better results.

5. Research and development activities

In summer 2015, the focus was on beginning the operations safely. No more-specific measurements or reports have been completed on the cost-effectiveness, environmental friendliness and traffic safety of HCT combinations.

5.1 Transport operations

At the start of the summer season, Speed Oy was approved as a training centre providing qualification training. The company now intends to prepare a separate Eco-lorry driver's training programme and to have this approved. A driver completing the periodic training for professional drivers defined in Directive 2003/59/EC would be entitled to a certificate demonstrating that he or she had completed the training day. Speed Oy has the largest number of HCT drivers, with two additional drivers starting in the summer season. The other permit holders have also provided training for drivers allowed to drive HCT combinations.

The correct loading of a timber combination was determined in cooperation with Metsäteho, by loading test loads with different timber grades on Orpe's combination. The axle weights of the vehicles were measured with wheel weighing scales and the timber was loaded in such a manner that the load on the vehicles was distributed as intended. The tests also included an exploration of how easily the axle loads alter when the location of timber in the cargo space is changed. The results were reviewed together with the loaders.

In most cases, the trailers have been loaded without problems being experienced in the vehicle's weight distribution. Before setting off, the driver always checks the weight distribution and total weight of the vehicle. Individual instances of incorrect loading have been corrected prior to setting out, and the matter has been discussed with the loader.

The permit holders have applied for and been granted new and complementary routes in order to rationalise the functionality of their transport chain. In many cases, complementing the routes only arises as an issue in the light of experience following the startup of transport operations.

5.2 Development of the transport fleet

Together with transport companies, vehicle manufacturers have been systematically keeping track of the wear and operation of towing vehicles and trailers of HCT combinations under larger stresses. Considering the kilometres driven, no unusual wear or particular failures were noted in the vehicles or trailers. Such tracking will become more interesting when the transport fleet begins to wear.

New settings for the power trains of vehicles equipped with an advanced cruise control were received from the vehicle manufacturer; minor savings in fuel consumption were achieved as a result. Even small relative savings are significant, since the annual fuel consumption of a large combination can reach up to 200,000 litres.

Small adjustments have been made to the dimensions of the combinations, modifying their weight distribution, turnability and driving dynamics. This work will be actively continued and the results will be sifted through for information on what works well and what may cause problems on the road. With regard to towing vehicles, adjustments are made through structural changes. The loading of the different axles can also be adjusted during driving, via the air suspension control.

5.3 Research activities of permit holders in 2016

To make transports smooth during the winter, HCT combinations use almost the full range of solutions for improving traction. Different winter tyres are tested on powered axles in cooperation with tyre manufacturers. Automatic tyre chains and sand applicators have been installed on several towing vehicles, providing a temporary improvement in traction in slippery conditions. Data will be collected during the winter season in order to determine which of these solutions are necessary for larger combinations.

The tracking of transport fuel economy will be improved. Such tracking will include other transport costs and a comparison with normal-sized combinations.

5.4 Universities

Lappeenranta University of Technology and Metsäteho have been preparing a research project called "Terminal Operations in Energy Efficient Timber Logistics". As part of this project, research that began early in the year is modelling the use and impact of HCT terminals in overall timber logistics, with a closer look being taken at issues such as fuel consumption and emissions.

The University of Oulu is currently investigating the driving stability of HCT timber combinations, by comparing driving dynamics measurements on 60 and 76 tonne combinations. The large sample size will give a reliable idea of the driving stability, mobility and controllability of HCT combinations. Measurements are being performed both on the road and in closed areas, as well as in computer simulations. Driver experiences are also being collected from the drivers' journals. Regarding the above, the research carried out in closed areas will involve the monitoring of tyre wear and performance of tyre research based on computer simulations.

A sub-project on road and bridge stresses will determine and measure the deformations in the road base caused by HCT combinations. The results will be compared to road stresses caused by regular vehicle combinations, with the purpose of drawing conclusions on road durability. This research is partly in the form of a follow-up study, in which monitoring occurs over a longer time period.

In the case of drawbar measurements and observation studies of other vehicle structures, the drawbar is fitted with sensors enabling the determination of the loads to which the towing device in question is subjected. Towing devices wear down – as the mass of the vehicle combination increases, so too does the load on the towing device. Measurements are being made to determine by how much the loads actually increase.

A master's thesis is nearing completion at **Aalto University**, based on an investigation of the lateral movement of a Duo2 type HCT combination in slippery conditions. According to this thesis, the studied Duo2 combination is relatively unstable at high speeds in slippery conditions. The twin wheels of semi-trailers and the long drawbar of the front bogie attached close to the rear axles of the vehicle unit in front significantly increase stability during lateral movement, even in slippery conditions.

A master's thesis on the impact of HCT combinations on the traffic flow is under way at **Aalto University**. In practice, this study is being performed by filming the traffic behind, in front of and to the sides of each combination using a total of three video cameras, before analysing the data thereby generated.

In addition to the filming, the location and speed of the vehicle combinations is being tracked using GPS devices. Three HCT vehicle combinations – each of which also has a vehicle combination operating on the same route and generating reference data – were chosen as the subjects of this study.

The camera study is being used to determine how HCT combinations affect overtaking, overtaking behaviour and traffic congestion. The measuring equipment also enables monitoring of the speeds of vehicle combinations. To a certain degree, the cameras

also enable the monitoring of the behaviour of vehicle combinations, such as the oscillation of trailers. Additional information will be obtained by interviewing the drivers.

6. Conclusions

Overall, the HCT trials are still in their initial phase and the results are only indicative at this stage. Reporting is still being developed in order to better meet the requirements of the authorities in drawing final conclusions. In addition to studies performed by the permit holders, information will be obtained from several university-level studies currently ongoing at institutions such as Aalto University, and the universities of Lappeenranta and Oulu. *In the future, the variety of research activities should be both ensured and expanded to cover the logistical operating concepts and guarantee the functionality and efficiency of the transport system.*

Loaded HCT combinations have so far proven to be stable, agile and safe in traffic. HCT transport has been a success and the combinations have encountered no major problems. Most challenges for HCT transport were posed by unusual situations or traffic arrangements, such as accidents, road repairs and the related detour arrangements. *Indeed, the authorities should develop a clear procedure for giving notification of exceptional situations sufficiently early.*

One HCT combination was involved in a traffic accident, the cause of which was a low level of alertness in the driver. The fact that an HCT combination was in question is unlikely to have played any role in the accident. The rearmost trailer of a regular modular combination would probably have suffered the same fate. *The traffic safety of HCT combinations will continue to be subject to careful scrutiny in the future.*

Improving logistical efficiency depends on the efficiency of the entire transport system. The efficiency of HCT transports is also affected by the entire transport chain and terminal operations, such as the concept based on which forest trucks load timber onto an HCT combination. In the case of miscellaneous cargo, backing up a larger combination towards a loading dock poses challenges of its own. *The gains achieved on the road can easily be lost during operations at the terminal.*

Increasing the length of the vehicles seems to improve transport efficiency more than increasing their weight. *Furthermore, increasing vehicle length requires no major changes to the transport environment, thereby avoiding extra costs to society.*

Reducing fuel consumption per transported unit is more challenging when transporting large weights than lightweight goods. If the transported number of units is doubled, and the transport is not overweight, an HCT combination has high energy efficiency. *Monitoring of the energy efficiency of HCT transports will be continued.*