INFRES – Innovative and effective technology and logistics for forest residual biomass supply in the EU (311881)

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NOVEL BUSINESS AND SERVICE MODELS OF THE FOREST BIOMASS SUPPLY – D3.5

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Preface

Finnish Forest Research Institute (Metla) is coordinating a research and development project 'Innovative and effective technology and logistics for forest residual biomass supply in the EU – INFRES'. The project is funded from the EU's 7th framework programme. INFRES aims at high efficiency and precise deliveries of woody feedstock to heat, power and biorefining industries.

INFRES concentrates to develop concrete machines for logging and processing of energy biomass together with transportation solutions and ICT systems to manage the entire supply chain. The aim is to improve the competitiveness of forest energy by reducing the fossil energy consumption and the material loss during the supply chains. New hybrid technology is demonstrated in machines and new improved cargo-space solutions are tested in chip trucks. Flexible fleet management systems are developed to run the harvesting, chipping and transport operations. In addition, the functionality and environmental effects of developed technologies are evaluated as a part of whole forest energy supply chain.

This publication is a part of the INFRES project. The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2012-2015] under grant agreement n°311881.

In this publication a novel business and service solution that could meet the future raw material demand was tested. The authors wish to thank Dr Juha Laitila, Finnish Forest Research Institute, for his valuable help.

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Title	**Title**
Author(s)	Perttu Anttila, Teemu Mustonen, Antti Asikainen, Matti Tuukkanen
Abstract	The objective of this study was to test a novel service model in forest chip supply, i.e. TCS Opti software in modeling and analyzing supply chains of forest chips. This was accomplished in a case study, where different supply chains and transport restrictions for a delivery company located in Eastern Finland were compared. The specific aims of the case study were 1) to evaluate the actual cost savings with larger trucks in transportation of forest chips, and 2) to identify possible bottlenecks and suitable routes of the road network for the bigger trucks. The results indicated that up to 20% savings in transport distances and 13% savings in transport costs could be obtained in the study area. The high cost savings are due to the fact that there was only one bridge constraining the transport with bigger trucks in the study area. The results are, however, valid for the case study area only and cannot be generalized to whole country. The service model itself appears to be feasible. TCS Opti software gave sensible results in modeling and analyzing supply chains of forest chips, although no final judgment can be given based on this small test.
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1 Background

From the beginning of October 2013 heavier and higher vehicles have been allowed on Finnish roads (Ministry of Transport… 2013). Before, the maximum mass of trucks was 60 tonnes and the maximum height 4.2 metres. Now trucks up to 76 tonnes and 4.4 metres are allowed (*Figure 1*). The changes in legislation have been motivated by reductions in logistical costs and greenhouse gas emissions.

Figure 1. The maximum mass of this chip truck trailer unit is 76 tonnes. Picture: Perttu Anttila.

According to a novel enquiry, functionality of road network is the by far the most important development area in wood procurement in Finland (Väätäinen et al. 2014). The need for development is even higher now with introduction of the bigger trucks. Due to increased masses and heights; the Finnish Transport Agency (FTA), which is responsible of maintaining and developing the public road network, has set new restrictions on bridges and underpasses. In March 2014, new restrictions (65 or 70 t) had been set on more than 500 bridges on the roads maintained by FTA. This is a considerable increase to the number of some 100 bridges that had a mass restriction before (ranging from 16 to 60 t). In addition, there are 28 ferries that cannot bear the new maximum masses and at least 80-120 bridges that are maintained by municipalities or private road maintenance associations that will have a mass restriction.

For a transport company the actual cost savings by using bigger trucks depend very much on the restrictions of the road network in its operation region. Should there be a mass restriction on a bridge on the operator’s main transport route, either a truck cannot carry full load or a detour must be found. Either one of the alternatives reduces the cost savings of the entrepreneur. Especially in this situation better planning of logistics would help to cut down the extra costs caused by the road network restrictions. Consequently, a tool for modeling and analyzing route logistics might be a solution to the problem.

The overall objective of the study was to test a novel service model in forest chip supply, i.e. TCS Opti software in modeling and analyzing supply chains of forest chips. This was accomplished in a case study, where different supply chains and transport restrictions for a delivery company located in Eastern Finland were compared. The specific aims of the case study were 1) to evaluate the actual cost savings with larger trucks in transportation of forest chips, and 2) to identify possible bottlenecks and suitable routes of the road network for the bigger trucks.

2 Materials and methods

In the case study the actual cost savings, bottlenecks and suitable routes were evaluated by comparing three different transport scenarios (*Table 1*) of one, hypothetical transport company. The maximum load volume for a 60-t truck was fixed to 120 m^3 (Karttunen et al. 2012, Hakonen & Laurila 2011) and the corresponding value for a 68-t and a 76-t truck to 150 m^3 (Vepsäläinen 2014, Laitila & Väätäinen 2011). In transport of forest chips truck load space is usually the constraining factor rather than the total mass. This is why scenarios *76upgraded* and *76new* are similar for both 68 and 76-t trucks. Scenario *76new* represents the present situation, where new restrictions for bigger trucks on the road network have been set. On the other hand scenario *60t* is comparable with the situation before October 2013. In scenario *76upgraded* the underlying assumption is that the bigger trucks could operate on the same road network as before, i.e. the bridges which have restrictions for bigger trucks at the moment would be upgraded.

Table 1. The transport scenarios.

Scenario	Truck mass (tonnes)	Load volume (m^3)	Road network restrictions
60t	60	120	No restrictions for 60-t trucks
76upgraded	68 or 76	150	No restrictions for truck mass
76new	68 or 76	150	Restrictions for trucks heavier than 60 t

The transport company delivers logging residue chips to a combined heat and power plant (29°50’ E, 62°35’ N) in North Karelia, Eastern Finland. The company has a register of roadside storages which is utilized in transport planning (*Figure 2*). The data on the roadside storages were based on real roundwood storages by Stora Enso company. The data on roads and restrictions originated from FTA.

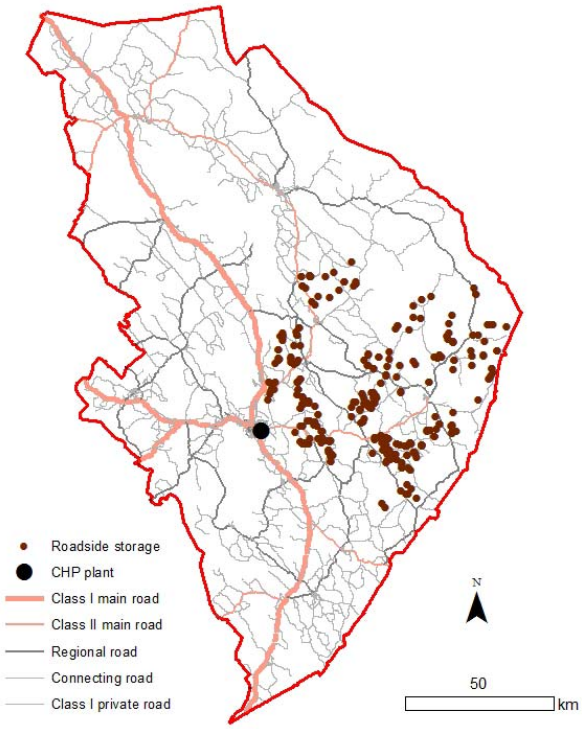

Figure 2. Spatial distribution of road side storages of the transport company within the province of North Karelia.

When a storage is chosen to be delivered, the residues are chipped to a chip truck and transported to a selected plant. The plant has a certain monthly demand that the company must meet.

The transportation distances and used transport routes during one year of operation were calculated by simulating the operation with TCS Opti software. TCS Opti is a commercial tool for planning and optimizing routes and resources with various different constraints which are essential in planning. The constraints are divided into three high level ones:

- Resource constraints
    - Availability of trucks and drivers, as well as start and stop points (As the focus of this study was on the bridge restrictions, the number of trucks was not constrained in the analysis.)
    - Size and equipment of truck (e.g. does the vehicle have a crane or not)
    - Working hours and allowed driving time for drivers
- Pick up place related information

    - Location name, address and coordinates
    - Opening hours and other access related data like road constraints (e.g. what kind of a truck can access the location)
    - Information related to available amount and quality and possible equipment needed for loading
- Delivery place information
    - Location name, address and coordinates
    - Opening hours, number of trucks/hour that can be unloaded etc.
    - Amount of different qualities needed in daily, weekly or monthly level and their minimum and maximum

Part of the solution is TCS Operation which consists of Office (ERP) and mobile solutions for managing the whole operations from ordering to invoicing. TCS is a highly parameterized server based solution and it can be used in various different industries. It is using digital maps for planning, guidance and follow-up increasing the efficiency remarkably. In addition to solving complex operative problems, TCS Opti can be used as a simulation tool in strategic level. The tool has not been applied in planning of forest chip transport before, but it has applications in round timber wood logistics as well as various other types of logistics such as transportation logistics, waste management and services in companies like SITA Finland, Lassila &Tikanoja, Lindström, Anticimex, Eco Baltia and many others.

Based on the distances driving time with and without load was calculated (Nurminen & Heinonen 2007). The loading and unloading time was obtained by scaling the corresponding times in the study by Laitila et al. (2010) by the size of the load space. The hourly cost of the truck when driving was EUR 88.2 and when loading or unloading EUR 63.3. The figures were taken from the report of Laitila et al. (2010) and updated to the current cost level with the cost index of forest machinery and vehicles produced by Statistics Finland (Statistics… 2014).

3 Results

In total, 17 out of 26 bridges in North Karelia had a restriction for the total mass of a vehicle (*Figure 3*). However, on the optimized routes of the transport company there was only one bridge which constrained driving with bigger trucks. This resulted in five inaccessible roadside storages in scenario *76new*.

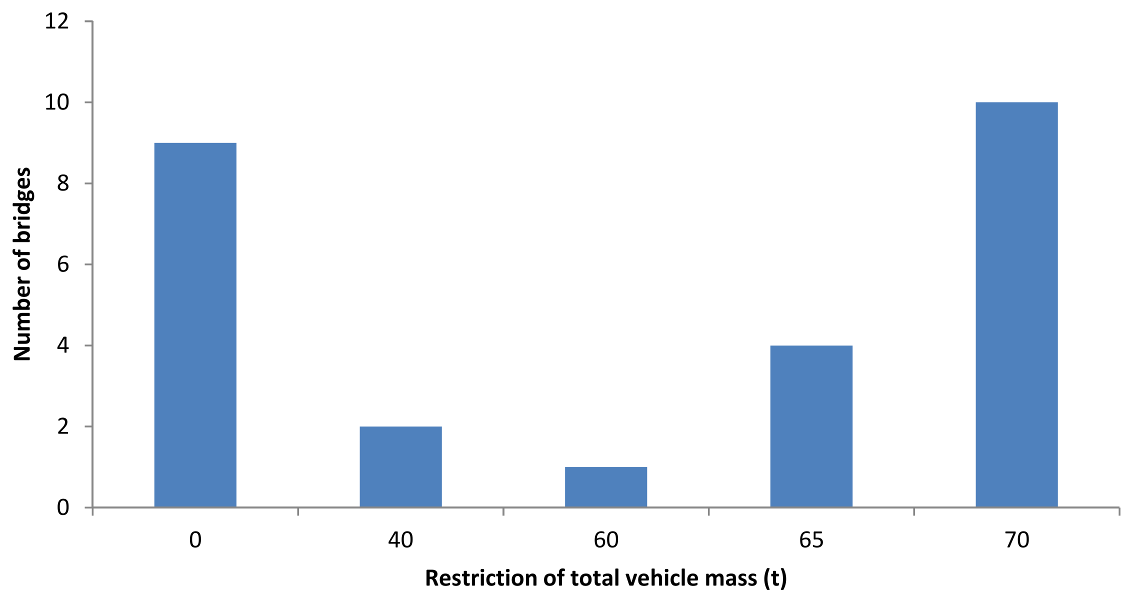

Figure 3. The distribution of restrictions of total vehicle mass in North Karelia.

The total delivered loose volume within one year was 144,317 m^3 when all the storages were accessible and 141,375 m^3 when the five storages were isolated (*Table 2*). Transport costs of the inaccessible storages were not considered in the costs for scenario *76new*.

Table 2. Results for the different transport scenarios. For comparison the results for scenario 60t without the isolated storages and the average road transport cost of roundwood in Finland in 2013 (Strandström 2014) have been presented. The transport costs are expressed per solid m^3.

Scenario	Total distance (km)	Number of loads	Nr of isolated storages	Total loose volume (m^3)	Avg load size (m^3)	Transport cost (€m^{-3})	Transport cost (cent m^{-3} km^{-1})
60t	130660	1220	0	144317	118	10.54	9.8
76upgraded	104645	976	0	144317	148	9.16	8.5
60t - wo isolated	125292	1195	0	141375	118	10.43	9.9
76new	100417	957	5	141375	148	9.08	8.6
Average cost of roundwood transport in Finland						8.02	7.5

The total transport distance was 20% lower with the 76-t truck than with the 60-t truck when new restrictions were taken into account (*Figure 4*). The corresponding saving in euros was approximately 13%.

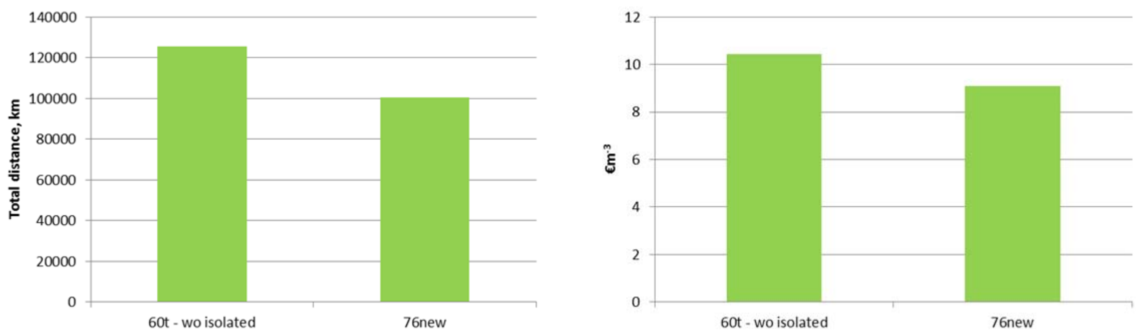

Figure 4. Total driven kilometres (left) and unit costs (right) with a 60-t and a 76-t truck.

4 Discussion and Conclusions

The use of bigger trucks yielded cost savings in the case study region. However, as the number and effect of bridge restrictions vary from place to place, the results cannot be generalized. The case study area may actually be more suitable for bigger trucks than an average area, because it is located in a region, where the bridges have been built to last large timber trucks. If the study had been carried out in a region where the bridges were built long time ago, the savings might have been smaller.

It must also be noted that the higher investment and operating costs of bigger trucks compared to the 60-t trucks were not considered. If they were, the savings would have been, again, smaller.

In practice it is also difficult to maneuver the bigger trucks on forest roads. The bigger size may hinder turning of the trucks on tight crossings. The problem will be, however, alleviated by the time when forest roads are being rehabilitated.

The service model itself appears to be feasible. TCS Opti software gave sensible results in modeling and analyzing supply chains of forest chips, although no final judgment canbe given based on this small test.

For strategic or tactical planning also other tools could be feasible. There is a number of examples of models for optimization of energy wood flows (e.g. Gunnarsson et al. 2004, Gronalt and Rauch 2007, Kanzian et al. 2009, Palander and Vesa 2009). For operational planning there exist systems developed in managing storage data and resources. Compared to those systems, the extra benefit of complex optimization systems like TCS Opti may not be significant for a small contractor having only one or two trucks. When the scale of operation gets larger, i.e., the contractor have several trucks; the benefit could be bigger. Therefore, the tool should be tested with data of a larger contractor.

References

Gronalt, M. & Rauch, P. 2007. Designing a regional forest fuel supply network. Biomass and Bioenergy 31(2007): 393–402.

Gunnarsson, H., Ronnqvist, M. & Lundgren, J.T., 2004. Supply chain modelling of forest fuel. European Journal of Operational Research 158, 103–123.

Hakonen, T. & Laurila, J. 2011. Metsähakkeen kosteuden vaikutus polton ja kaukokuljetuksen kannattavuuteen. Seinäjoen ammattikorkeakoulun julkaisuja B55. 31 s. (In Finnish)

Kanzian, C., Holzleitner, F., Stampfer, K. & Ashton, S. 2009. Regional energy wood logistics–optimizing local fuel supply. Silva Fennica 43(1): 113–128.

Karttunen, K., Föhr, J., Ranta, T. Palojärvi, K. & Korpilahti, A. 2012. Puupolttoaineiden ja polttoturpeen kuljetuskalusto 2010. Metsätehon tuloskalvosarja 2/2012. 17 p. (In Finnish)

Laitila, J. & Väätäinen, K. 2011. Kokopuun ja rangan autokuljetus ja haketustuottavuus. Metsätieteen aikakauskirja 2/2011: 107-126. (In Finnish)

Laitila, J., Leinonen, A., Flyktman, M., Virkkunen, M. & Asikainen, A. 2010. Metsähakkeen hankinta- ja toimituslogistiikan haasteet ja kehittämistarpeet. [The challenges and development needs of the supply logistics of forest chips.] Espoo 2010. VTT Tiedotteita – Research Notes 2564. 143 s. (In Finnish). Available at: http://www.vtt.fi/inf/pdf/tiedotteet/2010/T2564.pdf.

Ministry of Transport and Communications. Better competitiveness through new masses and dimensions for heavy goods vehicles. Press release 6 June 2013. Available at: http://www.lvm.fi/pressreleases/4150413/better-competitiveness-through-new-masses-and-dimensions-for-heavy-goods-vehicles.

Nurminen, T. & Heinonen, J. 2007. Characteristics and time consumption of timber trucking in Finland. Silva Fennica 41(3):471-487.

Palander, T. & Vesa, L. 2009. Integrated procurement planning for supplying energy plant with forest, fossil, and wood waste fuels. Biosystems Engineering 103:409-416.

Statistics: Cost index of forest machinery and vehicles [e-publication]. 2014. Helsinki: Statistics Finland [referred: 29.8.2014]. Access method: http://www.stat.fi/til/mekki/index_en.html.

Strandström, M. 2014. Timber Harvesting and Long-distance Transportation of Roundwood 2013. Metsätehon tuloskalvosarja 3b/2014.

Väätäinen, K., Anttila, P., Laitila, J., Nuutinen, Y. & Asikainen, A. 2014. Aines- ja energiapuun kaukokuljetuksen tulevaisuuden haasteet ja teknologiat. [Future challenges and technologies of transportation of industrial rounwood and energywood.] Metlan työraportteja / Working Papers of the Finnish Forest Research Institute 291. 31 p. (In Finnish with English summary)

Personal communication

Vepsäläinen, M. Phone conversation with Matti Vepsäläinen, Kome Ltd on 20 May 2014.

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