Simulation of timber truck transport logistics – Case Central Finland

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Discrete-event simulation as a study method

- Efficient method in complex system analysis
  - Systems with internal interactions, machine idling, stochasticity, several study scenarios
  - Cost/time efficient compared to real world piloting
- Purpose-build models
- Visualization of the system simulations
- Various data sources and data-matrixes can be used

"A simulation is the imitation of the operation of a real-world process or system over time" (Banks et al. 2010)
Introduction to the case study

• **Challenges** of timber logistics in the prevailing operation environment
  – Many small roadside storages and wood assortment piles
    • In the case data 31% of all piles less than 10 m³
  – Number of transported wood assortments and mills are high
    • In total 25 different wood assortments
      – No of assortments in roadside storage: avg: 9, range: 2-12
    • 12 delivery facilities
      – eight saw mills, two pulp mills and two train loading terminals
• Study was conducted to Metsäkolmio Ltd under the S2Biom project
Objectives of the study

- **Objectives** of the study
  - Reveal the economy and operation potential of
    a) multi-assortment load model
    b) bigger timber trucks,
    in prevailing operation environment
Scenarios for the transport methods

Single-assortment load method

1. full load
2. 
3. 
4. full load

Multi-assortment load method

1. full load

8 delivery places had an option for multi-assortment transports
Scenarios for the sizes of timber trucks

64 tonnes, 7-axel unit

68 tonnes, 8-axel unit

76 tonnes, 9-axel unit

84 tonnes, 10-axel unit

Consisted in study scenarios

To be studied…
Material & Methods

• Roadside storage data
  – co-ordinates, wood assortments, volumes, distances to delivery facilities and parks (by ArcGIS and Digi Road)
  – derived and recalculated from the earlier stand data
    • Area, storage size, assortment specifications from the customer
• Characteristics of the operation environment/-model
  – work-shifts, wood reception times, routing rules
  – time-element functions from Nurminen et al. 2007
• Cost factors and values derived from the Finnish Transports and Logistics SKAL and the truck dealers
Demand of each wood assortment in each end use facility over one year

Different colors represent different end-use facilities.
Roadside storages, delivery facilities and truck parks
Roadside storages and sawmills of pine sawnwood
Scenario control in Excel workbook

Roadside storage data

Monthly demands of mills

Output from the Witness

Cost calculation

Results

Parametres for the operations specifications
Witness simulation environment
Results

Work element comparison

- Driving empty
- Loading
- Driving to next pile
- Driving loaded
- Unloading
- Loading to train
- Shift change
- Idle
- Interruptions
- Off-shift

- 64 tons, 1 assortment
- 68 tons, 1 assortment
- 76 tons, 1 assortment
- 64 tons, multi-assortments
- 68 tons, multi-assortments
- 76 tons, multi-assortments
Results

Transported timber and operating hours per truck in one year

Annual demand 258,000 m³
Results

Unit cost comparison, €/m³

Avg. Load cycle: 64 ton 168.8 km 68 ton 170.6 km 76 ton 175.0 km 64 ton 162.7 km 68 ton 163.6 km 76 ton 167.2 km

Transport capacity not in full use
**Discussion**

- Multi-assortment load method resulted 1.6–3.3 % lower unit costs compared to single-assortment load method
- Bigger truck size decreased transporting costs 1.5 % and 2.5 % while comparing 64 tonne truck to 68 and 76 tonne trucks in single-assortment scenarios
  - 0.4 and 0.8 % lower costs in multi-assortment scenarios, respectively
- Reasons for the low cost-benefit of the bigger trucks
  - 76 tonne trucks’ capacity was not in full use (idling time)
  - Bigger trucks have higher investment and variable costs
  - Transport distances were relatively short (Avg. load cycle: 163-175 km)
  - Small pile size is not favorable for the trucks with big load space
- Fixed load volumes were used for each wood assortment
  - 48, 51 and 58m³ for 64, 68 and 76 tonne trucks
Research for the future

• The developed model can be used to analyze the effect of different logistical concepts and operation models on e.g.
  – transport costs
  – transported volumes
  – utilization rates of capacities

• The model can be extended to other geographical regions and timber supply environments

• Special interest in
  – the use of terminals as a part of timber supply
  – new operation models for trucks with varying sizes
  – the influence of routing rules, no. of assortments, RS storage size etc. on cost-efficiency
Volume variation of load spaces

(for future simulations)

Maximum load spaces in m³ for each assortment - Mid-winter (crane included - 3.5 tons)

Sawn wood assortments, 18 assortments

Pulp wood assortments, 7 assortments
Thank you!