Optimal transport scheduling: Demonstration of Capability and Potential Gains with FastTRUCK

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Outline

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- Objectives of the study
- Background (truck scheduling)
- Methodology (data sets, FastTRUCK tool, scenarios modelled)
- Results (tasks completed, trucks utilised, utilisation, unit cost)
- Conclusions and Recommendations

Objectives

- Demonstrate the versatility of FastTRUCK (truck scheduling tool) by applying it to a set of real scenarios

- Compare actual with predicted performance metrics for a typical day of transport operations

- Provide recommendations to improve the utility of FastTRUCK for use by forest companies

Background

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- Some companies in Australasia harvest and deliver millions of cubic meters per year. This represents thousands of truck trips per year from coupes to customers which have to be optimally scheduled to reduce costs and meet their demand

- Transport of logs from forest to customer (mills or ports) is a significant cost component in the life cycle of a forest. Reductions in transportation costs ranging between 5 and 30%, as a result of optimal allocation of trucks to routes, have been reported in the literature

- Heuristic procedures, which provide near optimal solutions, have been implemented by some forest companies because of their much faster and more acceptable solution times compared with MIP.

Background- Daily truck scheduling problem

1 truck, 4 forests, 6 customers, 3 trips = 14,000 possibilities

3 trucks, 4 forests, 6 customers, 5 trips = 24,000,000 possibilities!!!

Source: Skogforsk

Background- Solution approach (heuristics)

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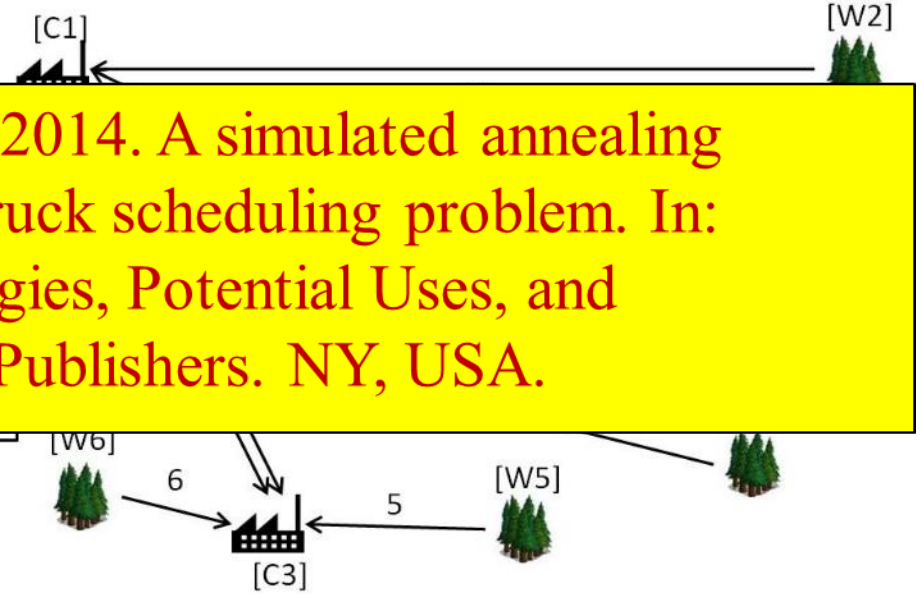

ACUNA M., SESSIONS J. 2014. A simulated annealing algorithm to solve the log-truck scheduling problem. In: Simulated annealing: Strategies, Potential Uses, and Advantages. Nova Science Publishers. NY, USA.

FastTRUCK provides a near optimal solution based on a simulated annealing (SA) algorithm which allocates transport tasks to trucks in order to minimize transport costs

Route for truck 1 →	Task 9	Task 7	Task 6
Route for truck 2 →	Task 8	Task 5	Task 1
Route for truck 3 →	Task 10	Task 2	Task 4
Route for truck 4 →	Task 11	Task 3	

Methodology – Study location

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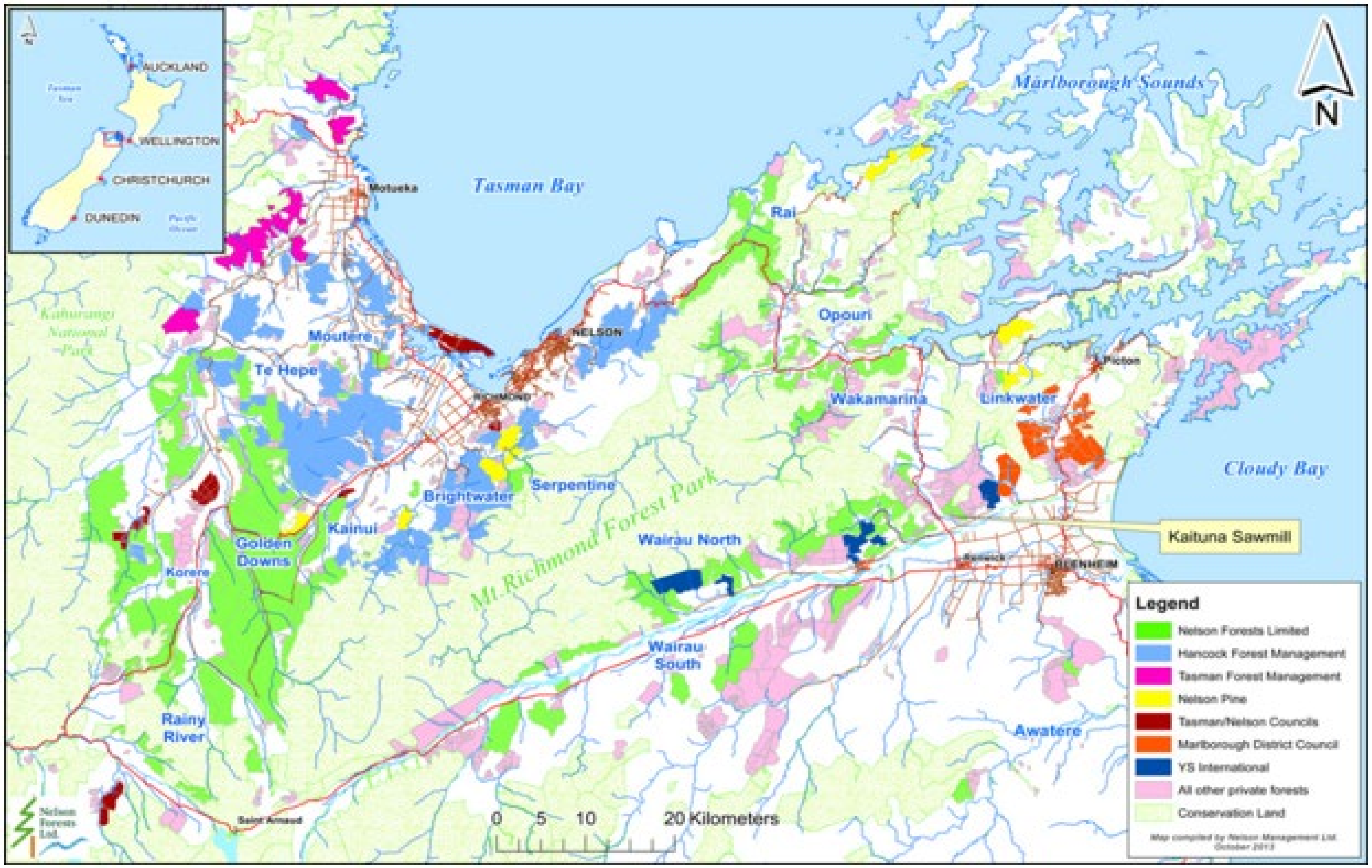

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Methodology– Representative day

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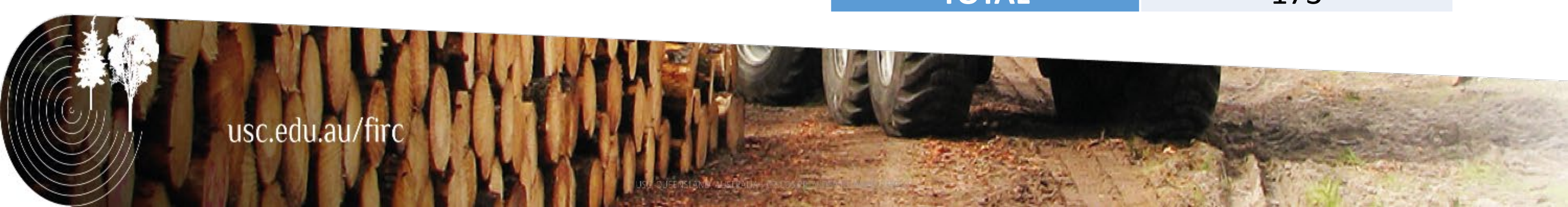
- The forest company selected a representative day against which the solutions from FastTRUCK were compared

- On the representative day 173 tasks (delivery of a load of wood from forest coupe to customer) were selected for inclusion in the project scenarios

Customer	Loads
1	30
2	14
3	4
4	25
5	21
6	49
7	16
8	6
9	4
10	1
11	3
TOTAL	173



Methodology– FastTRUCK tool

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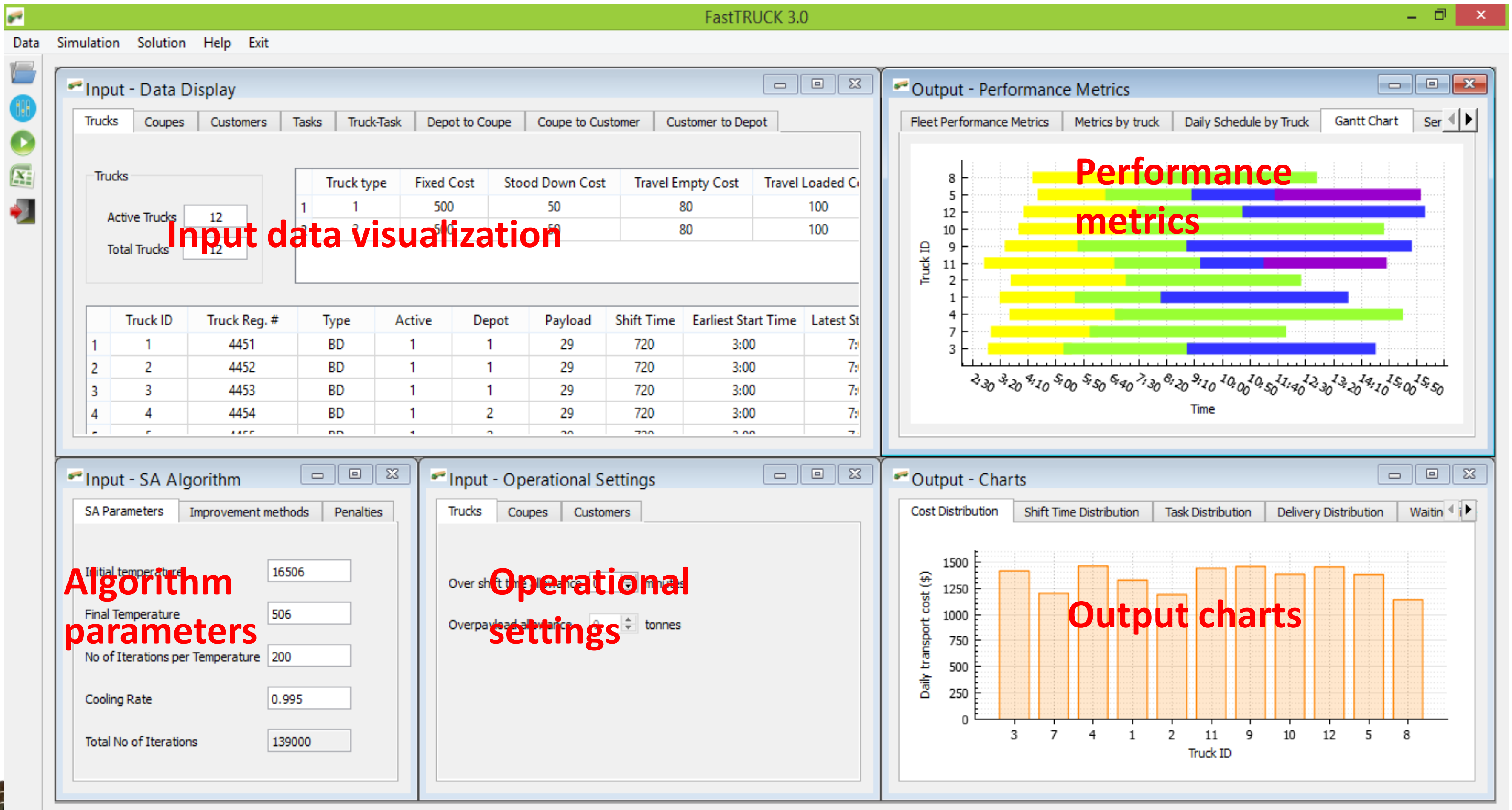

Methodology– FastTRUCK's data requirements

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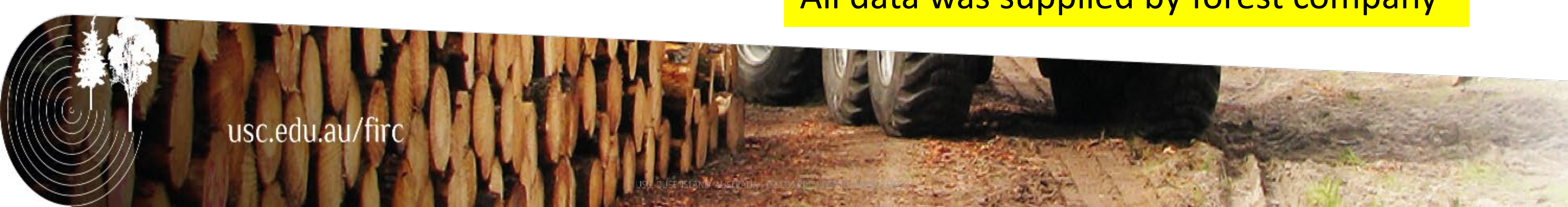
1. The number of depots at which trucks are based
2. Individual truck data (truck type, their depots, payload, shift length, start and stop shift times, and costs)
3. Coupe (harvest unit) ID's, opening and closing times with respect to loading, loading times for each truck type
4. Customer ID's, earliest and latest unloading times, unloading times for each truck type
5. Tasks that have to be completed (where a task is delivery of a load of logs of a specific product from a specific forest coupe to a specific customer)
6. Nomination of which trucks are capable of undertaking which tasks
7. Travel distances and travel times from each depot to each coupe
8. Travel distances and times from each coupe to each customer
9. Travel distances and times from each customer to each coupe
10. Travel distances and times from each customer to each depot.

All data was supplied by forest company



Methodology– Scenarios modelled

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Scenario	Waiting Time Assumption	Total Trucks Available	Trucks by Depot Location	Trucks by Shift Type
0: Representative day	Yes	<70		12 N&D
1a: Base Case	Yes	60	47 Depot 1, 13 Depot 2	12 N&D
1b: Base Case	No waiting	60	47 Depot 1, 13 Depot 2	12 N&D
2: Fewer Trucks	No waiting	52	42 Depot 1, 10 Depot 2	10 N&D
3a: Additional Night-and-day trucks	Yes	64	51 Depot 1, 13 Depot 2	16 N&D
3b: Additional Night-and-day Trucks	No waiting	64	51 Depot 1, 13 Depot 2	16 N&D
4a: Additional Trucks in Depot 2	Yes	64	47 Depot 1, 17 Depot 2	13 N&D
4b: Additional Trucks in Depot 2	No waiting	64	47 Depot 1, 17 Depot 2	13 N&D

Results: General observations

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- A validation of predicted round-trip times with actual times indicated that predicted times on average were about 12 minutes lower per trip than actual times. Assumed activity times by company were too tight.
- Solution times were generally obtained within 5 to 7 minutes, once the scenarios were set up. Solutions were sensitive to how waiting time was handled in the modelling process.
- FastTRUCK predicted average waiting times of up to 64 minutes per day per truck. Under these predicted conditions the 173 tasks could not be completed. Modelling the scenarios with shorter load and unload times, and no waiting at customer sites yielded solutions that would complete all 173 tasks with 54 or 55 trucks.
- Adding extra night-and-day trucks, or locating extra trucks at Marlborough lead to increases in the number of tasks completed and the predicted run loaded percent for those scenarios where waiting time was included

Results: Tasks completed & trucks utilised by scenario

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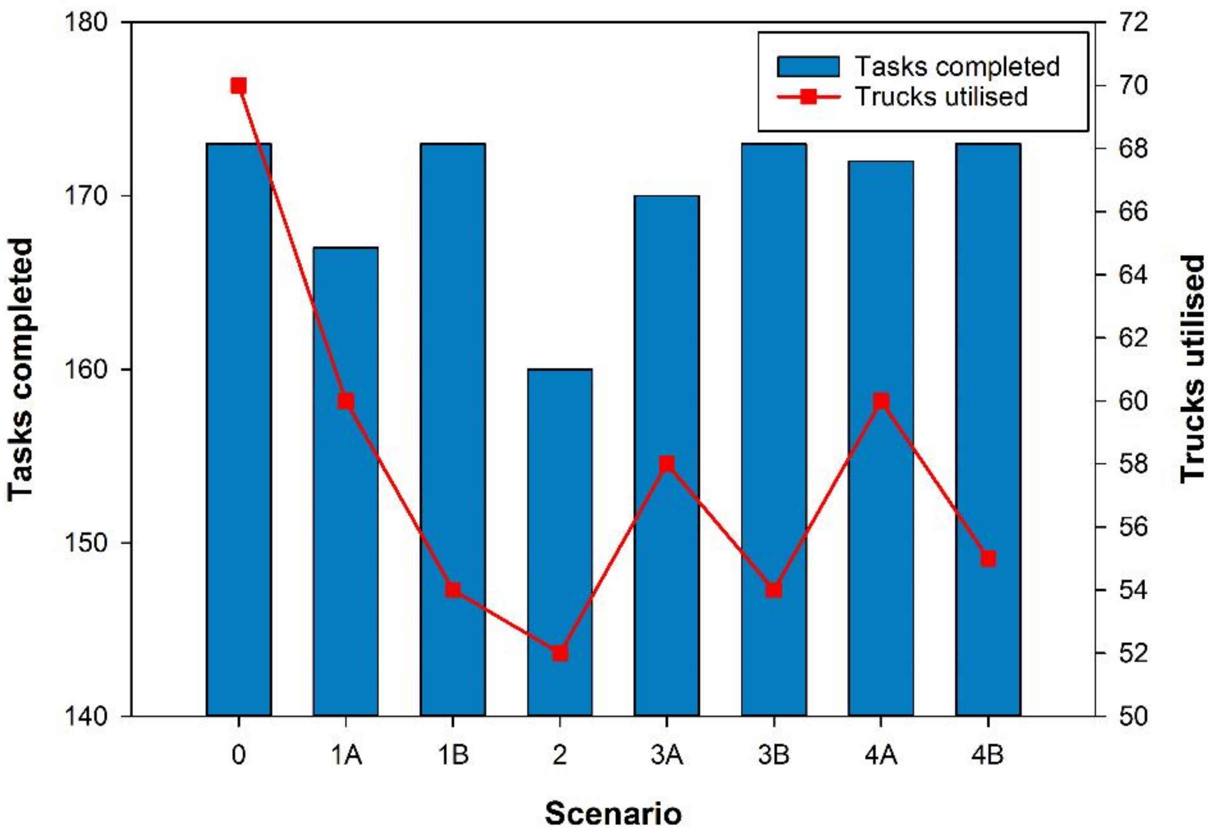

Scenarios

0. Representative day
1a. Base case – Waiting
1b. Base case – No waiting
2. Fewer trucks – No waiting
3a. Additional N&D trucks – Waiting
3b. Additional N&D trucks - No waiting
4a. Additional trucks Depot 2 – Waiting
4b. Additional trucks Depot 2 – No waiting

Results: Run loaded %, utilisation %, and cost per tonne by scenario

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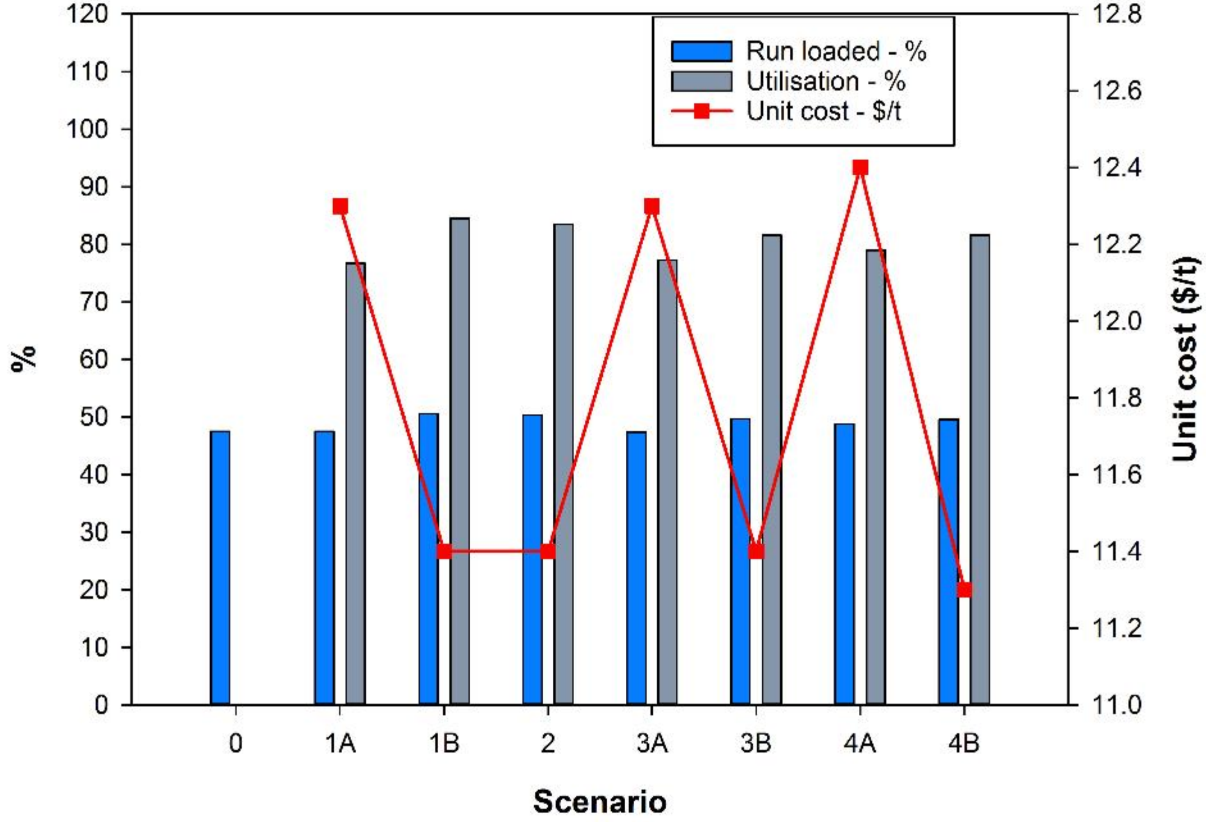

Scenarios

0. Representative day

1a. Base case – Waiting

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3a. Additional N&D trucks – Waiting

3b. Additional N&D trucks - No waiting

4a. Additional trucks Depot 2 – Waiting

4b. Additional trucks Depot 2 – No waiting

Conclusions & Recommendations

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- The versatility of the FastTRUCK scheduling tool was demonstrated by applying it to four sets of scenarios

- FastTRUCK provides optimized schedules for individual trucks based on minimizing average unit costs. It also reports the average run loaded percent for the truck fleet, a metric of particular interest to forest companies.

- FastTRUCK indicated that improvements of up to 3% in run loaded percent, compared with that from the representative day, were attainable depending on the scenario being modelled.

Conclusions & Recommendations

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- A closer look should be taken into the accuracy of the travel data and loading/unloading data. The number of machines available at each customer's site for unloading should also be quantified.

- The impact on task completion of staggered starting times and on-carts should be investigated.

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