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A CONTINGENCY PLANNING TOOLBOX IN THE WOOD SUPPLY CHAIN

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ABSTRACT

The climate crisis challenges wood supply chain management by more frequent and extreme natural calamities. Although, insights, literature and tools on contingency planning for multimodal wood supply chains are missing. Consequently, bottleneck and queuing time analyses were performed with a discrete event simulation model for the wood supply chain to investigate key performance indicators such as truck to wagon ratios, truck and wagon utilization, worktime coordination, truck queuing times, terminal transshipment volume, and required stockyard. This enabled the development of a contingency planning toolbox consisting of transport strategies, frameworks and templates to analyze outcomes of planning decisions before real, inefficient, unsustainable and long lasting changes are made. Thereby, a special focus was set on close to reality delivery time, transport tonnage, and train pick-up scenarios for highly relevant business cases to provide rapid, straightforward and helpful decision support for short term contingency planning.

1 INTRODUCTION

Management of multimodal wood supply chains is a complex tasks and industrial practice relies massively on experience and patterns established over time. Due to a lack of professional data-driven decision support and the absence of contingency plans for recurring risk events such as supply disruptions (e.g., available transport capacity, technical breakdowns), demand disruptions (e.g., delivery stops at mills, limited inventory) and natural calamities (e.g., high volumes of salvage wood due to windstorms and bark beetle infestations), potential outcomes of planning decisions are not estimated before real, inefficient, unsustainable and long lasting changes are made. Discrete event simulation is highly appropriate to investigate the wood supply chain and therefore, was intensively used in literature and reviewed by Kogler and Rauch (2018), Opacic and Sowlati (2017) as well as Shahi and Pulkki (2013). Discrete event simulation covers dynamic and interdependent changes and thus is well-suited for queuing time and bottleneck analyses as well as stakeholder workshops (Kogler and Rauch 2020). However, no short-term contingency plans for multimodal wood supply chains are available and neither strategies to cope with challenging planning conditions nor critical factors for bottleneck and queuing time analyses were identified.

2 METHOD

In order to close the existing research gap, a established discrete event simulation model of Kogler and Rauch (2019), which was described as “perhaps the most detailed railroad terminal study to date for the wood supply chain” (Acuna et al. 2019), was accordingly refined. A more universal approach for the supply network consisting of three categories of delivery times (short, medium, long) between harvesting districts and terminals, 1-25 trucks with three categories of transport tonnages (low, moderate, high), terminals with and without storage areas and one loading siding for up to seven wagons, one or two train pick-ups per day and industrial sites was chosen. Furthermore, key performance indicators such as terminal transshipment volume, required terminal stockyard, average queuing time and maximal queuing time were analyzed for different transport strategies (MAX VOLUME, NO STOCKYARD and BEST FIT) to estimate system performance under various contingency planning business cases.

3 RESULTS

Robust solutions saving truck and train resources as well as keeping transshipment volume on a high level and stockyard and queuing time on a low level were provided by the multi objective transport planning strategy BEST FIT. Moreover, it was shown, that increased truck transport tonnages reduce truck trips if working times and train pick-ups are coordinated. The discrete event simulation setup for analyses on an operational level allows to deliver detailed transport templates and frameworks with beneficial (i.e., high truck and wagon utilization) supply chain configurations. This provides decision support to wood supply chain managers developing customized contingency plans for restricted truck or wagon availability, queuing time reduction, defined delivery quota, terminal selection and inventory accumulation.

4 DISCUSSION

Multimodal wood transport holds the potential to reduce supply chain risks (e.g., buffer capacity to supply industry when harvesting is not possible), supply chain challenges (e.g., reducing the bottleneck of crane truck capacity by limiting their operation to unavoidable short distance wood transport by trucks to terminals) and effects of climate changes (e.g., CO2 emissions). Contingency plans for the multimodal wood supply chain are influenced by the delivery time from forest to industry, number of train pick-ups and truck net transport tonnage. Moreover, critical factors for advance contingency planning are number of available trucks and wagons, required terminal stockyard, terminal transshipment volume, truck and train utilization, average and maximal queuing times at the terminal, as well as work time coordination. Results indicate in line with Korpinen et al. (2017) and Väätäinen et al. (2020) that there is a potential to reduce truck trips, transport costs and emissions with higher truck transport tonnages, but in a political discourse further factors such as shift from rail to road, traffic intensity and social compatibility have to be taken into consideration. Promising opportunities for further research include managerial options such as staggered shifts (Eliason et al. 2017) and over time working as well as management and modeling of wood value loss, caused by long lead times and disadvantageous weather conditions.

REFERENCES

Acuna, M., J. Sessions, R. Zamora, K. Boston, M. Brown, and M. R. Ghaffariyan. 2019. "Methods to Manage and Optimize Forest Biomass Supply Chains: A Review". *Current Forestry Reports* 5:124–141. https://doi.org/10.1007/s40725-019-00093-4.

Eliasson, L., A. Eriksson, and S. Mohtashami. 2017. "Analysis of Factors Affecting Productivity and Costs for a High-Performance Chip Supply System". *Applied Energy* 185:497–505. https://doi.org/10.1016/j.apenergy.2016.10.136.

Kogler, C., and P. Rauch. 2018. "Discrete Event Simulation of Multimodal and Unimodal Transportation in the Wood Supply Chain: A Literature Review". *Silva Fennica* 52(4):1–29. https://doi.org/10.14214/sf.9984.

Kogler, C., and P. Rauch. 2019. "A Discrete Event Simulation Model to Test Multimodal Strategies for a Greener and more Resilient Wood Supply". *Canadian Journal of Forest Research* 49:1298–1310. https://doi.org/10.1139/cjfr-2018-0542.

Kogler, C., and P. Rauch. 2020. "Game-Based Workshops for the Wood Supply Chain to Facilitate Knowledge Transfer". *International Journal of Simulation Modelling* 19(3):446–457. https://doi.org/10.2507/IJSIMM19-3-526.

Korpinen, O. J., M. Aalto, P. Venäläinen, and T. Ranta. 2017. "Impacts of a High-Capacity Truck Transportation System on the Economy and Traffic Intensity of Pulpwood Supply in Southeast Finland". *Croatian Journal of Forest Engineering* 40:89–105.

Opacic, L., and T. Sowlati. 2017. "Applications of Discrete-Event Simulation in the Forest Products Sector: A Review". *Forest Products Journal* 67(3–4):219–229. https://doi.org/10.13073/FPJ-D-16-00015.

Shahi, S., and R. Pulkki. 2013. "Supply Chain Network Optimization of the Canadian Forest Products Industry: A Critical Review". *American Journal of Industrial and Business Management* 3(7):631–643. https://doi.org/10.4236/ajibm.2013.37073.

Väätäinen, K, J. Laitila, A. Perttu, A. Kilpeläinen, and A. Asikainen. 2020. "The Influence of Gross Vehicle Weight (GVW) and Transport Distance on Timber Trucking Performance Indicators – Discrete Event Simulation Case Study in Central Finland". *International Journal of Forest Engineering* 31(2):156–170. https://doi.org/10.1080/14942119.2020.1757324.