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A DISCRETE EVENT SIMULATION MODEL TO TEST MULTIMODAL STRATEGIES FOR A GREENER AND MORE RESILIENT WOOD SUPPLY IN AUSTRIA

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ABSTRACT

Increasing occurrence of natural disturbances such as windstorms and high snow cover as well as uncertainty according to queuing and lead times, bottlenecks, utilization, stock level, wagon and truck availability and machine breakdowns lead to supply chain risks and seasonal irregularities in wood harvest and transport. Innovative multimodal systems via rail terminals offer the potential to increase buffer capacity and reduce greenhouse gas emissions. Therefore, a train terminal is included in a new virtual environment spanning the whole wood supply chain and enabling manager involvement in testing, analysis and evaluation of a complex multimodal transport system. The simulation model facilitates carrying out experiments and scenario designs for strategy comparisons in workshops with supply chain managers and provides intuitive decision support by animation and a KPI-cockpit. Adapting collaborative supply chain control strategies in participatory simulation enhances the development of advanced risk management and therefore improves supply chain resilience, efficiency and sustainability.

1 INTRODUCTION

The forest based sector in Austria is lacking a comprehensive multimodal concept to improve sustainability, resilience, efficiency and cost-effectiveness along the wood supply chain. Significant new challenges for wood supply management require an integrated framework for modelling and analysis of efficiency and resilience to supply chain risks. Therefore, the need for an integrated framework focusing on risks will be satisfied by a discrete event simulation model to support managers in their decisions and contribute to a better understanding of the multimodal wood supply chain. This wood supply chain simulation model for testing multimodal strategies point`s the way to a greener and more resilient wood supply in Austria.

2 LITERATURE REVIEW

In the last twenty years the relevant literature for discrete event simulation of multimodal wood supply chains was mainly published by Finnish (Asikainen 2001; Saranen and Hilmola 2007; Karttunen et al. 2012; Karttunen et al. 2013), Canadian (Mobini et al. 2013; Mobini et al. 2014) and Austrian (Wolfsmayr et al. 2016; Rauch and Gronalt 2018) research groups. The majority of this research includes a case study, considers risks and concentrates either on train, vessel or both transport modes. Every research group seems to have a preferred simulation environment (AnyLogic, ExtendSim or Witness) to simulate time periods from weeks to one year on a wide spread of abstraction levels and planning horizons. Within multimodal wood supply chain studies, a focus on terminal operations was found as a common feature in literature. Currently, risk is considered only rudimentary and great external risks such as natural disasters (e.g., windstorm, bark beetle infestation), weather and delivery stops of mills were not covered at all. Contrary, these risks have a considerable impact on supply chain performance and should be managed proactively by robust risk management. The simulation study on hand is a first step in this direction and should be extended and further complemented.

3 CASE STUDY

A comprehensive case study of a multimodal supply chain in Austria was conducted with special focus on a train terminal in Großreifling (Styria). The case study was supported by interviews and data collection of the Austrian Federal Forests, Rail Cargo Austria, carriers and the central agency for meteorology and set the stage for the development of a simulation model based on a real life case. The Austrian Federal Forests are property of the Austrian state and administered in a stock company. Their 1100 employees are responsible for 15% of Austrian forests and deliver a wood supply volume of more than 1,5 million cubic meters, of which a quarter is handled multimodal. Four of 121 forest districts directly supply the observed train terminal Großreifling. Regularly, three regional carriers transport about 2000 cubic meters wood per month to the terminal or directly to the industry. Once (twice after storms) a day a locomotive picks up two to four (up to nine after storms) wagons and leaves empty wagons until the next day at one of the loading railroad tracks. After natural disturbances like wind storms up to 30000 cubic meters per month pass through the terminal. In this case up to 10000 cubic meters can be stored directly at the terminal.

4 SIMULATION MODEL

The simulated supply chain reaches from the forest to the industry and covers wood harvest and truck pre-carriage to wood terminals or industry, storage in a terminal, transshipment to rail wagons and final rail transport to and unloading at woodworking plants. Therefore, the AnyLogic simulation model consists of parameterization, animation, scenario, statistics, logic and code views and modules for forest, truck transport, terminal, train transport and industry. In the parameterization view prepared transport plans (BAU = business as usual, SNOW -75% production in the first quarter, STORM = +300% in the third quarter) can be selected, new ones entered or read from excel files. Additionally, also other parameters e.g. the number of wagons and trucks, distributions for drive times, capacities and costs can be adjusted. Moreover, scenarios based on number of train pickups, transport mode, transport priority and runtime can be designed. These parameters can be adapted during runtime and the changes can be observed in the animation window, where trucks and trains transport wood according the transport plan. Simulation results are provided in the management cockpit where KPIs for stock levels over time, CO2 emissions, costs, utilization, lead times, queuing times and service level are presented.

REFERENCES

Asikainen, A. 2001. “Simulation of Logging and Barge Transport of Wood from Forests on Islands”. *International Journal of Forest Engineering* 12(2):43–50.

Gronalt, M., and P. Rauch. 2018. “Analyzing Rail Road Terminal Performance in the Timber Industry Supply Chain – a Simulation Study”. *International Journal of Forest Engineering*. Published online: 2.8.2018:1–9.

Karttunen K., L. Lättilä, O.-J. Korpinen, and T. Ranta. 2013. “Cost-efficiency of Intermodal Container Supply Chain for Forest Chips”. *Silva Fennica* 47(4):1–24.

Karttunen, K., K. Vaatainen, A. Asikainen, and T. Ranta. 2012. “The Operational Efficiency of Waterway Transport of Forest Chips on Finland's Lake Saimaa”. *Silva Fennica* 46(3):395–413.

Mobini, M., J. C. Meyer, F. Trippe, T. Sowlati, M. Frohling, and F. Schultmann. 2014. “Assessing the Integration of Torrefaction into Wood Pellet Production”. *Journal of Cleaner Production* 78:216–225.

Mobini, M., T. Sowlati, and S. Sokhansanj. 2013. “A Simulation Model for the Design and Analysis of Wood Pellet Supply Chains”. *Applied Energy* 111:1239–1249.

Saranen, J., and O.-P. Hilmola. 2007. “Evaluating the Competitiveness of Railways in Timber Transports with Discrete-event Simulation”. *World Review of Intermodal Transportation Research* 1(4):445–458.

Wolfsmayr, U. J., R. Merenda, P. Rauch, F. Longo, and M. Gronalt. 2016. “Evaluating Primary Forest Fuel Rail Terminals with Discrete Event Simulation: a Case Study from Austria”. *Annals of Forest Research* 59(1):145–164.