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INTRODUCING A DISCRETE EVENT SIMULATION MODEL FOR THE WOOD SUPPLY CHAIN IN WORKSHOPS FOR STUDENTS, SCIENTISTS AND MANAGERS

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ABSTRACT

Complex considerations to plan, design, operate, control and monitor wood supply chains challenged by increasingly frequent natural disasters such as windstorms and forest fires intensify the need for knowledge transfer between science, industry and education. Discrete event simulation provides a powerful method for decision support, but simulation models are rarely used in university education and industrial training mainly because they are complicated and customized for scientific use only. In addition, within science, documentation of highly specific simulation models provides mainly a rough overview, failing to facilitate external expert evaluation and valuable feedback. Consequently, a scientific discrete event simulation model extending from forest to industry was further developed with special focus on animation, visualization and intuitive usability in a workshop setting. Tested in several workshops, it proved to facilitate decision support for managers and to provide means to train students and sensitize researchers on how to deal with challenging supply situations.

1 INTRODUCTION

Support for today's (managers) and tomorrow's (students) decision makers by scientists, has to be enhanced by the combination of state of the art methods such as simulation with stakeholder participation in tool development or analyses. Therefore, the adaption of an discrete event simulation (DES) model (Kogler and Rauch 2019) allows the development of different workshop designs for scientists, managers and students. This enables a learning process through playing a serious game and analyzing the outcome of decisions according to key performance indicators (KPIs) in group discussions. The simulated supply chain covers wood harvesting, forwarding and pre-carriage to a wood terminal, storage, transshipment to rail wagons and final transport to, and unloading at, wood-based industry plants. In the area of wood supply chain research with DES, many papers do not report on knowledge transfer (Kogler and Rauch 2018). This work showcases the benefits of knowledge transfer through an adapted scientific simulation model in order to provide a guideline to disseminate DES models.

2 LITERATURE

DES models have a high potential for pedagogical purposes and stakeholder participation due to the active involvement of trainees, their suitability in providing experience of complex system characteristics and decision support within a safe learning environment (Van der Zee et al. 2012). Guidance for developing these models is rare, but conceptual modeling (Robinson 2008) as well as simplification (Van der Zee et al. 2018) and gamification (Despeisse 2018) play fundamental roles. So far, stakeholder participation has been mainly focused on SWOT analyses combined with strategy formulation, analytic hierarchy processes and the delphi method. Furthermore, stakeholder workshops were held primarily for scenario design and back-casting, but there are also examples for facilitated modelling (Kotiadis and Tako 2018, Robinson et al. 2014). Regarding knowledge transfer through simulation education, earlier studies concentrated mainly on course and workshop designs for teaching simulation model development. Others authors developed simulation games to teach special principles and motivate students. However, the integration of adapted, professionally developed, scientific simulation models in classes and workshops is rarely discussed.

3 WORKSHOP

The generic structure of workshops for students, scientists and managers can be organized in the stages: input, learning by doing and analysis, where each stage will take between 30 and 60 minutes. The input stage answers the initial question of participants, "Why are we here?", by giving an overview of the workshop agenda, problem setting and goals. This guides to the question, "How can we experience, observe or analyze the problem?". Consequently, the DES model is introduced by a live demonstration of process flows for wood-, truck- and train agents, a detailed animation of the wood supply chain and changes of KPIs to observe the behavior of the system. The learning by doing stage starts with a clear problem definition, before participants get hands-on experience and play the defined simulation scenario (i.e., period, harvesting volumes, system capacities) usually in small groups from 3 to 5 people. Week-by-week, every group discusses their strategies and decides on the transport plan (e.g., number of trucks, wagons, train pickups, unimodal/multimodal ratio) for the next week based on harvesting volumes, stockyard utilization as well as other KPIs. At the end of the simulation period, all KPIs are exported to an Excel file and this provides the basis for the last stage. The analyses stage reflects strategies, problems, solutions and findings. KPIs like transport volume, stockyard sizes, delivery quotas, number of full loaded wagons, fulfillment levels, CO_2 emissions, truck utilizations, lead times, queuing times or transport costs are compared over time and between groups in different graphs. Finally, the discussion is wrapped up, results are documented and next steps to tackle outstanding problems are defined before a final feedback session.

First delivered workshops to various expert groups (scientists, managers and wood management students) in different levels of mastery according to their experience in wood supply chain management indicated, that the adaption of a scientific DES model in an early development stage increases model's reliability and suitability to address real world challenges. Future research would benefit from simplification, visualization and collaboration at the earliest development stages of next level DES models.

REFERENCES

Despeisse, M. 2018. "Games and Simulations in Industrial Engineering Education: A Review of the Cognitive and Affective Learning Outcomes". In *Proceedings of the 2018 Winter Simulation Conference*, edited by M. Rabe, A.A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B. Johansson, 4046-4057. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.

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.

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* (in print). https://doi.org/10.1139/cjfr-2018-0542.

Kotiadis, K. and A. Tako, A. 2018. "Facilitated Post-Model Coding in Discrete Event Simulation (DES): A Case Study in Healthcare". *European Journal of Operational Research* 266(3):1120–1133.

Robinson, S. 2008. "Conceptual Modelling for Simulation Part I: Definition and Requirements". *Journal of Operational Research Society* 59(3):278–290.

Robinson, S., C. Worthington, N. Burgess, and Z. Radnor. 2014. "Facilitated Modelling with Discrete-Event Simulation: Reality or Myth?". *European Journal of Operational Research* 234(1):231–240.

Van der Zee, D. J., B. Holkenborg, and S. Robinson. 2012. "Conceptual Modeling for Simulation-Based Serious Gaming". *Decision Support Systems* 54(1):33–45.

Van der Zee, D. J., A. Tako, S. Robinson, P. Fishwick, and O. Rose. 2018. "Panel: Education on Simulation Model Simplification – Beyond Rules of Thumb". In *Proceedings of the 2018 Winter Simulation Conference*, edited by M. Rabe, A.A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B. Johansson, 3987-4001. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.