Optimizing the Wood Supply Chain by tight coupling of Spatial Decision Support Systems and Operations Research

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Abstract. Wood Supply Chain management lacks of intelligent tools for spatial decision support, although this problem is complex and spatial in its nature. Through a tight-coupling strategy we intend to incorporate methods from Operations Research in a Spatial Decision Support System to facilitate spatial decision support. Rolling schedule approaches are one possibility to optimize the wood supply chain management. This method is capable of reacting to dynamic customer demand. The introduction of an intended system architecture ensures the tight-coupling strategy and helps to overcome the shortcomings of traditional Wood Supply Chain processes. This research work is the topic of a dissertation at the Graz University of Technology.

1 Introduction

The term Wood Supply Chain comprises the linkage between customers, suppliers and shippers in the forest business and implies every action to transport and process timber. Within forestry there is a demand for intelligent decision support tools optimizing the Wood Supply Chain (Gronalt et al. 2005). The problem of Wood Supply Chain management is complex and spatial in its nature, due to the great number of participants and the complex information that have to be processed. Therefore Spatial Decision Support Systems (SDSS) are appropriate to support supply chain management.

To acquire “good” results, mathematical methods help to find optimal solutions to a given problem. In the field of Operations Research (OR) valuable research work has been done to solve optimization problems, but mostly don’t have a connection to the spatial dimension.

Through tight coupling of SDSS and OR an increase in the planning accuracy and optimality may be achieved. This research focuses on the application of OR methods within a web-based SDSS to optimize logistic operations within the Wood Supply Chain.

2 WOOD SUPPLY CHAIN SHORTCOMINGS

The supply chain involves a bidirectional flow of products and information (Gronalt et al. 2005). Bodelschwingh et al. (2003) and Gronalt et al. (2005) state that the wood supply chain has several shortcomings that limit the performance. Here, we focus on the uncoordinated logistic chain and several media disruptions.

3 COUPLING OF SDSS AND OPERATIONS RESEARCH

Through a tight coupling of SDSS and OR methods we intend to support the Wood Supply Chain management with intelligent tools.

3.1 SDSS Theory

SDSS's are founded on the theory of Multi Criteria Decision Analysis (MCDA) (Malczewski 1999) and are interactive systems that support users in decision making (Malczewski 1997). SDSS's consist of three components: Spatial Database Management System (DBMS), Model Base Management System (MBMS) with models from OR and the Dialog Generation and Management System (DGMS).

3.2 Operations Research

In a nutshell, "operations research (OR) is the discipline of applying advanced analytical methods to help make better decisions" (Informs 2004). A variety of mathematical models are discussed in literature, but in this paper we focus on rolling schedule approaches.

Rolling schedule approaches (Spitter 2005; Teng et al. 2006) may be considered as "special" Travelling Salesman Problems (TSP). The classical TSP tries to find a minimum cost tour among the cities that have to be visited, whereas every city has to be visited exactly once. In the case of rolling schedules there is a customer demand with given weighting (e.g. turnover value), and a set of customer nodes which should be visited within a defined time slot, which is regarded as the Travelling Salesman Subset Tour Problem (TSSP) (Mittenthal and Noon 1992). Through a limited working time constraint, the problem is called time constrained TSP (TCTSP) (Cloonan 1966) or orienteering problem (Golden et al. 1987).

In the rolling schedule approach presented by Teng et al. (2006) the customer demand is dynamic over time. Thus an exact single TCTSP-tour can't be planned. To overcome this, a multi-period TCTSP is constructed as follows: in the current and the few next time periods we know the customer demand quite accurate. Thus a rolling horizon scheme implements the schedule for the current period, i.e. customer picking and tour generation, and updates the data according to new customer demand.

3.3 Application in Wood Supply Chain Management

The coupling of SDSS concepts and OR methods should be possible in an SDSS environment, where OR methods are part of the MBMS, which ensures a tight-coupling strategy (Malczewski 2006).

The intended system architecture is shown in Figure 1. The following components can be identified: DBMS, MBMS as part of the Decision Engine, Web Mapping Engine, Tracking Engine, Mobile Devices and Desktop PC's. The DMBS stores spatial and non-spatial data. A numerical solver masters the optimization problems using the OR methods provided in the model base. The Web Mapping Engine serves as the main visualization engine, whereas the Tracking Engine collects tracking information of the Mobile Devices, which are located on trucks. The Mobile Devices are capable of providing location based service functionality comprising routing and transmitting information. Any Desktop-PC accesses the system via a web-based Interface and alter model parameters.

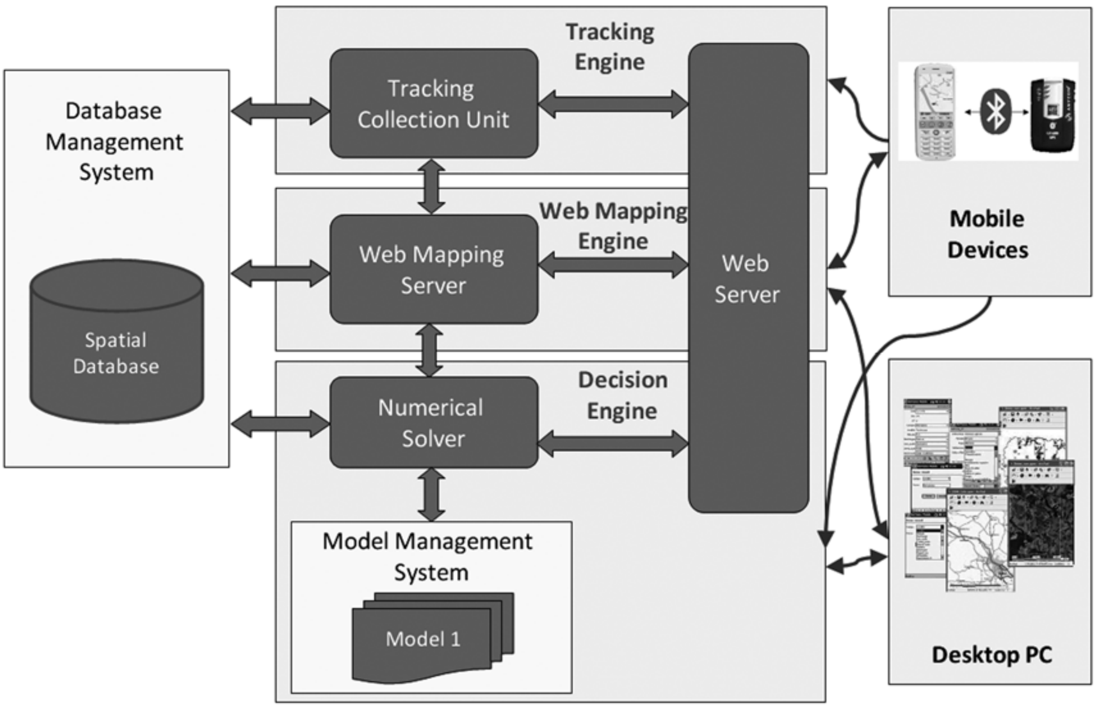

Figure 1: The intended SDSS system architecture.

4 CONCLUSION AND OPEN QUESTIONS

We propose an SDSS to support Wood Supply Chain management. We focus on tight coupling of OR and SDSS including rolling schedule approaches as one possible optimization model.

An open question is what to optimize: least cost assumption, ecology driven assumption or combinations of both. The least cost assumption tries to increase the profit gained, whereas the ecology driven assumption would try to reduce ecological impact of the transportation process.

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