Optimising load planning and container routing in intermodal rail transport

Peer-reviewed author version

HEGGEN, Hilde (2019) Optimising load planning and container routing in intermodal rail transport. In: 4OR-A Quarterly Journal of Operations Research,18, p. 127-128..

DOI: 10.1007/s10288-019-00415-z

Handle: <http://hdl.handle.net/1942/28863>

Dear Author,

Here are the proofs of your article.

- You can submit your corrections **online**, via **e-mail** or by **fax**.
- For **online** submission please insert your corrections in the online correction form. Always indicate the line number to which the correction refers.
- You can also insert your corrections in the proof PDF and **email** the annotated PDF.
- For fax submission, please ensure that your corrections are clearly legible. Use a fine black pen and write the correction in the margin, not too close to the edge of the page.
- Remember to note the **journal title**, **article number**, and **your name** when sending your response via e-mail or fax.
- **Check** the metadata sheet to make sure that the header information, especially author names and the corresponding affiliations are correctly shown.
- **Check** the questions that may have arisen during copy editing and insert your answers/ corrections.
- **Check** that the text is complete and that all figures, tables and their legends are included. Also check the accuracy of special characters, equations, and electronic supplementary material if applicable. If necessary refer to the *Edited manuscript*.
- The publication of inaccurate data such as dosages and units can have serious consequences. Please take particular care that all such details are correct.
- Please **do not** make changes that involve only matters of style. We have generally introduced forms that follow the journal's style. Substantial changes in content, e.g., new results, corrected values, title and authorship are not allowed without the approval of the responsible editor. In such a case, please contact the Editorial Office and return his/her consent together with the proof.
- If we do not receive your corrections **within 48 hours**, we will send you a reminder.
- Your article will be published **Online First** approximately one week after receipt of your corrected proofs. This is the **official first publication** citable with the DOI. **Further changes are, therefore, not possible.**
- The **printed version** will follow in a forthcoming issue.

Please note

After online publication, subscribers (personal/institutional) to this journal will have access to the complete article via the DOI using the URL: [http://dx.doi.org/\[DOI\]](http://dx.doi.org/[DOI]).

If you would like to know when your article has been published online, take advantage of our free alert service. For registration and further information go to: <http://www.link.springer.com>.

Due to the electronic nature of the procedure, the manuscript and the original figures will only be returned to you on special request. When you return your corrections, please inform us if you would like to have these documents returned.

Metadata of the article that will be visualized in OnlineFirst

ArticleTitle	Optimising load planning and container routing in intermodal rail transport	
Article Sub-Title		
Article CopyRight	Springer-Verlag GmbH Germany, part of Springer Nature (This will be the copyright line in the final PDF)	
Journal Name	4OR	
Author	Family Name	Heggen
	Particle	
	Given Name	Hilde
	Suffix	
	Division	
	Organization	
	Address	
	Phone	
	Fax	
	Email	
	URL	
	ORCID	http://orcid.org/0000-0002-4436-2746
Schedule	Received	
	Revised	
	Accepted	
Footnote Information		

Optimising load planning and container routing in intermodal rail transport

Hilde Heggen

© Springer-Verlag GmbH Germany, part of Springer Nature 2019

This is a summary of the author's PhD thesis supervised by An Caris, Kris Braekers (Hasselt University, Belgium), Stan van Hoesel and Andre Berger (Maastricht University, The Netherlands). The thesis was defended on June 19, 2019 at Maastricht University as a results of a double-degree programme with Hasselt University as main institution and Maastricht University as partner institution. The thesis is written in English and is available from the author upon request at hilde.heggen@uhasselt.be. This work deals with decision support in the context of intermodal rail transport by studying two planning problems, integrated intermodal routing and multi-objective train load planning.

With the rising focus towards more sustainable transport systems, intermodal transport is a promising alternative for unimodal road transport. However, it also presents a number of challenges for intermodal operators and planners who are in charge of executing transport planning in an increasingly dynamic environment. As multiple transport modes and decision makers are involved, intermodal transport is more complex. Moreover, the level of integration of different transport modes and decision levels influences the attractiveness of intermodal transport. Innovative and integrated transport systems reflecting real-life problems should be developed in order to provide adequate decision support tools for intermodal planners and support a synchromodal vision. However, a gap between academic research and practice can be observed, because real-life characteristics of intermodal transport companies are ignored. Therefore, the focus of this thesis is on decision support for human planners at the operational decision level during the planning process of intermodal rail transport.

This dissertation aims at offering intermodal planning support in order to minimise total transport costs and maximise service capacity utilisation, which in turn decreases costs of the transport system. Two decision support tools are proposed by means of fast planning algorithms which include real-life characteristics. These concepts are inherent to the synchromodal vision in order to encourage a modal shift away from unimodal road transport. After a literature review on intermodal routing and vehicle routing in intermodal transport, two problems usually considered separately, an integrated intermodal routing problem is presented. Both a mathematical formulation as well as a large neighbourhood search heuristic algorithm are presented for the sequential and the integrated version of the problem. In the integrated version, operators are dedicated to the integrated nature of the problem. By including information of local vehicle routes in the assignment of transport requests to long-haul routes through a

service network, better-informed decisions can be obtained. Insights are presented on how such integrated approach can be used for decision analysis in practice by means of a real-life case.

With transport requests assigned to intermodal routes through an intermodal rail service network, they should be assigned to specific locations on an intermodal train. This is the train load planning problem. It includes detailed loading restrictions, as omitting relevant loading constraints could result in infeasible solutions. Both an exact and a multi-directional local search heuristic solution approach are presented. Multiple objectives and additional real-life loading constraints are included, resulting in multiple feasible train load plans. Routes might still change for some transport requests and information about future orders should be accounted for. By providing multiple plans, planners can select the most appropriate load plan at a specific moment in time. The problem is applied to a real-life case to demonstrate advantages for practitioners.

Decisions on these two planning problems, intermodal routing and train load planning, influence the throughput and efficiency of the intermodal transport system. Fast decision support by means of planning algorithms is provided for improved, more efficient planning. Results contribute to a better understanding of the way in which intermodal operators can maximise their service network's transport capacity based on the expected demand of transport orders, and lead to an increased transport capacity utilisation and a minimisation of total transport costs.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.