A Decision Support System for Synchromodal transport

T. Ambra
Hasselt University/Free University of Brussels, Research group Logistics/MOBI
e-mail: tomas.ambra@uhasselt.be

A. Caris
Hasselt University, Research group Logistics
e-mail: an.caris@uhasselt.be

C. Macharis
Free university of Brussels, Research group MOBI
e-mail: cathy.macharis@vub.ac.be

The growing cargo demand, increasing road congestion as well as reliability, safety and environmental concerns are pushing researchers, transport operators and policy makers to develop and deploy more efficient freight transport solutions. Given these developments, the current transport setting needs a modal shift towards modes with a smaller societal impact. Critical issues in this perspective are the modal choice preferences and transport mode selection (Arencibia et al., 2015; Arnold et al., 2004; Bierwirth et al., 2012; Brooks et al., 2012; Feo et al., 2011; Feo-Valero et al., 2014). The findings of the modal choice literature often yield higher user preferences related to road transport based on the user's needs. Intermodal transport, which is a combination of two or more modes in a single journey (Reis, 2015), provides more options and opportunities for a positive modal shift. However, the development of intermodal decision support models, where more actors and modes are incorporated (compared to unimodal), are hampered by limited data availability and its static nature (Caris et al., 2013). The latest synchromodality concept presents an extension of intermodal transport by including real-time re-routing of loading units over the network to cope with disturbances and operational or customer requirements (Riessen et al., 2015; Verweij, 2011). Thus, appropriate solution approaches are necessary to facilitate decision support and transport optimization in real-time. Unexpected data changes caused by disturbances or other events result in congestion, delays and time/money losses. The incorporation of real-time and dynamic elements can facilitate re-routing, re-scheduling and modal shift, contributing to higher competitiveness (Ghiani et al., 2003). With regard to these dynamic characteristics of transport, Moccia et al. (2011) focus on a routing problem in a multimodal network. Furthermore, Xiong and Wang (2014) propose a multimodal routing problem solution with time windows in order to find a transport route with the best transport combination. Due to the widespread use of modern communication technologies, some promising real-time freight control models have been introduced. For instance, Bock (2010) devised an innovative real-time-oriented freight control approach, integrating multiple transshipments in a transport system subject to disturbances. However, most of the studies take a single forwarder perspective without a holistic combination of the wide variety of transport actors and different modes in real-time management. Thus, the proposed PhD project will take advantage of the available literature advances related to multimodal routing and real-time modeling with disturbance elements in order to provide such a holistic combination. The synchromodal concept may offer better performance than intermodal transport on flexibility, reliability and other modal choice criteria. The synchromodal notion has received limited attention in terms of modeling and cost-effectiveness (Li et al., 2013; Riessen et al., 2015) and no attention in terms of disturbances and blockages.

The aim of the project is to develop and delineate a synchromodal theoretical framework which will be empirically utilized in terms of an innovative dynamic assignment model. This model will assist in the dynamic allocation of freight flows within a synchromodal context by using a re-optimization algorithm. The model will assign the freight movements to the multimodal network according to user preferences (transport time, price, reliability and environmental performance) and transport system capacity. The transport system capacity will make use of an innovative approach that integrates infrastructure capacity (road, rail slots, inland waterways) with service capacity (vehicle capacity, frequency). The outcome will express the most appropriate transport service and quality characteristics that are needed to transport a given payload. The new synchromodal framework will be further integrated in an existing decision support system and consequently validated. The final evaluation of the project will be based on the stakeholder criteria and preferences by using the Multi Actor Multi Criteria Analysis. This will lead to identification of policy measures to further stimulate the synchromodal concept and delineate its role for broader implementation.

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References

Arencibia, A. I., Feo-Valero, M., García-Menéndez, L., Román, C., 2015. Modelling mode choice for freight transport using advanced choice experiments. Transportation Research Part A: Policy and Practice 75, 252–267.

Arnold, P., Peeters, D., Thomas, I., 2004. Modelling a rail/road intermodal transportation system. Transportation Research Part E: Logistics and Transportation Review 40 (3), 255–270.

Bierwirth, C., Kirschstein, T., Meisel, F., 2012. On transport service selection in intermodal rail/road distribution networks. BuR-Business Research 5 (2), 198–219.

Bock, S., 2010. Real-time control of freight forwarder transportation networks by integrating multimodal transport chains. European Journal of Operational Research 200 (3), 733–746.

Brooks, M. R., Puckett, S. M., Hensher, D. A., Sammons, A., 2012. Understanding mode choice decisions: a study of australian freight shippers. Maritime Economics & Logistics 14 (3), 274–299.

Caris, A., Macharis, C., Janssens, G. K., 2013. Decision support in intermodal transport: A new research agenda. Computers in Industry 64 (2), 105–112.

Feo, M., Espino, R., García, L., 2011. An stated preference analysis of spanish freight forwarders modal choice on the south-west europe motorway of the sea. Transport Policy 18 (1), 60–67.

Feo-Valero, M., García-Menéndez, L., del Saz-Salazar, S., 2014. Rail freight transport and demand requirements: an analysis of attribute cut-offs through a stated preference experiment. Transportation, 1–22.

Ghiani, G., Guerriero, F., Laporte, G., Musmanno, R., 2003. Real-time vehicle routing: Solution concepts, algorithms and parallel computing strategies. European Journal of Operational Research 151 (1), 1–11.

Li, L., Negenborn, R. R., De Schutter, B., 2013. A general framework for modeling intermodal transport networks. In: Networking, Sensing and Control (ICNSC), 2013 10th IEEE International Conference on. IEEE, pp. 579–585.

Moccia, L., Cordeau, J.-F., Laporte, G., Ropke, S., Valentini, M. P., 2011. Modeling and solving a multimodal transportation problem with flexible-time and scheduled services. Networks 57 (1), 53–68.

Reis, V., 2015. Should we keep on renaming a+ 35-year-old baby? Journal of Transport Geography 46, 173–179.

Riessen, B. V., Negenborn, R. R., Dekker, R., Lodewijks, G., 2015. Service network design for an intermodal container network with flexible transit times and the possibility of using subcontracted transport. International Journal of Shipping and Transport Logistics 7 (4), 457–478.

Verweij, K., 2011. Synchronic modalities–critical success factors. Logistics yearbook edition, 75–88.

Xiong, G., Wang, Y., 2014. Best routes selection in multimodal networks using multi-objective genetic algorithm. Journal of Combinatorial Optimization 28 (3), 655–673.