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Contents

Sustainable and energy-efficient logistics through the conceptual design and evaluation of cross-company logistics models

Felix Meizer und Margarethe Prochazka (Wilfried Sihn)
Institute for Management Sciences
Vienna University of technology
Vienna, Austria
Email: prochazka@imw.tuwien.ac.at

Abstract —
In this paper the results of a research project that deals with the conceptual design and evaluation of cross-company logistics models are presented. Individual companies often do not have access to highly productive transport networks due to limited volume of shipments. Therefore a simulation and evaluation model was designed that supports the development of new inter-company logistics concepts. The novel approach combines ecological, economical and factors of logistic competitiveness in the assessment of logistic networks and depicts potentials of cross-company logistic models.

I. INTRODUCTION

In the last few years many car manufacturers and component suppliers have set up new production sites in or moved existing locations to the Automotive Region Eastern Europe (AREE) not just to take advantage of the emerging market there but also because of the low wage costs [1].

The trend towards relocation has shown that the exchange of goods leads to new demands and challenges for transportation and logistics. At an economic level, one of the main areas of focus for logistics in this context is how to plan and manage transport capacities to cope with the transport flows and the related planning and management of logistics networks for goods, services and information [2].

Taking this situation as a starting point, a new simulation and evaluation model has been developed as part of a research project that supports the development and evaluation of new logistics concepts. This is being used to validate and evaluate cross-company logistics models.

II. TRANSPORT BUNDLING

Logistical cooperation between different companies is characterised by the bundling of transport volumes. Bundling, also referred to as consolidation, happens when transport volumes are combined to form larger transport batches in order to lower transport unit costs and the unit costs of incoming goods at the target point or of outgoing goods at the source point.
The starting points for the scenarios for transport bundling are the individual parameters of the logistical network structure. The following forms may thus be used:

- **Source-point bundling** often following the principle of the "milk run"
- **Target-point bundling**
- **Transport bundling**, where shipments are collected and delivered in one tour.

Further forms of bundling can be inventory bundling or temporal bundling, and vehicle bundling and transhipment point or transit terminal bundling as forms of spatial bundling.

III. EVALUATION OF LOGISTIC MODELS

The starting point for the design and evaluation of new logistics models was the current state of the art with regard to known logistics models and structures that involve the organisation of transport according to ecological principles. The control variables required to achieve the objectives (minimise emissions, reduce costs of logistics and increase logistical competitiveness) are the following:

- Traffic avoidance
- Bundling of goods flows
- Switching freight transport to other means of transport (intermodal transport)

In the long term it is also necessary to validate the results of models conceptual design. This should be performed in accordance with the main target dimensions - emissions, costs and competitiveness.
The emission model aims at intermodal design of transport structures and evaluates a selection of the most harmful emissions - CO2, NOX and amount of particulates - that are mainly accounted for in the dominant means of transport - road haulage. The emission levels are mainly dependent on the journey, i.e. distance covered by the predefined journey profile and on the allocated transport resource.

The cost calculation model is somewhat more extensive and can be subdivided into three different

categories (Transport costs, transhipment costs and inventory costs).

With transport costs it is important that the model is based on the actual costs incurred and not on the transport tariffs charged by shipping companies. The road charges are particularly difficult to determine due to the differing systems in the individual countries and play a considerable role in fixing the route.

The third criterion of the model is logistic competitiveness, which is made up of ability to deliver (a measure of the extent to which the company can guarantee the logistical service requested by the customer - short delivery times compared to the competition are especially important for high ability to deliver) and delivery reliability (delivery reliability rates the service provision of the logistics process - it indicates the proportion of the complete and punctual deliveries compared to all delivery orders) [3].
The evaluation models are populated with data from actual surveys or based in part on assumptions and research findings and then analysed, or are the result of the simulated models, whereas the simulation framework itself is not presented in this paper.

IV. Results of Pilot Application

In the research project funded by the Federal Ministry for Transport, Innovation and Technology (BMVIT) as well as the Austrian Research Promotion Agency (FFG) the developed logistic models are demonstrated by means of the region Timis in Romania. Focusing on 7 automotive companies volumes of outgoing transports were analyzed. Starting from the current state of individual transports, different scenarios were defined. The scenarios are aimed at cost reduction and sustainability in using modes of transport for high volumes like rail traffic.

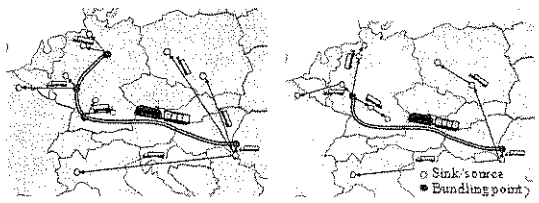

Figure 1: Scenarios 1 and 2.

Figure 1 shows 2 defined scenarios of transport bundling for the Timis Region. Scenarios 1 using block train with 3 stops and direct relations from the end of the train not considering locations in Poland and Italy that cannot profit from consolidation with the block train. Scenario 2 limits the block train to one stop but bundles transports further leaving the train to their final destinations. Destinations not considered in the main leg bundling where consolidated as well. Simulating the given transport flows from the companies and putting these into the evaluation model, the following results could be attained. Shifting the main leg to railway and optimizing the collection and distribution of goods from and to transshipment points logistic costs could be reduced by 15 % in the given case. The ecological impact in reduction of CO_2 emissions by 40 %, cutting fuel consumption in half, shows the success in more than one target dimension. The main deficit of the models is overcoming the doubled lead time coming from the ceteris paribus inspection of transports.

In addition to the simulation and evaluation of scenarios a sensitivity analysis was executed to cover the ecological and economical results. Therefore the evaluated scenarios indicated were simulated with lower basic loads keeping all other factors stable. At a level of 70% of the load, block train concepts as well as the transfer of 66% of transports to railroad could be maintained. Negative effects of the change in basic loads were determined in the capacity utilization of transport capacities and the flexibility especially for block trains. Nevertheless the developed transport concepts and cross-company models can stand up to the actual transport handling. Economic considerations show lower costs of scenarios compared to the actual situation. Therefore the model indicated shows full functionality even with fluctuation of volumes and prices.

V. Concluding Remarks

This paper presented an evaluation approach to cross-company logistic bundling considering not only economic but also ecologic influences. The empirical analysis showed the great complexity of the problem that was built in an evaluation framework and therefore the challenge for possible implementations which constitute further research developments.

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