## Abstract

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**Topic: System analysis of the German less-than-truckload transport segment – an explorative study**

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The objective of this thesis is to gain comprehensive insights into the system of the German general less-than-truckload transport segment, both at the macroscopic and the microscopic level, the latter especially by interviews with experts. Furthermore, optimization models which are tailored to the tactical and operative planning problems of less-than-truckload service providers will be analyzed and evaluated regarding their application to the modeling of traffic generation of the less-than-truckload transport segment. The insights, generated previously from the macro- and microscopic analysis for assessment of closeness to reality of the models, enter evaluation criteria of the models.

First the system of the German less-than-truckload transport segment is analyzed from a macroscopic point of view. Financial, performance and network key figures with their manifestations, which describe the German less-than-truckload segment, are identified. It turns out that the less-than-truckload market is characterized by a very high level of outsourcing and degree of concentration, so by far the largest part of the entire market volume is transacted by few, large less-than-truckload providers. It can be concluded that few providers are the origin of a high traffic generation. So modeling of traffic generation could be limited to the large providers to display the major part of the less-than-truckload traffic. Furthermore, it can be noticed that the turnover of the ten largest providers is distributed in almost equal proportions among the two business forms cooperation and group. While groups have a nationwide, captive network, a cooperation is an association of economically independent, medium-sized forwarders. Moreover, vague estimations regarding the Germany-wide number of less-than-truckload depots and hubs can be made. Characteristic values regarding individual players can also be detected, e.g. the average number of national depots of a less-than-truckload provider. Next, current developments at the less-than-truckload market, which have effects on the traffic generation, are shown. An example is the trend towards internationalization and pan-Europeanization, respectively. After that the fundamental structure of a less-than-truckload service provider´s long-distance traffic network is characterized. Most of the less-than-truckload networks are mixed structures consisting of grid- and multihub-structures, i.e. there are both direct transport trips between the depots (but not all of them) and transports with a transshipment at a hub. The hub can be either a regional or a central hub. The procedure of the transport processes takes place by pre-run, main run and post-run, their approximate time windows, separated according to direct- respectively hub-transport at long-distance traffic, are pictured. In addition to the hub consolidation, a so-called loading device consolidation is possible, too. In this process the loading devices are transshipped at a depot during their way from starting to destination depot at direct long-distance traffic.

Next, the transportation systems of the five less-than-truckload service providers with the strongest revenues (combined, they have a share of over 50 percent of the entire market volume) are analyzed separately, yielding valuable information specific to the respective service provider, e.g. about the number of depots or the number of long-distance lines. The collected information is not sufficient for a comprehensive description of an individual provider. After this the customer side at the less-than-

truckload system is considered. Most of the service providers, especially large ones, are not focused on a special sector, but they serve customers form different segments. Over 50 percent of the less-than-truckload market volume is demanded by the three sectors food, metal/machines and construction. At the end of the macroscopic consideration the characterizing features of service providers´ networks are compiled and complemented by so far researched findings regarding the manifestations of these features. For the further clarifying of the feature manifestations detailed information is required, which could be gathered only partially by the previous research. For this reason experts are consulted, whose experience at the less-than-truckload sector should be used to answer open questions.

In addition to the generating of concrete feature manifestations, by the expert interviews a review of the already gained findings should be made, previously unnoticed interdependencies should be detected and parameter values for the optimization models should be gained. For this purpose the method of the problem- respectively theme-centered, semi-structured expert interviews is chosen. To that a guideline is created, which is mainly built on the previously mentioned, characteristic features of a less-than-truckload network. Theory-based aspects, e.g. the interlocutor´s service provider´s turnover level to represent a high degree of traffic generation, play a role at choosing the experts on the one hand. On the other hand the requirements regarding these aspects have to be lowered because of the potential interlocutors´ limited availability. However, highly skilled interview partner from DHL, CargoLine, IDS, 24plus and VTL can be gained, including two chief executive directors of less-than-truckload cooperations. The interviews are evaluated in a way which follows the method of the qualitative content analysis.

The results of the evaluation are used to describe microscopically the questioned less-than-truckload players and their networks, complemented by information from freely accessible sources. A comprehensive description can only be carried out with 3 of 5 players due to interview statements. The representatives of 24plus and VTL can only provide very few respectively no information about the local short-distance traffic and the direct transports in long-distance traffic, because the mentioned cooperations are almost exclusively responsible for long-distance traffic which is transshipped at a central- or regional hub. After that a discussion of the interview results follows, whereby they are divided into three categories: Confirming findings, which are basically in accordance with the previous observations, disproving findings, which are in contrast to them, and new findings, whereby their content is generated from the interview statements. After the discussion of the results a critical assessment of the interviews and the hereby achieved results follows. It was already mentioned that two of the five interlocutors can give few (24plus) respectively no (VTL) insights into short-distance traffic; moreover they are focused on hub transports in long-distance traffic. The interview partner of DHL can give the most information as a representative of a group, whereby the central planning office even intervenes in short-distance traffic, at least for tactical planning. General points of criticism are the missing depth of some information (especially regarding the parameter values and the short-distance traffic) and the unbalanced composition of the interview partner.

At last the optimization models are dealt with. For this purpose the different planning levels of less-than-truckload service providers are shown, especially the tactical and operative ones, separated to short-distance and long-distance traffic. Thus the basic problems, the optimization models have to handle with, will be previously described and thereby restricted. In long-distance traffic there is the organization of the lines at the tactical level and the operative scheduling of less-than-truckload shipments, in short-distance traffic there is tactically the planning of the tour areas and operatively the short-distance scheduling for a depot.

Thereupon optimization models for the short-distance traffic are analyzed. The problem is previously specified as a Vehicle Routing Problem due to the short-distance structure and then further localized with the problem, depot, customer, vehicle and objective characteristic of the less-than-truckload traffic. After that on this foundation four different models are presented and assessed on structure, data basis, solution methods and achieved results. Due to a comparing evaluation the usage of a Vehicle Routing Problem with Time Windows with a Cluster-First-Route-Second-solution method is recommended for modeling of the traffic generation. The advantages of this model, compared to others, are the easy structure and the easy solution method, which additionally enables a practically oriented procedure. At the first step of this solution method, the clustering, aspects of the actual, practical planning of tour areas could flow in (e.g. orienting towards postal code). Alternatively the modeling of tour areas could be made with the Vehicle Routing Problem with Stochastic Customers and Demands. In this respect it is noted that none of the discussed short-distance models promises an especially outstanding, realistic representation. Modifications regarding tour areas and the combined pre- and postrun seem necessary.

In long-distance traffic the occurring planning problem is identified as network-flow problem at the general classification. Different optimization models, e.g. the classical transport problem, are previously excluded from further exploration due to their insufficient structure for the less-than-truckload long-distance traffic. After that the general Multi Commodity Network Flow Problem (MCNF) and a Service Network Design Problem (SNDP), which is especially adjusted to less-than-truckload traffic, are explored and evaluated. The latter one is recommended for the modeling of traffic generation in long-distance traffic, because there are clear advantages regarding a realistic representation compared to the MCNF. This disadvantage of the MCNF cannot be compensated by its advantages regarding simplicity of structure and solution methods. However, the SNDP also needs modifications regarding its structure, depending of the concrete less-than-truckload network which will be modeled.

There are further modifications and additions regarding the situation of less-than-truckload traffic necessary for both the recommended short-distance and long-distance model, before the aspired modeling of traffic generation can be done with these optimization models. Further data collections regarding the parameter values for the models are also required, because the data gained from the interviews only provides a rough indication. Generally the interdependencies detected from the interviews need further specifications. Additionally it would be desirable to check the DHL interview partner´s statements through information from a representative of another group and to get further information regarding short-distance traffic.