September 25th — 26th, 2017 | Darmstadt, Germany
Interdisciplinary Conference
on Production, Logistics and Traffic
www.icplt.org

Delays and other Quality Characteristics of Transport Supply and their Impact on Mode Choice in Freight Traffic

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Abstract. This paper discusses a path towards the development of an approach for the monetarization of delays in freight traffic to be used in transport demand models. It describes the relevance of supply quality characteristics, from both a qualitative and quantitative perspective, through expert interviews and surveys. The focus sheds light on the customers' delay valuation by taking applied production and logistics concepts into account.

1 Overview

As the volume of freight traffic increases [1], the surging utilization of infrastructure can entail availability and quality issues. Among other things, a restricted investment framework induces the need for a careful selection of measures performed by means of a Comparable Assessment [2] of possible quality improvements. For example, a measure is expected to create benefits through a change in transport duration and delays. These time adjustments form part of the supply quality and should be applied in the Transport Demand Models to include a dependence of the customer's valuation as the offered supply quality influences the mode choice decision of customers [3]. Punctuality and other quality related characteristics of transportation arise from the customers' needs due to their current requirements of transport chains and the production as well as logistics concepts implemented before and after transportation. Therefore, their needs are substantial when compiling and assessing a set of quality characteristics.

The need to make an improvement on supply quality rateable requires an integration of supply quality characteristics into the assessment. Some publications and models aim at including quality characteristics in terms of reliability (e. g. [4]) or delay valuation (e. g. [2]). Nevertheless, Oetting and Rio [2] clearly state that further explorations in regards to thresholds for delay assessment as well as a more detailed analysis of possible influences of the production concept on the customer's valuation are necessary. Detailed information as to when a customer classifies transport as unpunctual has not yet been derived, so the authors had to assume a punctuality limit of "0 minutes" in their model. This threshold is important, as the decision maker's opinion is probably guided by the incurred costs of the delays in the form of induced extra costs. However, costs do not necessarily need to occur within the first minute of a delay. Their starting value and its further development most likely depend on the implemented production concept.

The aim of the presented study is to develop the basis for an approach to monetarize delays regarding their impact on production and logistics as well as an evaluation of other possible impact factors on mode choice. The study detects possible quality characteristics and their evaluation range and provides an initial valuation of these impact factors while focusing on delays.

2 Methodology

The aim of the described research is directed towards the evaluation of the transport supply quality characteristics within a logistics-related framework while maintaining transport mode independence. In a first step, expert interviews were conducted capturing all relevant reliability and mode choice factors for freight transport. 21 experts (forwarder or shipper) from different sectors were questioned as regards their crucial transport mode choice criteria. The results provide an initial assessment regarding the relevance and the valuation range of quality characteristics.

Secondly, based on the expert interviews a survey with around 60 forwarding companies was conducted. The main requirement of the survey was to achieve unambiguous statements within a very heterogeneous survey group. Especially for the often complex and scientific related questions, it needed to be ensured that the surveyed practitioners had an equal understanding. Therefore, prior to the survey, a test was carried out with the purpose of clearing any misunderstanding and ambiguity in the questionnaire. Peers, specialists from the surveying field and expert interview partners examined the questions on comprehensibility and survey design. In addition, they uncovered possible substantive gaps due to their proximity to the matter and identified ambiguous passages.

The questionnaire itself is divided into four segments: General Section, Supply / Distribution Processes, Determination of Value Ranges and Assessment of the Importance of Criteria Influencing Mode Choice. It mainly addresses the importance and effects of delays, damages and resulting costs as well as a constant-sum method analysis of the impact of 15 different quality characteristics on the mode choice.

3 Results

3.1. Interviews

The interviewed experts were largely forwarders, but also some shippers were included. The field experts mostly have direct responsibility for the mode choice or advise customers on choosing a particular transport mode; and therefore, can give precise information about the decisive criteria. The expert interviews have given a good overview regarding which criteria is of special relevance in the selection of transport mode. Criteria, which are to be considered when choosing a mode of transport, are - apart from the price - volume and time flexibility, transport duration, punctuality, mass efficiency and CO_2 emissions. Besides these objectively assessable factors, the costumer's personal experiences play an important role as well.

The most important notion within these criteria is the price, but also the punctuality appears to be of central relevance. There is usually a time window in which a transport is considered to be on time. This range appears to be between 30 minutes to one day.

Based on the expert interviews a valuation structure for delays can be designed as shown in Figure 1.

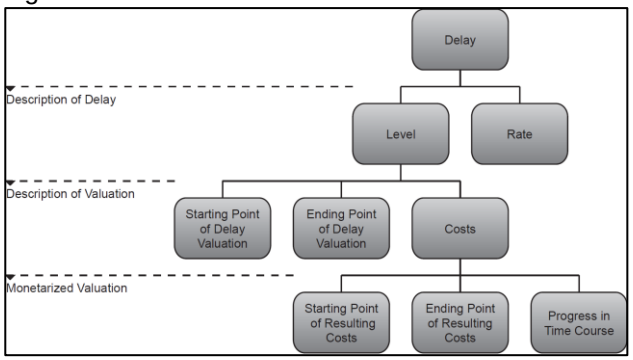

Figure 1. Differentiation of the valuation of delay [5] based on [3]

On the one hand, delays can be described through their rate of occurrence and on the other hand, by means of their level in minutes per occurred delay. The impact caused by the delay level is split into: start of the delay (i.e. a point in time at which the deviation from the scheduled delivery date is actually valued as delayed), end of the delay (i.e. delay valuation no longer changes and becomes constant) and resulting costs. The resulting costs are classified with a start and end and an in-between progress.

3.2 Survey

All survey data interpretations have been made based on the processes implemented directly after delivery: storage, production (all production-related processes like just-in-time are summarized) and others (either project business, where a direct construction of facilities takes place, or direct consumption of goods at the end customer).

As seen in Figure 2, it can be stated that the valuation of arrival deviations does not necessarily begin with the minute exceeding the delivery time, but moves in a range between hours and one day. It can be detected all three categories display a large proportion in the range from 12 hours to one day. In the first hours, many companies seem to be flexible in handling deviations, so that they do not value them as delays per se.

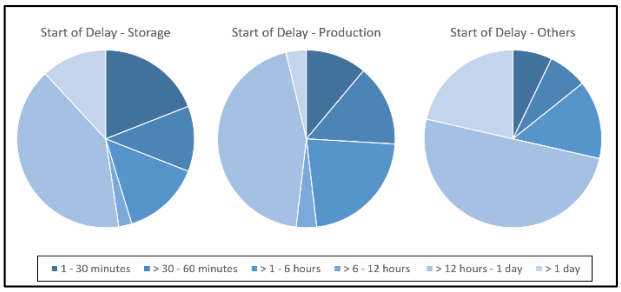

Figure 2. Categorized start of delay valuation

Storage has the highest percentage of all three categories in the range from 1 - 30 minutes. This indicates that admission processes and personnel plans in some firms might be disrupted perceptible by small delays. Production does not show significant proportion in the smallest range of the start of delay. This might be linked to an implemented safety buffer as a form of risk management ensuring that an impact on the production is excluded in case of smaller delays.

The data on the starting point of the impact on the production also shows that most answers in all three categories lie in an area from 12 hours to one day. However, in production, a small accumulation of 15% appears in the 1-6 hour delay time frame. This might indicate that especially in JIT and JIS concepts the critical period is currently in this area and a buffer is only available for a short period of time. The valuation of delays is depicted in its time course with a time-and-process-dependency connected to different impacts and resulting costs in production and logistics as seen in Figure 3.

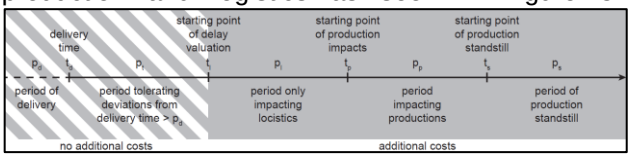

Figure 3. Delay induced costs in time course

In addition to the quantification of the description of delay valuation points (see Figure 1); the importance of 15 criteria on mode choice was studied as shown in Figure 4.

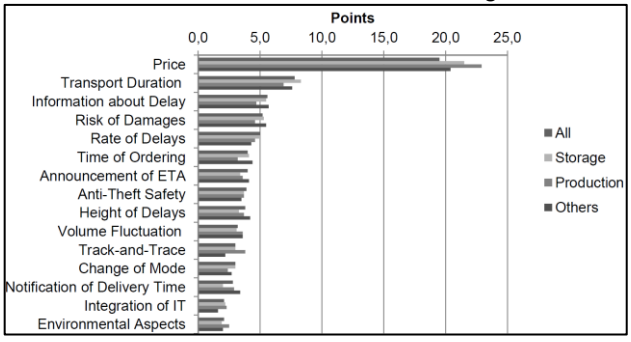

Figure 4. Importance of 15 criteria on mode choice [5]

It appears that the rate of delay occurrence generally has a greater impact on mode choice than the height of delay. However, the distance between the two criteria in Production is much lower than in Storage. In deliveries with a direct connection to the production, the level of a delay has a greater importance than in Storage. There, the effects occur rather constantly and independent of the delay rate. Mutually for the height of delay as well as its rate: they are ranked after the transport duration, but the gap is much smaller than between the transport duration and the price. It turns out that the available information can be assigned prior to the delay itself. The information about developing delays imply the possibility to be able to intervene. The influencing criteria being the information about the origin of delays was described in the glossary of the questionnaire as a proactive action taken by the carrier. This shows that a proactive approach is more important than the availability of a track-and trace functionality.

4 Conclusion

Reliability, expressly delays, have a high relevance for the mode choice due to their relevance concerning a performing value chain. Ultimately, the presented relations of supply characteristics, mode choice and rising costs can be used to develop monetarize algorithms for intermodal transport decisions.

As a whole, these algorithms could be included in further transport demand models to enhance their validity concerning actual decisions on freight transport modes.

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