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Freight Trip Generation in Switzerland

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Abstract

This work introduces research which aims to fill the gap of reliable freight traffic generation rates for Switzerland. The results are use-specific generation rates and simple statistical models for estimating expected freight traffic trips which can be used for transport and spatial planning. The study uses data from three sources: disaggregated data from a survey of firms, nationwide aggregated data, and ad-hoc traffic measurements. This paper centres on the establishment-based survey, which collects information on size, equipment, and volume of freight traffic generated by 250 establishments across Switzerland. The survey was conducted using a stratified random sampling method.

Keywords: freight trip generation rates; establishment-based survey; rail siding; Switzerland.

1. Introduction

The topic of freight traffic generation rates has been studied extensively in international literature over the past decades (McLeod et al., 2019). However, little research has been carried out in Switzerland in this field so far, and as a result there are no current reliable freight generation rates. While generation rates and guidelines for the determination of transport demand are available for passenger transport (Schweizerischer Verband der Strassen- und Verkehrsfachleute VSS, 2019), the situation is different for freight transport. There are outdated freight traffic generation rates from the 1970/80s (Hidber & Meier, 1986) The most recent generation rates were published in 2008 (Bundesamt für Strassen (ASTRA), 2008). These were based on a combination of two methods, namely expert interviewing, and an establishment-based survey on a relatively small sample.

The use of foreign generation rates in Switzerland is particularly risky, especially for transport-intensive types of land use. In general the transferability of freight traffic generation rates and models is to be treated with great caution:

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local restrictions and country-specific conditions need to be considered (Ibeas et al., 2012). Freight traffic in Switzerland is characterized by rare peculiarities that can significantly influence generation rates and make the application of foreign generation rates particularly error-prone. One of the main reasons for this is the Distance-related heavy vehicle fee (HVF) that commenced in 2001, which is a heavy vehicle user fee based on mileage and emissions that is implemented on all roads (unlike in many other countries where this fee is levied only on highways). This fee has major repercussions on both vehicle choice and average load, two consequences that are also reflected in the amount of transport generated (Bundesamt für Raumentwicklung (ARE), 2007). Other particularities that may affect the applicability of foreign generation rates in Switzerland are the night-time ban on heavy vehicles (>3.5 t) and the high rate of sites that are connected to the rail network with a rail siding. In international comparison, Switzerland shows a relatively high share of freight transport by rail. The share of domestic freight transport by rail (in ton-km) in Switzerland is 32.5 percent, nearly double the European average of 16.8 percent. (European Commission, 2023). Consequently, Swiss road freight traffic generation rates could be significantly different from those of other countries and the application of foreign rates is biased for certain types of land use.

2. Objectives

The absence of recent rates in Switzerland and the problematic applicability of rates calculated abroad have resulted in a pressing need to estimate generation rates that are specific to Switzerland. The objective of this study is to derive use-specific generation rates and basic statistical models that can be employed in the practical planning of transportation and spatial infrastructure. Our research addresses this knowledge gap by computing freight trip generation (FTG) rates in Switzerland using multiple different datasets. In this publication we focus on generation rates resulting from the establishment-based survey.

3. Methods

This study presents the results of a project aimed at developing tools for estimating freight traffic volumes generated by various types of land use. To identify the needs and requirements of potential users (as traffic and city planners), a survey was conducted among 74 respondents, primarily from planning offices and authorities at regional and national levels. The questionnaire included questions regarding current estimation practices, user needs, and the preferred format for the estimation tools to be developed. The findings indicate that the majority (62%) of potential users do not currently conduct estimations. Among those who estimate freight traffic volume, the most common practices include using reference values or making ad hoc measurements. The survey results reveal that potential users primarily require tools to estimate freight traffic volume at the individual establishment level. The feedback from potential users revealed a preference for simpler generation rates over more precise, but time-consuming, methods such as regression models. However, these simpler methods have inherent limitations, which users need to be made aware of. Due to their simplicity, constant generation rates can only consider a single denominator, typically the firm size expressed as floor area or number of employees (Pani et al., 2018). Another weakness of the simple generation rates is that they assume a linear relationship between traffic generated and the size of the establishment considered (Holguín-Veras et al., 2016).

Through the survey, potential users expressed their preferences regarding establishment types to be considered. From the options provided, a total of 13 types of establishments were selected and can be categorized into four distinct business sectors: logistics, manufacturing, trade, and services. Furthermore, in the preliminary investigation, there were requests for differentiating the generation rates. Specifically, respondents asked to differentiate between establishments that use a rail siding and those that do not. We used data and different methods to calculate freight trip generation rates. In addition to offering alternatives to practitioners, the mix of approaches provides pioneering work on which method should be chosen for more specific and in-depth research in Switzerland in the future. We used three different types of data:

- Disaggregated data, collected through a survey of firms

- Nationwide aggregated data from existing statistics
- Ad hoc traffic measurements at different types of facilities

The disaggregated data obtained from an establishment-based survey of Swiss firms turned out to be the most reliable dataset out of the three datasets considered. The survey was conducted online using a questionnaire that was based on previous research (Holguín-Veras et al., 2016; Patier et al., 2014). To cover all selected sectors and firm sizes we used stratified random sampling.

The sample was stratified according to establishment type and size, expressed in terms of the number of full-time employees (FTEs). We linked the establishment types indicated by potential users with the corresponding categories in the Swiss General Classification of Economic Activities (NOGA), which is derived from the Statistical Classification of Economic Activities in the European Community (NACE). This allowed us to determine the total number of active establishments in the relevant types and the number of full-time employees they employ. We then defined four size classes (up to 10, between 10 and 20, between 20 and 50, and greater than 50). For each of the 52 strata, which were defined based on establishment type and size, 9,000 addresses were extracted from a national register provided by the Federal Statistical Office. These addresses were randomly selected across the entire country covering all 4 language regions. The 9,000 establishments were contacted by mail. The inquiry letters contained a link (QR code) to access the online questionnaire. Since the response rate was limited, we additionally disseminated the questionnaire through the mantle organizations of the chosen sectors. We distributed a total of more than 10,000 questionnaires through mail and electronic mail. We carried out the survey between spring and summer 2022. By that time, all restrictions to counter the COVID-19 pandemic in Switzerland had already been revoked.

Through the questionnaire we collected information about the establishments, including size (measured in terms of full-time equivalent employees and gross floor area), equipment (such as rail siding connection and number of vehicles), and volume of freight traffic generated. The freight traffic information was obtained in terms of both the number of trips and volume in tons. The collected data allowed us to calculate Freight Trip Generation (FTG) per full-time equivalent (FTE) separately for establishments with or without rail for the 13 types of establishments.

4. Results

Despite a rather low response rate, thanks to the use of stratified random sampling and a large spread of the questionnaire, we obtained a well-structured sample of 248 complete observations covering all sizes of firms, all regions of the country and covering both rural and city regions as well as all the 13 types of establishments of four activity sectors. Other publications have used datasets of comparable size for similar purposes (e.g. Caspersen, 2018). It is worthy to note that the questionnaire used in our study included an option for establishments to select the “category "other" within the four business sectors in addition to the 13 predetermined types of establishments. This was necessary since the survey was conducted outside the strata defined.

Table 1 presents the freight trip generation rates for establishments without a rail siding. At the establishment type level, the trade sector appears to be the most homogeneous, with rates ranging from 0.48 to 0.55 and a standard deviation of 1.96 (up to 0.77 if the "Other" category is also considered). The differences between facilities in the logistics sector seem to be slightly higher, with a standard deviation of 2.71. The storage facility type exhibits higher generation rates than the other establishment types in the logistics sector. However, the sample for this facility type is limited to a single observation. Slightly greater heterogeneity is observed in the production sector, where the standard deviation is 3.04 and rates vary from 0.18 to 0.60 trips per FTE per operating day. Compared to other establishment types in the service sector, the gastronomy sector exhibits noteworthy generation rates, with 0.33 trips per FTE.

Table 1. FTG per FTE per workday – establishments without a rail siding

	Median Total trips per FTE	Mean Total trips per FTE	Std. dev.	2nd quartile	3rd quartile	Sample
Logistics	**0.51**	**1.63**	**2.71**	**0.32**	**1.71**	**51**
Storage	2.33	2.33	NA	2.33	2.33	1
Forwarding	0.42	1.17	1.91	0.33	0.75	23
Handling	NA	NA	NA	NA	NA	0
Distribution centers	0.82	1.85	3.35	0.30	1.85	23
Other	2.38	2.86	2.97	0.63	4.61	4
Production	**0.28**	**1.18**	**3.04**	**0.14**	**0.82**	**48**
Building materials	0.60	4.56	8.16	0.39	4.78	4
Consumer goods	0.18	0.47	0.88	0.09	0.34	11
Food products	0.37	1.26	2.93	0.14	1.10	20
Other	0.23	0.62	0.80	0.14	0.60	13
Trade	**0.54**	**1.35**	**1.96**	**0.34**	**1.59**	**28**
Only food products	0.48	0.67	0.58	0.30	0.86	9
Various goods with food	0.55	1.38	1.98	0.40	0.87	5
Other	0.77	1.78	2.46	0.35	1.63	14
Service	**0.10**	**0.29**	**0.44**	**0.04**	**0.33**	**68**
Office	0.07	0.16	0.23	0.05	0.15	15
Gastro	0.33	0.60	0.56	0.19	1.12	17
Hotel	0.08	0.20	0.24	0.06	0.21	9
Service	0.05	0.12	0.19	0.02	0.11	9
Other	0.07	0.25	0.49	0.02	0.18	18

Looking at the establishments with a railway siding (Table 2), the traffic volume generated in the logistics sector is essentially the same as for the locations without a railway siding. The rates for the former are 0.62 trips per FTE per operating day and characterised by a higher standard deviation (20.36 instead of 2.71 for the sites without a siding). Establishments connected to rail sidings exhibit higher extreme values compared to establishments without such connections. The mean values of the two groups are markedly different, in contrast to the median values.

In the non-logistical fields of activity, establishments with sidings generate more traffic per FTE than those without sidings. In production, the rate of 0.86 trips per FTE is about three times as large, in trade, one and a half times as large (0.80 trips per FTE).

Table 2. FTG per FTE per workday – establishments with a rail siding

	Median Total trips per FTE	Mean Total trips per FTE	Std. dev.	2nd quartile	3rd quartile	Sample
Logistics	**0.62**	**7.31**	**20.36**	**0.44**	**2.27**	**28**
Storage	NA	NA	NA	NA	NA	0
Forwarding	0.61	6.66	18.01	0.48	0.76	9
Handling	6.67	6.67	NA	6.67	6.67	1
Distribution centers	0.56	8.33	24.67	0.36	1.71	15
Other	2.25	4.34	4.12	1.97	5.67	3
Production	**0.86**	**3.38**	**7.67**	**0.22**	**1.11**	**8**
Building materials	0.93	1.10	0.42	0.86	1.26	3
Consumer goods	NA	NA	NA	NA	NA	0
Food products	0.25	4.75	9.83	0.14	0.95	5
Other	NA	NA	NA	NA	NA	0
Trade	**0.80**	**0.70**	**0.50**	**0.59**	**0.90**	**4**
Only food products	0.00	0.00	NA	0.00	0.00	1
Various goods with food	NA	NA	NA	NA	NA	0
Other	S66	0.93	0.23	0.80	1.00	3
Service	**0.01**	**0.01**	**NA**	**0.01**	**0.01**	**1**
Office	NA	NA	NA	NA	NA	0
Gastro	NA	NA	NA	NA	NA	0
Hotel	NA	NA	NA	NA	NA	0
Service	NA	NA	NA	NA	NA	0
Other	0.01	0.01	NA	0.01	0.01	1

A comprehensive comparison with other sources is challenging due to the varying definitions of the facilities and the differing general conditions across different countries. We have limited ourselves to publications from Switzerland and Germany. As a reference for comparison, we used the only publication that refers to Switzerland (Bundesamt für Strassen (ASTRA), 2008) as well as from a German publication (Bosserhoff, 2000) and a dissertation at the Technical University of Hamburg-Harburg (Wagner et al., 2009).

Table 3 presents a comparison between the reference values reported in other publications and our results. The generation rates reported in the Swiss publication are in good agreement with those obtained in our study. On the other hand, the generation rates calculated in this study tend to be lower than those reported in the German publications, with the exception of storage. Among the facility types considered, handling and freight forwarding exhibit the largest deviations from the reference values, with only one observation available for handling in our sample. Consequently, the traffic generation rates of these two facility types should be interpreted with caution.

Table 3. Comparison with other countries

Establishment	Calculated FTG	FTG reference	Reference
Production	0.28	0.06 - 0.24	Switzerland, (Bundesamt für Strassen (ASTRA), 2008)
Trade	0.54	0.14 - 0.46	Switzerland, (Bundesamt für Strassen (ASTRA), 2008)
Logistics	0.51	0.27 - 1.13	Switzerland, (Bundesamt für Strassen (ASTRA), 2008)
Service - Gastro	0.33	0.70 - 0.90	Germany, (Bosserhoff, 2000)
Service - Hotel	0.08	0.40 - 0.60	Germany, (Bosserhoff, 2000)
Service - Service	0.05	0.10	Germany, (Bosserhoff, 2000)
Service - Office	0.07	0.10	Germany, (Bosserhoff, 2000)
Logistics - Transhipment	6.67	40 - 60	Germany, (Bosserhoff, 2000)
Logistics - Forwarding	0.42	2 - 9	Germany, (Bosserhoff, 2000)
Logistics - Storage	2.33	2 - 4	Germany, (Bosserhoff, 2000)
Trade	0.54	2.9	Germany, (Bosserhoff, 2000)
Trade	0.54	0.8 – 2.4	Germany, (Wagner et al., 2009)

The primary weakness associated with the use of constant rates is the simplification of the relationship between the number of employees and the generated traffic, by assuming linearity. At the business sector level, we have evaluated the extent of the error arising from this simplification. In Fig. 1. Index FTG per FTE by establishment size category, we present FTG rates indexed according to four establishment size categories. The rate of the smallest category (1-4) is used as the reference for the index. The solid lines depict the change in FTG based on the establishment size category relative to the FTG of category 1-4. The dashed lines show the calculated FTG value across all size categories. To the left of the intersection point of the dotted line with the solid line, estimates based on the constant FTG are underestimated. To the right of the intersection point, the estimates based on the constant FTG rate are overestimated. In all business sectors, category 1-4 yields higher FTG values than the constant FTG value.

In the logistics sector, this threshold corresponds to the "20-49" category. This indicates that for establishments with less than 20 FTE, estimates based on the constant FTG rate underestimate the volume of generated traffic. Conversely, for establishments with 20 FTE and above, the estimate overestimates the traffic volume. For non-logistics sectors, this threshold is set at the "10-19" category.

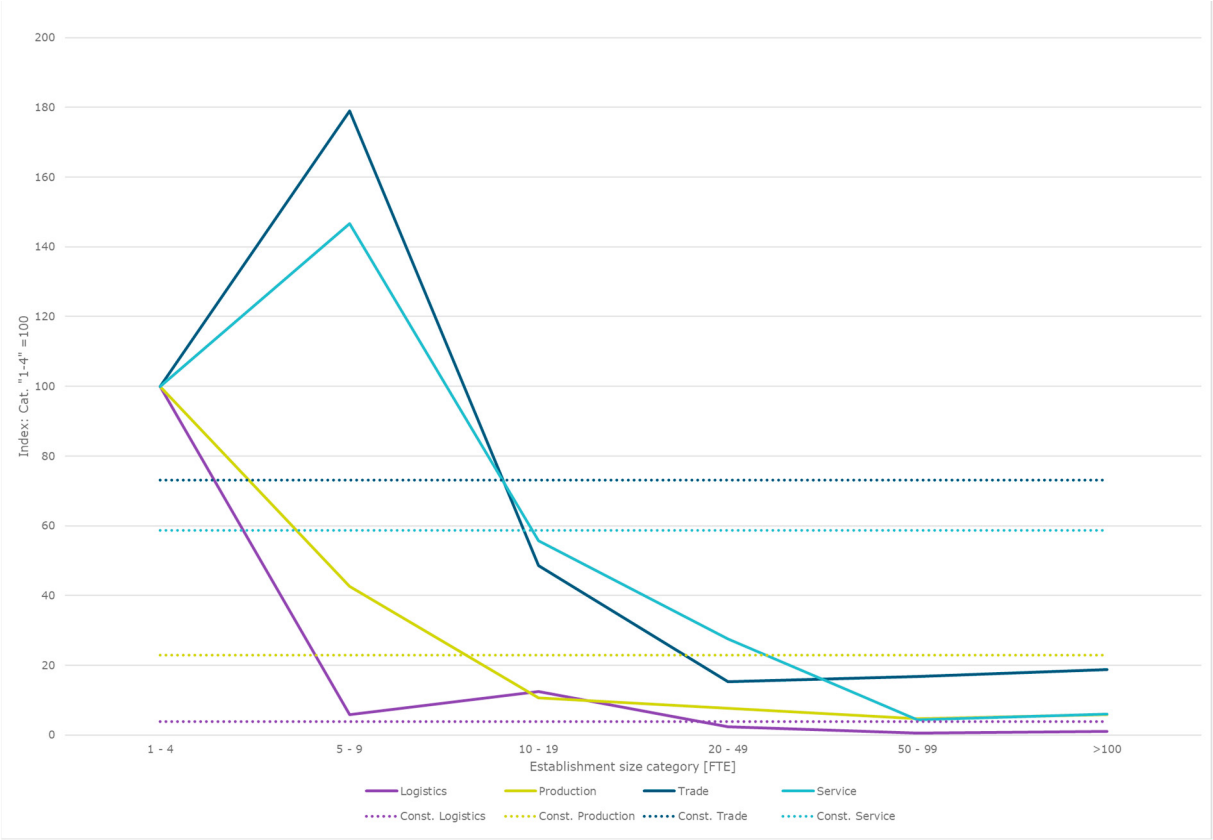

Fig. 1. Index FTG per FTE by establishment size category

5. Conclusions

This study aimed to fill the gap in the knowledge of freight trip generation (FTG) rates in Switzerland and provide tools to the practitioners (as traffic and city planner) for estimating freight traffic volumes generated by various land use. To achieve this objective, a preliminary survey of potential users was conducted to understand their needs and preferences, and stratified random sampling was used to collect data through an establishment-based survey of Swiss firms. The survey collected information about the size, equipment, and volume of freight traffic generated by firms in trips and tons.

The calculated generation rates serve as a useful tool for traffic and land-use planners mainly in the infrastructure planning process. Despite being associated with substantial margins of error, they provide a basis for the estimates required by planners.

Among the three methods employed, the establishment-based survey emerged as the most reliable and the one we recommend for future research. Its results are presented in this paper.

The calculated generation rates are characterised by large standard deviations. For establishments with rail sidings, the traffic volume generated in the logistics sector was similar to that of the locations without sidings. However, the locations with sidings generated more traffic per FTE in the non-logistical fields of activity, particularly in production and trade. The rate of 0.86 trips per FTE in production was three times higher and 0.80 trips per FTE in trade was one and a half times higher than the locations without sidings.

We compared our findings with those from other publications in Switzerland and Germany. The generation rates reported in the prior Swiss publication are in line with those presented in our paper. Nevertheless, these rates tend to be lower compared to the German publications, except for the storage establishment type for which we found values

close to those obtained in Germany. Our calculated values fall within the confidence interval of the German values. The handling and freight forwarding establishment types have the greatest discrepancy with the reference values and should be used with caution.

One possible explanation for the lower values compared to other publications could be related to the respondents' perception of the freight traffic they generate. A significant portion of the interviewed seemed to be unaware of the freight traffic generated by their establishments. During our study, we encountered several reports from facilities of different types claiming that their site does not generate freight traffic. Upon reminding them of the various deliveries and shipments that occur (e.g. office supplies, mail and courier services, waste disposal, and food supplies), it was confirmed that such activities do indeed take place. This could have a significant impact on the calculated transport intensities. Furthermore, we believe that this lack of awareness could also have contributed to the low participation rate in our survey, particularly among non-logistics companies that did not perceive themselves as being concerned by a survey on freight transport.

The simplification of assuming linearity between establishment size and the volume of freight traffic generated underlying constant generation rates, according to the literature, results in distortions in the estimation process. We have confirmed through a brief analysis that this is also applicable to the generation rates presented in this study. Therefore, it is crucial to inform the users of generation rates about these potential distortions.

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