Business structure and localization affects transport generation and traffic flow

M. Pettersson
City & Mobility, Chalmers University of Technology, Sweden

Abstract

Goods transports are increasing faster than the GNP and they are increasing most in the urban areas, which are great production and consumer areas. There are very little data referring to urban goods transports, and national statistics do not allow analyses on the intra- or interurban level. Studies indicate that the future capacity problems will occur not in the national main road system but in or around the urban areas. Today about 20% of the traffic (road vehicle kilometer) in the urban areas are goods transports generated by the commercial and industrial life. Despite this, town- and traffic planning focus personal transports by tradition.

To estimate the urban goods transports and to analyse how the business structure and localization affect the transport generation in urban areas, we need empirical data suitable for urban conditions. An empirical study has therefore been performed in 45 Swedish communities. The study has mapped all transports to and from a number of companies during one week.

The study will estimate the trip generation for businesses in different branches and of different sizes in terms of trip frequencies, vehicle kilometres and origin-destination analyses. The aim is to create a transport generation model that can be used in urban planning in terms of environmental decisions, business localization and land use. A second aim is to develop methods to analyse transports with GIS-tools. This paper will present the design of the empirical study, and it will focus a discussion on method and definitions in the field of transportation.
Introduction

Transportation is increasing faster than the GNP, and road transportation is increasing most. Trip frequencies are also increasing at the same time as the amount of goods carried each trip is decreasing. Since 1975 the total amount of goods carried in Sweden has decreased by 26% and at the same time the performed transport work has increased by 62% [1]. Transports are getting longer and more frequent. Economic growth is the most important factor explaining the increase of transports. But geographical and organizational changes are also part of the explanation.

Goods transports are increasing mostly in the urban areas, which are production and consumer areas of great importance. According to SIKA there are not likely to be any severe capacity problems on the national road system, but in and around the urban areas capacity problems are expected. Yet neither national nor local authorities focus their attention on urban goods transports. By tradition local town and traffic planning focuses on personal transports while goods transports are neglected. The national level focuses on heavy transports and infrastructure planning in order to locate transport corridors and analyse the capacity of the national road network. One reason for this is that most goods transports are assumed to operate on a national and international arena. Yet 73% of the goods carried and 36% of the traffic work have their origins and destinations within the same county [1].

The problem is two-fold, the local planning process, and the local and national process to achieve environmental goals. The local level decides about business localization and land, use but there is no data about how much transportation different businesses generate, or how the localization effects the transport generation to support their decisions. The local and national process to formulate and achieve environmental goals calls for action, both from technical development and from managing the increasing urban goods transports. But there is no data to support the formulation of goals, or the means to achieve them. To manage to reduce the negative effects of increasing urban transports and at the same time establish good accessibility for goods transports for commerce and industry is a great challenge and calls for knowledge about how transports are generated. This paper will present the data available, the design of an empirical study, some preliminary results and a transport generation model.

2 Aim

The project aims to create a transport generation model to be used in urban planning to support environmental decisions, business localization and land use. Further aims are to; provide a general description of the urban goods movements; produce key figures for transport generation; the number of transports generated by businesses of different branches and of different sizes; develop methods to analyse transports with Geographical Information Systems (GIS); create a GIS-database, which can be used for other analyses; calculate traffic work with GIS-tools.
3 Available transport data

National transport statistics are designed to create data for national infrastructure issues. These are shown by; how the amount of transportation is expressed, the one sided focus on links and how the studies are designed. This focus is reproduced on many levels in the society and influences the physical planning and the general transport discussions. It also affects the possibilities of using the data for other analyses.

3.1 How transport data is expressed

In the national statistics Swedish transports are expressed in four different measures; 1) goods carried, 2) transport frequencies, 3) traffic work and 4) transport work. These measures describe the same transports in quite different ways, and they give different results. Transport frequencies indicate that most transports are performed over short distances, 81% of the number of transports was shorter than 100 km, and 51% were shorter than 25 km. The goods carried also show dominance for short distances, 68% of the goods were carried less than 100 km, and 38% were transported less than 25 km. Transport work, on the other hand, indicates that long distances are more dominant, almost 80% of the transport work was performed over distances more than 100 km (figure 1). Traffic work also shows predominance for long distances, 66% of the traffic work was performed over distances more than 100 km. Most statistics, research investigations, data for political decisions etc. concerning transports, are presented as transport work (ton-km) and show a predominance for long heavy transports and under estimate short distance distribution and light goods, which are particularly frequent in urban areas.

![Figure 1: Swedish transports 1999 in figures [1].](image-url)
3.2 There are no transports without nodes

The national infrastructure emphasis is a focus on the links. In terms of nodes, and network, the local units are all nodes, and the roads are the links that constitute the network. The nodes are the dimensioning parts of the system. How crowded the network is on specific links is dependent on how the nodes are distributed. If a great deal of the local units are relocated the load on the network also will change. The amount of traffic on the links in the network is measured in several ways, but the generation at the nodes is seldom measured. When environmental issues and overcrowding are discussed, the most loaded links, and where infrastructure investments ought to be invested, come to focus. Studies of public and private personal transports always have an origin and a destination, and they always relate to where the living-, service- or work areas are located. But when analyzing goods transports the network seems to be the interesting part. If the impact from traffic is to be analysed, the nodes are more interesting parts of the system than the links. If the transport generation in the nodes is known (with O/D information), it is even possible to analyse the load on the links with GIS-tools.

To some extent, it is possible to affect the localization of the nodes. Some forms of business need authorization and permission from the local authority to set up. For these businesses it is possible to affect the localization. Another situation providing possibilities to affect localization is when a business needs land to set up or relocate an activity. Descriptions of the environmental consequences are also requested when starting or moving an activity. This also offers opportunities to control the nodes to optimal localizations, or at least possibilities of avoiding the most unfortunate localizations. Of course we are unable to rearrange the whole city to achieve the optimal solution, but it is possible to influence localization if we know how the localization affects the transport generation and traffic flow.

3.2 Study design

In Sweden National statistics has produced comparable data since 1972. Since 1995, the statistics follows EU directives [2]. National Statistics and the official statistics of EU address the vehicle owner as the study unit. This does not allow analyses of transport generation based on localization or local unit size since one cannot calculate the total amount of transports from single units. The results are distributed in commodity groups, and are not possible to link to branch of business.
4 The empirical study

4.1 Method

Since transport generation is not possible to analyse with existing data, an empirical study has been performed in 45 Swedish communities. The study takes its point of departure in commerce and industry, in the companies that generate transports, in other words the nodes. Almost every business company orders goods and generates transports. This may be a shop ordering goods, an office ordering papers for its printer or an industry ordering or sending goods to or from its production. The study unit is the local unit of the businesses. A company may have one or more local units.

Since the aim is to analyse the transport generation for units of different sizes and with specific localizations, the local unit is more appropriate than the whole company, which may consist of several units with quite different activities, sometimes related to different branches. A sample was created from the Business Register of Statistics Sweden by selecting local units with 0-499 employees. The sample was stratified according to the branch and size of the community it was situated in. The questionnaire was delivered by post, but all units were also contacted by phone.

In the study all transports to and from the local units during a single week have been charted with origin and destination addresses, times of the day, types of goods and vehicles used (fig 2). The study sets out to estimate the trip generation for businesses in different branches and of different sizes in terms of trip frequencies, vehicle kilometres and origin-destination analyses. It is possible to show the transport generation for specific branches, for different community sizes and different local unit sizes. But the material does not provide statistically safe results for both branch and community size, or local unit size. If disaggregated to this level the uncertainties become too big.

4.2 Questions and analyses

The research question may be formulated, as “are there any relationships between transport generation, traffic work and business structure and localization?”

The question may be divided into three sub-questions; 1 How many transports do companies of different branches and of different sizes generate? 2 How large is the traffic work for companies of different branches and of different sizes? 3 How does localization affect the traffic work?
5 Results

Since this is an ongoing study, this section will bring you some results from the statistical part of the study. Primarily the presentation consists of results shown in the empirical study, with some remarks but no discussion.

5.1 The commercial and industrial structure

The analysis of the commercial and industrial structure in the 45 communities shows:

- a homogeneous branch structure, commerce and industry has the same branch structure independent of community size (figure 3),
- a homogeneous size structure, commerce and industry has the same size structure independent of community size (figure 4),
- that the proportion of local units within each branch increases with community size. (Every branch has the greatest proportion of local units in the biggest community, and less in the smallest communities (figure 5).
Figure 3: The branch structure is quite similar in communities of different sizes. The retailers, for example, constitute nearly 10% of the local units independent of community size.

Figure 4: Commerce and industry has the same size structure independent of community size.
5.2 Local units without transports

A large proportion of the local units had no transports the week under review. The largest proportion of local units with no transports was found among the service branches (figure 6),

The largest proportion of local units with no transports was found among local units with no employees (figure 7),

The proportion of local units with no transports decreased with increasing local unit size (table 1),

The proportion of local units with no transports increased with the community size.

Figure 5: Every branch has the largest proportion of local units in the biggest community, and less in the smallest communities.

Figure 6: Share of local units with and without transports presented for various branches.
Table 1: Share of local units without transports presented for local unit size.

<table>
<thead>
<tr>
<th>Local units without transports %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No employees</td>
</tr>
<tr>
<td>1-4 employees</td>
</tr>
<tr>
<td>5-9 employees</td>
</tr>
<tr>
<td>10-499 employees</td>
</tr>
</tbody>
</table>

5.3 Transport generation

Transport generation depends on branch (figure 7). Transport generation increases with increasing size of local unit (figure 8), transport generation does not depend on community size. The transport generation is highest for the industries, the wholesalers and the retailers. In all of these branches the generation is highest for food-related businesses. Transport generation is lowest in what we might call the service branches. (One exception not shown here is hospitals, which usually have a high transport generation, but this is not shown in the figures for health-care because they often have more than 500 employees).

Figure 7. Transport generation in different branches.
Transport generation increases with increasing business size (figure 8, I). This is not surprising, but the small businesses without employees are also the greatest proportion of the businesses (figure 8, II). One consequence of this is that businesses without employees generate more than 20% of the total amount of transports in a community (figure 8, III). The largest companies generate nearly 40% of the transports. This shows that businesses without employees have low generation figures treated singularly, but together they are responsible for a great part of the transports. This is why I included them in the study. They are often excluded, because they have very few transports. But it is just this relationship that makes them interesting.

![Figure 8. The importance of business without employees.](image)

### 6 Transport generation model

The transport generation model is built on two sets of data in a GIS data bas: the actual Business Register from which you can outline the local units and the key figures for the transport generation from the empirical study. The model is a tool to analyse transport generation and to simulate how changes in business structure affect the amount and the flow of transports. This model can be used in urban planning with regard to business localization and land use in a specified geographical area, for example a community. By adding the key figures to the actual local units one is provided with a map over the transport generation nodes. If this model is combined with the model for traffic work one may also gain information about transport distances and emissions.

### References
