Summary:

Cost benefit analysis of lorries dimensions in city centres

TØI Report 1182/2011
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Oslo 2011, 72 pages Norwegian language

In this study we have developed a methodological framework for social cost benefit-analyses of harmonizing the dimensions of lorries and loading docks in urban areas. The framework is universal in the sense that it can be used for project evaluations in different cities, however based on local data.

The methodological framework is tested on data from the central parts of Oslo, limited by the orbital road, Ring 2. Estimations are made using four scenarios; two for estimating the effects of lorry size restrictions, and two focusing on dimensioning of loading docks. Only one scenario, assessing 10 meters maximum lorry length, resulted in a positive cost-benefit ratio.

The study has revealed that there is a lack of relevant data, especially as regards loading docks, which have rendered difficulties with calculating the needs for improvements and the costs and effects from new requirements. In our study, this has necessitated use of simplified calculations and judgments which have made it somewhat difficult to assure the quality of all calculation results.

The developed framework can be used for similar analyses in other city areas, and must then be based on local data. An important recommendation for improving the quality of future analyses is to ensure data collection from concrete actions directed at cargo distribution in city areas.

Background

Norway and the rest of the world experience increased urbanisation, causing high city growth, not necessarily accompanied by increased infrastructure capacity. Population growth increases the demand for cargo supplies, which involves several challenges in urban areas.

A frequent problem with cargo deliveries in cities is the adaptation between lorries and loading docks, including the areas for reversing, turning and parking the cargo vehicle. Several of the existing loading docks have unsuitable solutions regarding parking space, height of the cargo intake, safety and security. The reason for this may be many, for example that the loading docks in older buildings are adapted to older requirements on vehicles and working environment. The consequence is often that lorry drivers choose to unload on-street.

Unlike other freight transportation, distribution of cargo in cities takes to large extent place in street networks where pedestrians and freight vehicles uses a common road infrastructure. Studies indicate that approximately 70% of deliveries in cities take place on-street, which causes problems with both traffic flow and delivery conditions. Also the inconvenience for other road users and local inhabitants is noticeable. Relevant actions for reducing disadvantages due to cargo deliveries can be to increase use of smaller lorries and transfer the deliveries from street level to loading docks.

Purpose

The main purpose of this study has been to develop a methodological framework for performing social cost-benefit analyses on harmonization of lorries and loading docks in urban areas. The resulting framework is universal and can be used in analyses of similar projects in other cities, provided that local data are collected.

In the study we have prepared and tested an analytical instrument that renders possibilities to:

a) assess the socio-economic optimal sizes of distribution lorries used in Norwegian city centres
b) measure the socio-economic effect of adapting the dimensions on drive-ins and parking spaces at loading docks, considering the vehicles used for cargo distribution in cities

Contingent on improved data access, the method can also be utilized for analyzing the socio-economic effects of introducing restrictions on lorry size in city centers, with regards to serious accidents (killed or severely injured), safety and well-being of pedestrians and cyclists.

The method and framework is tested using data collected from projects inside the orbital road Ring 2 in Oslo.

Method, data and accomplishment

The study is carried out within the outlines of a social cost-benefit analysis, which is an estimate of the benefits and costs of public actions, measured in monetary value. The purpose of a social cost-benefit analysis is to determine whether the project is socio-economic beneficial or not, i.e. whether the total benefits of the public action exceeds the costs of the project.

In the analysis, we have only considered short term effects, and also disregarded demand effects of the projects. Moreover, some less quantifiable benefit and cost elements are set to 0 or based on assumption. The study revealed lack of data that necessitated additional simplifications of estimates on important elements in the analysis.

In some of the data and estimates the level of uncertainty is high. This is the case for some of the cost elements, especially on the needs and costs of rebuilding loading docks. For external costs, data problems especially affect the measuring of project enforcement and the inconvenience inflicted on pedestrians and cyclists.

The analytic work is based on literature study, processing of available public statistics, estimates of external costs, and interviewing and surveying transport providers with distribution in Oslo. Additionally, we have gained valuable information on the problems and experiences with cargo distribution in cities from a seminar on the future size of freight vehicles arranged by the Norwegian Forum for local goods transports.

Elements in the cost-benefit analysis

The elements we found reasonable to include in the cost-benefit analysis of actions directed towards lorry and loading dock dimensions are summarized in Table S 1. The different cost and benefit elements are grouped by theme, and for each element the assessment method is stated, divided into three categories:

- **Quantitative (Q)**: These elements are regarded as fully taken into consideration in the assessments, presupposing that the input data are reliable.
- **Simple calculation (SC)**: Elements we have attempted to quantify, however by use of far from satisfactory combinations of procedure and data.
- **Judgment (J):** For these elements we lack the foundation for estimating values, and have instead provided verbal considerations about the expected impacts.

In the last two columns in Table S 1, it is marked whether the cost-benefit element is assumed affected by actions directed towards lorry sizes (“Lorry actions”) and/or loading docks (“Loading dock actions”).

Table S 1.Cost-benefit elements with assessment method.

Component	Cost/benefit elements	Method	Lorry actions	Loading dock actions
A. Vehicles and logistics	Operative lorry costs	Q	X	
	Costs of additional reloading	SC	X	
	Forced renewal of lorry fleet	SC	X	
B. External costs	Local emissions, noise, accidents, road wear, global emissions, and congestion costs	Q	X	
	Costs of enforcement	J	X	
	Reduced safety for other road users	J	X	X
C. Costs related to loading docks	Costs of rebuilding loading docks	SC		X
	Alternative costs for expansion of loading area	SC		X
D. Delivery situation	Time used in delivery situation	Q	X	X
	Impacts on other traffic flow	J	X	X
	Area occupied on street level	J	X	
E. Other effects	Other societal costs of actions	J	X	X
	Lorry drivers’ working environment and accessibility conditions	J	X	X

The framework for socio-economic assessments contains the following components:

- Cost components related to *lorries and logistics*, such as operative lorry costs, reloading costs and possible costs of forced renewal of lorry fleet.
- *External costs* of lorry transports (local emissions, noise, accidents, road wear, global emissions, and congestion costs), plus enforcement costs and reduced safety experienced by other road users.
- Costs related to *loading docks* are the costs of rebuilding, and also the alternative costs, which include lost income from other profitable use of the expanded loading areas.
- *Effects on the delivery situation* involve the time spent loading and unloading, and the impacts on other traffic flow.
- *Other effects*, such as other societal costs of implementing the actions, and the lorry drivers' working environment and accessibility conditions.

Assessed scenarios

Different variants of actions are tested in the following four scenarios, where the example calculations are compared to a basis scenario representing the current situation:

Scenario 1. The Gothenburg solution. Maximum allowed lorry length of 10 meters.

Scenario 2. Low lorry solution. Maximum lorry length 10 meters and maximum lorry height 3.20 meters.

Scenario 3. Loading dock height. Requiring loading docks to accept 4.20 m lorry height (loading dock height 4.50 m), and 10.0 m lorry length.

Scenario 4. Loading dock height and length. Requiring the height and length of loading docks to accept 4.20 m lorry height (loading dock 4.50 m), and lorry length 12.0 meters.

Actions directed towards loading docks are only considered as relevant for new constructions, or change of use for existing buildings.

Results

In order to implement the calculation examples, several choices are made based on judgments, and the quality of the data material is also variable. Too much emphasize must therefore not be placed on the outcome of the calculations.

Table S 2 summarizes the change in cost and benefit components in the four project scenarios compared to the basis scenario. Benefits are recognized by positive numbers while the costs have negative signs.

Table S 2. Benefit and cost components in the project scenarios. Changes compared to basis scenario. Mill NOK yearly.

	Component	Scenario 1: Gothenburg	Scenario 2: Low lorry	Scenario 3: Loading dock height	Scenario 4: Loading dock height and length
A. Vehicles and logistics	Operative lorry costs	-12	-73	0	0
B. External costs	External costs of lorry transport	-1	-26	0	0
C. Costs related to loading docks	Rebuilding costs and alternative costs for loading area	0	0	-13	-42
D. Delivery situation	Time used in delivery situation	28	42	0	1
Total quantified result		15	-58	-12	-41

The results from the estimations show that only *Scenario 1. The Gothenburg solution* renders positive benefit, while the other project scenarios give, using our assumptions and data, negative outcome. The estimated benefit in the delivery situation is clearly highest in the scenarios involving restrictions on lorry size. The reason is that effects of loading dock actions only surface in the few cases where rebuild of loading dock is relevant, while the actions directed towards lorries are assumed to work under all delivery conditions. We see, however, that there are significant costs resulting from restrictions on lorry sizes, especially with the low lorry solution, where the operative costs and external costs of lorry transports increase considerably.

Another conclusion from the scenario calculations is that the influence on lorry transports with *Scenario 1. The Gothenburg solution*, focusing on lorry length, will be far more limited than with *Scenario 2 The Low Lorry Solution*, which restricts both height and length of the freight vehicles. This is due to the fact that a low lorry solution will exclude many of the currently used trucks. The benefit in the delivery situation is however also high with the Gothenburg solution, thus this action appears as the most attractive alternative.

Scenario 3 Loading dock height and *Scenario 4 Loading dock height and length*, i.e. the actions directed towards the loading docks, result in far smaller effects on delivery situation than does the two lorry related scenarios. The reason is that the loading dock actions only affect the delivery situation at a limited number of loading docks. In these cases, however, the actions could also be of benefit for other road users than those directly involved, but we did not have relevant data material for assessing and including this in the analyses.

In the study, several effects have proved difficult to quantify, and are thus not included in the calculations in Table S 2 of the scenarios inside Ring 2 in Oslo.

We have nevertheless made some judgments of the less quantifiable benefit and cost elements. The judgments are presented in Table 3, and are graded in the following way:

- ”--” =Significant cost
- ”-” = Moderat cost
- ”0” =No or very little effect
- ”+” = Moderat positive benefit
- ”++” = Significant positive benefit

Table S 3 Benefit and cost elements not quantified in the action scenarios.

	Component	Gothenburg	Low Lorry	Loading dock Height	Loading dock Height and Length
B. External costs	Enforcement costs	-	-	0	0
	Reduced safety for other road users	+	+	+	+
D. Delivery situation	Effects on other traffic flow	+	+	+	+
	Area occupied on street level	+	+	++	++
E. Other effects	Other societal costs of actions	0	0	0	0
	Lorry drivers’ working environment and accessibility	+	+	+	+

From the signs in Table S 3, we see that the not quantified effects are in general positive. The only negative component is the assumed enforcement cost of introducing restrictions on lorry sizes. In most cases where decisions are based on the framework for socio-economic assessments presented in this report, thorough examinations of the above mentioned effects must be carried out.

Our experience is that the amount of available data related to effects of cargo delivery in city areas is at present limited. One important recommendation is therefore to give a higher priority to collection of such data in order to improve the quality of future analyses of cargo distribution in central urban areas.

In order to illustrate how assumptions affect the scenario estimates, we carried out a sensitivity analysis by making adjustments on two assumptions, i.e. the number of deliveries per trip, and the time savings in the delivery situation. These examples show that changing the number of deliveries per trip (4 and 10 deliveries, respectively) does not alter our conclusions substantially. In calculations with the assumption that time savings only occur in 20 % of the deliveries with reduced lorry sizes, we find that even Scenario 1, The Gothenburg solution, does not render positive benefit.