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Sustainable bus transports through less detailed contracts

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ABSTRACT

The purpose of this paper is to investigate both environmental effects and cost effects of using less specified contracts regarding bus sizes in public bus transports. The process of choosing the best bid in the public procurement of bus transports is easier if the demands of the qualifications are well specified and detailed. On the other hand, detailed contracts can force the entrepreneurs to use less environmentally friendly and uneconomical alternatives. A mathematical model with binary variables is developed to evaluate the environmental and the economical effects of more optimized bus sizes. Computational results from a bus service provider are reported. The results of the model indicate that the emissions decrease considerably by using less detailed contracts. The results of a sub case indicate that the costs could be reduced as well, depending on how efficient the additional buses can be planned. The process of choosing the best bid in the public procurement process will be more complicated when the contracts are less detailed compared to current situations.

1. Introduction

The trade organizations within the public bus transport area in Sweden have a common goal to double the public transports to 2020 and this ambition is in line with the aim in EU declaring that the emissions should decrease considerably. Promoting public transport can be one of several potential solutions to the current environmental problems [1]. The public bus transport market in Sweden is deregulated and there is a process for the regulations for procurement of public bus transport based on EU public-procurement guidelines. The process of choosing the winning bid in the public procurement of bus transports is easier if the demands of the qualifications are well specified and detailed. On the other hand, detailed contracts will lead to limitations and could force the entrepreneurs to use uneconomical, but most of all, less environmentally friendly alternatives. The resulting contracts are indeed very detailed and there is not much inbuilt flexibility regarding for example the bus sizes. Using large buses with many bus seats for transporting few persons is expensive, both in economic terms and most important in emission terms. There is a need for testing other public procurement processes that could result in less specified contracts and that could in turn lead to reduced CO_2-emissions because smaller buses can be used for different tours. The overall question is how to define the performance of procurement of public transport services in order to reduce emissions and at the same time decrease costs and maintain (or improve) customer service. Reducing the CO_2-emissions by using the bus transports more effective is a very relevant approach both in a macro (public) perspective and in a micro (firm) perspective.

An earlier study shows that the CO_2-emissions can be reduced considerably by using less specified contracts with respect to bus sizes in the public bus transports [2]. The purpose of the present paper is to study the costs as well as the CO_2-emissions when using bus types adapted to the number of passengers in a sub area of the area presented in the earlier study [2]. The possibilities of reducing both costs and CO_2-emissions at the same time will be investigated.

The outline of the paper is as follows. In Section 2 some general comments of public procurement of bus transport services are given. The methodology is presented in Section 3 and in Section 4 the mathematical model for the problem is formulated. Data from a real-life case is studied and presented in Section 5. The computational results are presented in Section 6 and finally, in Section 7, some concluding remarks are viewed.

2. Public procurement of bus transport services

Many nations have converted their public transport systems from monopoly transit systems to competitive tendering. One of the first regions to use fully-tendering regime was London in 1985 [3]. An overview of the general competition for public transports in the world is presented in Cox and Duthion [4]. They have studied in what way the conversion to the system of competitive tendering has affected the productivity within the public transport sector in

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different countries. The tendency has during the last two decades been to use competitive tendering for public transports and the new system has led to lower costs. In average for the places in their study (Copenhagen, Denver, London, San Diego and Stockholm) the productivity has increased by 2.7% [4].

Hensher and Wallis [3] give an overview of international successful and less successful ways to use competitive tendering as a possibility to decrease the subsidies within the business of public bus transports [3]. They present a rigorous comparison between a number of countries where among others the level of decrease in costs in the bus transports depending on the transfer to competitive tendering. The level is an average 20–30% when the administration costs have been excluded [3]. The authors emphasize, however, that the costs have a tendency to be low at the first time competitive tendering is used and then instead increase for the second and third time the system is used. This form of tendering often leads to changes of the structure of the actors involved in the process. Going from a market including many small actors, the actors are now few and large [4]. The competitive tendering system has worked satisfactory in most of the European countries [3]. Two exceptions are Italy and France where the transfer to the competitive tendering system has not affected the transports costs at all [5]. A comparison of the market situation after entering the competitive tendering is done for France and London [6]. The results from the study illustrate that competitive tendering led to few competitors and collusive behaviors in France and the use of transparency of auction procedures in London led to sufficient competition. Brasileiro et al. [7] state that the public tender in bus transports is very slow and the results of their study, done in Brazil, indicate that the reason for that is a lack of trust between the participants involved in the tendering process. The lack of trust in the public procurement of bus transports is further discussed in Merkert and Hensher [8]. They compare the bus industry with the public air services and one of their conclusions is that the trust levels and relationship between transport authorities and airlines are better than those between transport authorities and bus operators [8]. Stronger relationship can be a way to overcome the problem with unclear bus contracts [8].

The system for public procurement in Sweden started through a national resolution in 1985, which led to a law coming into effect in 1989 [9]. The market in Sweden is deregulated and there is a process for the regulations for procurement of public bus transport based on EU public-procurement guidelines. The part of traffic being involved in the public procurement processes has been increased drastically since and was in 2010 around 90%. The structure of the traffic market in Sweden has as well as in others countries that have transit to competitive tendering, changed from many small actors to few large actors [9].

The contracts regarding bus transports can be of different types. The three most common contract forms are gross contract, net contract and incentive contract. Gross contract imply that the bus entrepreneur gets paid for the related costs regarding the bus transports. The contract states that the operator is only paid for the number of kilometers or hours driven. Other variables could also be considered, for examples costs related to the number of passengers. All ticket revenues are paid directly to the public transport authority. If the net contract is used all the revenues from the ticket sales go directly to the bus entrepreneur and can therefore be seen as an incentive to get more passengers on the buses. The incentive contract form is a combination of a gross contract and a net contract. The form has been used for example in Norway [10,11]. The revenues from ticket sales go to the public transport authority, but some kind of poundage based on either the number of passengers or the level of the quality accrues the entrepreneur. The most common contract form in Sweden is gross contract. Sonesson [12] describes the contract forms in detail and he also analyzes their advantages and disadvantages in what way they affect the citizens. Sonesson [12] also raises the question of which aim to strive for; the aim of the businesses or the aim of the society and he means they are not the same. A review of public procurement of bus transports in general and the situation in Sweden in particular can be found in Lidestam [13].

Regardless of which form of contract that has been constituted, the resulting contracts will be very detailed and therefore include a low level of inbuilt flexibility. Everything, from which color of the curtains to choose, to which kind of an engine to use in the bus, can be specified in the contracts.

3. Methodology

A mathematical optimization model with binary variables is developed to evaluate the environmental effects of more optimized bus sizes. The mathematical model is described in Section 4. We have used the program, AMPL, for modeling the problem and the commercial program CPLEX, version 10.2.0, is used to solve the model. These programs are suitable when the mathematical models include binary or integer variables. Data needed for the study is collected for one region in Sweden and is provided by a large Swedish bus entrepreneur, called Nobina Bus AB. All distances from one stopping place to the next stopping place on all chosen bus tours have been used as well as different kind of buses and their capacity in terms of number of seats. Finally, the levels of CO_2-emissions (kilogram per kilometers) and costs (Swedish crowns per kilometers) for each kinds of bus type are considered. Two opposite scenarios have been tested in order to evaluate the environmental effects of more details in contracts. The scenarios are shortly described below:

Scenario A – This is the basic scenario and it shows the current situation in the chosen region. The contract for bus traffic in the area defines which type of buses those have to be used on which bus tours.
Scenario B– The possibility to use additional buses along the lines is tested. Sometimes a large bus can drive empty from the starting place to the second last stopping place and then it can get a lot of passengers for the last part of the line. The scenario does not include any restrictions regarding the choice of bus type. The results in this scenario show the level of CO_2-emissions when as small buses as possible, with respect to CO_2 emissions, are used. The possibility to use other bus types is also tested.

The economic effects of using more flexible and less detailed contracts in the public procurement process are evaluated in the specific case described in Section 5. This case is a sub case of the general case. In order to get a more lifelike situation, some restrictions are added into the relevant scenarios. They are further described in Section 5. The results from the sub case are compared to the current daily planning by the involved bus entrepreneur. The results of the model will give a solution that uses as small bus sizes as possible with respect to the costs.

4. Mathematical model

In this section we present the mathematical model for the problem of evaluation of public procurement of bus transports. The model is used in order to find as small buses as possible to use of each part of the bus tours. The model consists of an objective function, binary variables, parameters and constraints. We first describe the parameters and the variables. Thereafter the objective function is presented and finally, the constraints are described.