

Pricing systems analysis of DRT systems

T. Andrejszki, Á. Török

BME Department of Transport Technology and Economics, 1111 Budapest,
Stoczek utca 2. building St

phone: +361 4631054

e-mail: tamas.andrejszki@mail.bme.hu, atorok@kgazd.bme.hu

Abstract: Flexible Transport Systems are becoming more and more popular in the sector of public transportation. The reason for this is mainly the economic sustainability of these systems which is reached by minimising the empty routes and using the capacities in a highly effective way. FTS systems use modern minibuses which have better conditions in emission and environmental pollution than the old vehicles of operating Hungarian public transport services. The aim of this study is to examine the opportunities of pricing regimes used in FTS systems. Firstly the conventional pricing methods such as average pricing will be reviewed than the new systems such as and marginal cost based pricing. Later on their mixing is going to be analysed. In the study the structure of FTSS were similar to “dial-a-ride” systems which aimed to handle the highest level of flexibility.

Keywords: *Flexible Transport Systems, pricing regimes, cost function*

1. Introduction

In the competition for technological, economical and social efficiency the professionals and researchers of each scientific field are working on the escalation of new results, in order to improve welfare in the society. The transport economist – having an interdisciplinary research field – are no exception of this: they have the simultaneous task of providing economical and social welfare, of providing efficiency and equity and of providing technological optimum for transport processes. A characteristic topic of this theme is to configure the cost calculation system and pricing method of the transportation companies: in this case the researcher cannot avoid the basic technical processes that are described by financial ones, and have special attributes, constraints and barriers. At the same time, attention has to be paid to the instructions of the economic theory, in order to help the company to contribute to the increase of social welfare. One of the currently consorting optimisation theories in economics is the neoclassical doctrine with its marginal costs and marginal revenues. [1] The neo-classical school was founded by Walras, and by his mathematical model that describes the usage of marginal costs and marginal revenues [2]. First application of this was evolved at the beginning of the 20th century with the welfare theories of Marshal [3] and Pigou [4]. As a result of their work, a new, prospective challenge was revealed before theorists and practitioners of the

economics: the mathematical equations that were resulted from the research don't only provide the profit-maximum of the company, but, at the same time they show the way to the optimal capital-allocation and efficiency among companies for the society. Some paper even aim to compare some conservative public transport policy options [5]. The aim of this article is to investigate different FTS related pricing regimes.

2. Static average cost based method

The average cost (AC) based method proves to be the simplest pricing method. This pricing uses the calculated flat rate based on previously carried out traffic surveys [6]. This price can ensure the return (or a specified part of the return) on investment if the number of passengers measure up to the surveys. The sum of the fee depends greatly on the market situation of the transportation companies. Therefore, the pricing of the competitive market and the state pricing used should be separated due to their monopoly position. State pricing is usually justified when due to certain reasons the supply-demand market mechanism and the economic competition cannot prevail. The highest price should be set as to cover for necessary expenditures of efficient operation and profit [7]. As to the lowest price, it should be fixed as to cover the expenditures of efficient operation. In both cases several funding cuts and subsidies have to be taken into consideration.

At a static average cost based pricing system, the travelling fare (€/passenger) is defined by the proportion of the operator's all fixed and variable costs to the estimated travel needs. In this case one journey's fare is influenced by the following:

- Transportation needs (e.g. number of passengers);
- The available transportation capacity;
- Profit margin;
- Return time.

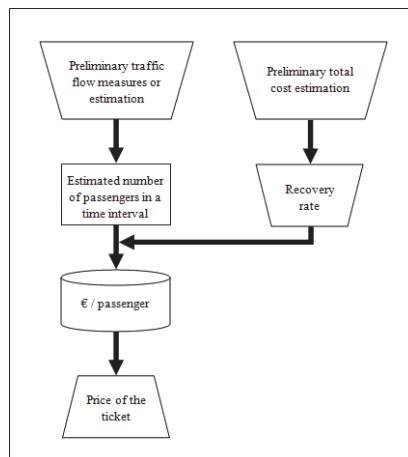


Figure 1. The process of static average cost based pricing

3. Dynamic average cost based method

Among the average cost based systems, certain pricing systems can be listed which determine the average specific cost based on one factor of the variable cost [8]. For such purpose, regarding passenger transportation, the passenger-kilometre can be applied for instance. In the case of such pricing systems the cost depends on the extent the passengers use the service.

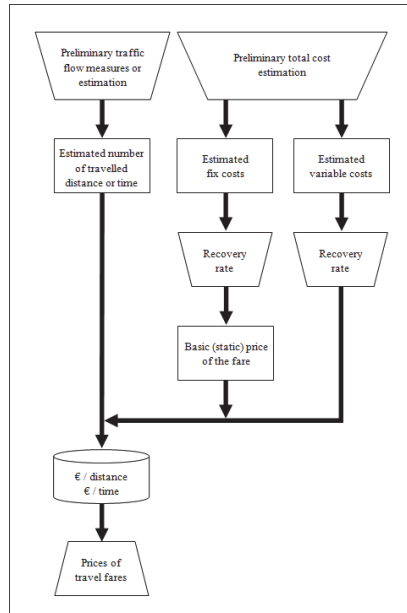


Figure 2. The process of dynamic average cost based pricing

So if the travel fare is previously not determined, but a specific price is used based on some measurable cost factors of an average route, in that case the pricing system can be defined as an average variable cost based system. In such a system the specific travel fare (e.g. €/km) is determined by the proportion of the total fixed and variable costs to the total estimated performance. In this case, the price of the travel fare is altered, besides the already listed factors of the average cost based system, by the following factors:

- Number of travelled stops;
- Travel time;
- Travel distance.

Regarding the average variable cost based system it is worth examining a certain case, in which a given passenger can be only transported through a longer route than the shortest between the departure and the arrival point [9]. Is it reasonable in such a case that this passenger pays more than the optimal price? If the passenger has to pay more than it is clear that the others have caused some sort of ‘damage’ to him or her. This can be adjusted e.g. if we determine the shortest route between the departure and the arrival point and calculate the difference between the shortest and the travelled actual route and

average these numbers. In proportion to the average deviation we adjust the fees to make certain that the “caused damages” are eventually even. However by using the method above, it will not be in the interest of the passengers for others to use this service.

Another question arises concerning the equity of the average variable cost based system when a passenger books a longer ride close from the centre, while a another one books a short one far from the centre. In such a case, based on the travelled kilometres the first passenger pays several times more than the second one, although the vacant bus route is due to the second passenger’s admission to the system.

4. Marginal cost based method

Compared to the average cost based pricing systems, marginal cost pricing is based on a certain principle which states that all new users should pay for the additive expenses caused by their person. The prerequisite of marginal cost pricing is to define relevant factors of marginal costs, as well as to calculate their significance. Along with this, the categorization of the different types of costs can only be evaluated if we identify the interested parties who create these costs. The next step is the interpretation of the mechanism between the different types of marginal costs and their causes, which in the long-term demands the identification of the relevant behaviour dimensions [10].

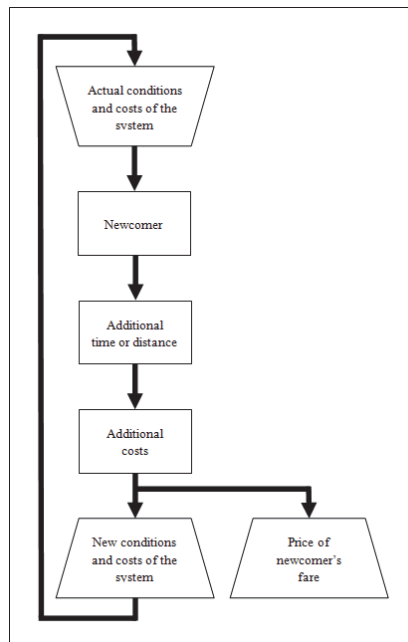


Figure 3. The process of marginal cost based pricing

The marginal cost term used in economics can be seen, in the field of flexible transportation as an extra cost by means of the route alternations due to a new registration. Thus, when the marginal cost based pricing is used all passengers pay the sum with which their admission to the system increased the costs of the operator.

$$MC = \frac{dTC}{dQ} \quad (1)$$

where:

- MC - marginal cost [€/passenger]
- TC - total cost [€]
- Q - quantity [passenger]

In case of a public transport service the quantity can be for example the number of passengers (and dQ is a new passenger incrementally admitted to the system – so after a new booking $dQ=1$). By this, if there is a service round consisting of n journeys which are inserted with one new booking, then the journey's marginal cost is the deviation between the service round with $n + 1$ journeys and the costs of the service round with n journeys.

In this system, users are interested in late bookings, since the first passenger is charged as if he was the only passenger to be transported, which seems to be rather expensive. To the contrary, if someone makes a booking just before the trip and the new passenger's route exactly corresponds with the set route then his cost can be zero. This characteristic of marginal cost based pricing does not coincide with the operator's interest.

Beside this, another case needs to be examined: when a new booking causes more extra operational cost (marginal cost) for the existing journey than the cost of separating him (so make 2 journeys with 2 vehicles). Though in the case of overcapacity, it can be solved by adding another vehicle to the system, however if surplus capacity characterizes the network then the above mentioned problem may turn out to be a determining point of conflict. This consideration would lead to the reconsideration of conservative vehicle and crew scheduling and reorganisation of operative scheduling as well [11], [12].

The contradictions of the pricing systems can be resolved by developing a mixed pricing system.

5. Mixed pricing

The new pricing system can be basically traced back to the average variable cost based pricing system, however in this case the base of the average cost is given by the loop cost. Individual loop cost refers to the cost of the shortest loop that starts from the headquarter, goes to the passenger's origin, then his final destination, and finally back to the headquarter.

So according to the new pricing method the costs of a complete route are divided in the proportion of the individual loop costs. Problems mentioned above -except one- are all resolved. Costs of vacant routes are distributed since the individual loops include the vacant routes. Passengers are motivated to suggest the service to other passengers as their expenses might decrease with the newcomers.

However if the marginal cost of the complete route (collecting loop) due to the new user is bigger than the given passenger's individual loop cost, than the other passengers'

expenses can even increase. To solve this problem, further correction needs to be applied. It is clear that every passenger causes some amount of externality to the others, since with more passengers the travel time and the level of comfort differs from travelling alone.

So the reason why the new system is called “Mixed” is the following. At every newcomer the system counts out these prices (based on individual loops) and compares them with the prices before the newcomer’s appearance. If any price of it increases then the newcomer’s price will be his marginal cost and for the others it will be the same as before. If there are no increases the new prices will be the individual loop-based prices.

It can be recognised that the mixed pricing method motivates passengers to order the service as early as possible because if they are in the first few volunteers the probability of being a passenger who should pay marginal cost is less. They can always count with that every newcomer might decrease their price. And at this point the system reached another important advantage: Passengers are motivated to advertise the DRT system and invite other peoples to use this service because it’s economically better for them.

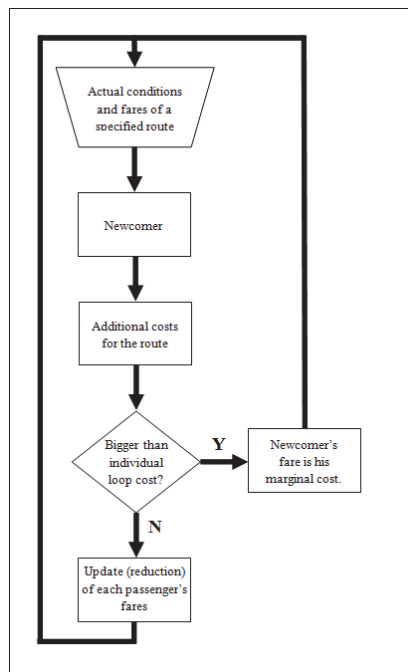


Figure 4. The process of mixed pricing

6. Conclusion

Different types of pricing regimes have been investigated in this article. Each of one has advantages and disadvantages.

On one hand average costs based pricing has simple formulas, it is clear and it can be calculated in a short time but it does not reflect the reality. On the other hand marginal

cost based pricing has a good reflection of the reality however the calculations take more energy and time to be done.

The mixed pricing system tries to compare the advantages of each one. Firstly in lot of cases mixed pricing is simpler than marginal cost based pricing. Secondly the mixed system is closer to the reality than the average cost based one. According to this it can be said that mixed pricing creates bridge or a golden mean between the two poles.

In theoretical way mixed pricing is worth to be used at transport companies but yet we have not had practical examples. Other studies are needed to examine the opportunities of putting this method into practise and then to evaluate the experiences for further development of this pricing system.

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