

# Road charging in urban areas in the middle-size city

J. DICOVÁ<sup>a</sup>, J. ONDRUŠ<sup>b</sup>

<sup>a</sup>University of Zilina, Faculty of Management Science and Informatics, Department of Management Theories, Univerzitná 1, 010 26 Žilina, Slovakia

<sup>b</sup>University of Zilina, Faculty of Operation and Economics of Transport and Communications, Department of Road and Urban Transport, Univerzitná 1, 010 26 Žilina, Slovakia

EMAIL: .dicova@fri.uniza.sk, jan.ondrus@fpedas.uniza.sk

## ABSTRACT

With transport problems such as congested streets we can meet today nearly in every bigger city. It arises from the main issue - an increase of individual car traffic in the city centre. The road charging in urban areas is very simple and efficient way to reduce traffic volumes, lower congestions or to limit individual transportation demand in the centres. In our paper we would like to point out a perspective solution of utilization of electronic charging system in city centre and focus on proposal of methodology for the implementation of an urban toll system

**KEYWORDS:** Road charging, electronic toll collection, congestions, individual transport

## 1. Introduction

Despite of implementation of regulation measures the increase of individual vehicle transport in city areas in the coming decades is expected. The main reason is the increasing demand for access in intra-site areas of cities. Trend related to the city mobility is now focused on limiting access of cars in city centres. One possible solution is traffic calming with city toll collection.

Toll collection is one of the ways how users of road network can pay for its utilization. Type of the vehicle, the distance run off in charging zone or the time period spent there are usually main factors to determine the rate of charging. There are three main reasons, why toll collection is introduced to:

- obtain finance that can be further used for construction of new road infrastructure or improvement of public transportation,
- to lower emissions, noise and other negative externalities produced by transportation,

- to reduce congestions on selected roads (areas) or time periods in order to increase capacity of road network. [1]

Currently there is a tendency to create electronic systems for collecting tolls, whose main advantage compared to the traditional choice of tolls is that for the realization of the charge is not necessary to stop vehicles. There are several cities in the Europe e.g. London, Bristol, Bergen, Stockholm, etc. that have already established or are considering establishment of this fee in their central parts [4].

## 2. The proposal of methodology for the implementation of urban toll system

This problem is too large and complicated. So proposed methodology shows only the basic steps which should adhere to implement this system.

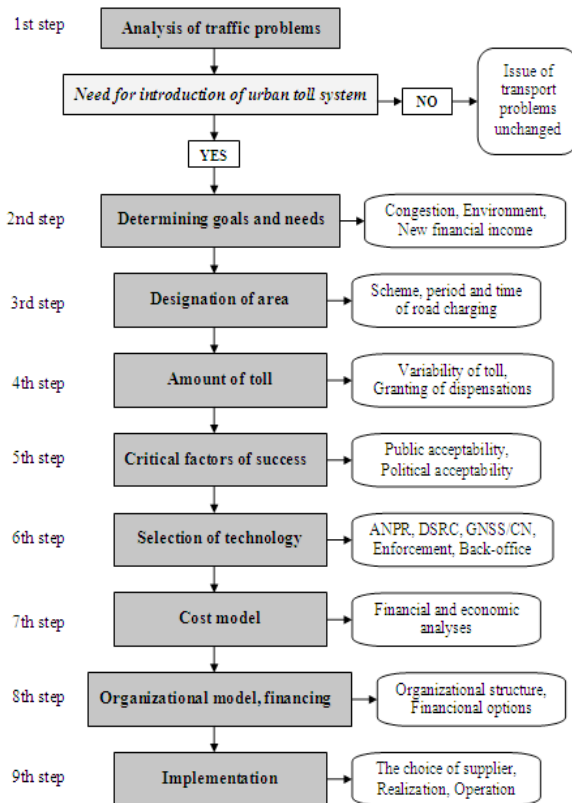


Fig. 1. Several steps of the methodology for the implementation of urban toll system  
Source: [own work]

Figure 1 presents several steps of the methodology, which are further described and explained. These steps can be further extended, subdivided or added. Figure 1 is taken as a basis from which is necessary to appear in implementation of urban toll system in any middle-size city.

For successful implementation of a particular project is necessary to focus mainly on technological options, profitability and financial opportunities, public acceptability and negative transport impacts. [3]

## 2.1. Analysis of traffic problems

The basis of a successful application of urban toll system is to know the current and complex state of the transport situation. Here, we have to deal with these questions:

- congestions,
- accident frequency,
- basic indicators of transport (number of registered vehicles, degree of automobilization, degree of motorization, transport performance, and the like),
- intensity of traffic in town with expected development (e.g., with detectors, manual counting),
- systems of public mass transport,

- analysis of static transport,
- quality of environment (emissions, noise, ...),
- and the like.

It is necessary to define from the final analysis and prognosis of transport situation whether it is necessary to deal with the traffic situation in town. Here, the discussion with public, professionals from other fields, representatives of the town as well as with participants of traffic is appropriate.

There are instruments that enable to deal with the regulation of individual automobile transport (IAT) with other (more moderate) forms, when the motorist would not even notice that there is any regulation. It is mainly the system of appeasing the traffic, making more one way streets or catching parking lots that are in question. Another option is urban toll system.

The realization of the first step of methodology leads into solution with the finding whether it is necessary to introduce the system of electronic toll in that particular town. Another step reckons with the first one, that is when the town will start to deal with its unfavourable situation by the means of the urban toll system.

## 2.2. Determining goals and needs

The first main step of introducing the urban toll system is to set goals and needs. In this step, the town should define clearly its potential and goals of introducing the toll. Then, on the basis of the analysis of transport problems, it should decide which way it will go, what the main priority for the town, which should help to improve the transport system, would be.

The main goals of the urban toll system can be divided into three basic groups:

### **Toll system with the goal of improving accessibility**

The aim of this system is reduction of congestion in certain areas, at certain hours, or at certain road networks, which increases the accessibility of transportation network. The majority of those who are in favour of introduction of the toll system consider this as a main advantage.

### **Toll system with the major goal of financing**

The major goal is to increase the income. The finance can be used to improve transport, to build new (sometimes concrete) road networks, to improve the public transport, but they can be invested in other spheres than to the transport system.

### **Toll system with the goal of improving the environment**

The toll system can be designed as precaution that improves the environment in town, e.g., by reducing noise, emissions, dustiness, vibrations and other negative influences caused by traffic. The aim can be overall reduction of traffic in town or, in other cases, protection of a certain

part of town e.g., its centre. The charge varies in dependence on degree of how much the vehicle is ecologically friendly, fuel consumption, and the like.

### 2.3. Designation of area

The important condition of successful realization and operation of the system is the right choice of the area into which the entrance of vehicles for individual automobile transport will be charged. The delimitation of this area is to be considered from several elementary angles, mainly:

- effectiveness and meaningfulness of the toll concerning the extent of restriction of traffic,
- possibility of free transit on rideable road networks,
- number of entries into the area and the financial and technical difficulty related to it,
- historical and monument value of the area and tourism in the area,
- fiscal contribution into town cash box. [8]

All these angles are to be considered very thoroughly.

The town decides into what extent it wants to influence the demand and the type of roads by choosing a **scheme of charging**. It means that it decides what travels in what area will be charged. We can distinguish four basic schemes:

- cordon charging,
- charging of an area,
- charging of certain sections,
- output charging.

Another point of design in this step is to decide in what area the toll will be valid. E.g., whether to introduce a **charging area** only in the centre of the town or also in its surroundings, or to tariff only concrete areas. The wider area of tariff has an influence on higher amount of voyages made and it will offer higher incomes.

**The period and time of road charging** – these parameters are to be made by the town according to its goals and needs that emerge mainly from traffic/transport problems. In a case of need of active time distribution of rush hour, the profile of daily and monthly demand is taken into consideration and tariff sets the period until which the demand exceeds capacity (e.g., tariff only workdays from 7 am until 6 pm). If the main aim is to increase incomes, the tariff can be set to 24 hours a day, 7 days a week.

### 2.4. Amount of toll

It is one of the most difficult steps of the design. The extent of the toll is highly dependent on the goal of introducing the toll. If the town sets as its goal the reduction of congestions, it is evident that the tariff can be introduced

only in the problem area and only at times when there are congestions. The charge has to be high enough to influence the requirement (demand). [5] If the town sets as its goal to increase the income, it sets a charge to attain the expected income and at the same time preserve acceptability.

In this step it is necessary to set an orientation amount of toll. We can set an optimal amount of toll only later, after the system will be accepted and after the expense items will be set up (investment and operational).

**Variability of the amount of toll** – the amount of toll can vary:

- during the day,
- in various areas,
- according to the type of vehicles,
- according to the owners of the vehicles.

Granting of dispensations – it concerns determining the types of vehicles and users who do not liable to tariff or are given discharges. It means that whether certain type of vehicle gets dispensation in paying the toll, whether the ecological vehicles will be factored into, or whether e.g., the amount of toll will vary according to weight category of the vehicles. There is a case point that all emergency vehicles, public transport vehicles and state vehicles that offer urgent services do not have to pay the toll. A matter of argument can be question of the taxi vehicles. Taxi is a part of transport system and that is why it should be granted a dispensation. Certain vehicles such as heavy trucks can be liable to higher tolls because they have higher impact on congestions and on wearing of road networks. The granting of dispensations is up to towns' consideration. The town should try to minimize the amount of dispensations in this decision and at the same time to maximize the effectiveness of the system.

### 2.5. Critical factors of success

Urban toll system is a phenomenon that is met with much displeasure, scepticism and protest. The attitude towards the implementation of the toll system is based more on expectations and estimations than on real experiences with the system (acceptability). On the other hand, behaviour after the introduction (acceptation) can be marked as a process of getting used to a new transport situation, the adaptation to it.

**Public acceptability** is one of the main problems of its implementation. It depends on how the question is formulated. If the system is introduced as an individual measure without any specification of the system and without any explanation where the income will go, majority of the people will be against. However, if the toll system is introduced as a part of whole strategy of improving the

transport system in town and if it will be fair and useful for public, the chance of acceptability is higher. Several basic conditions have to be met for successful acceptability of road charging in urban areas by the public:

- need of road charging,
- need of conception,
- necessity of visible usefulness,
- participation on decision making process,
- fairness of the system,
- alternative to travelling by automobile. [3]

**Political acceptability** is a key condition for introduction of toll system. It is necessary to know the standpoints of the politicians towards the implementations of specific measures and their acceptability on local level. The basic condition is thus strong and stable political leadership, as the proposed process of such a project is a long-term one. The advantage is strong and high-ranked person (city mayor, mayor), convinced of the necessity of the system who supports politically and enforces the project during the whole time of the process of the design and after the implementation of the system. The main subject matter in this phase should be surveying and planning of the necessary political decisions that include agreeing the conception of collecting the toll, legislative changes and adoption of necessary measures.

In conclusion, we can state that the idea of toll system is generally accepted. The more detailed the design, the more the opposition increases, as even before the implementation it is evident who will pay and in what extent, but the resident cannot see the contributions yet. After the implementation and experiences with the system, the opposition declines and acceptability slowly increases. [2, 6]

Very important question in connection to toll is determination of **legislative** (legal framework) for this measure and also determination of precise sanctions in case of not fulfilling specified rules – it means to examine whether the legislation in practice is satisfactory for implementation of the toll or whether the new legislative is needed.

## 2.6. Selection of technology

The selection of technological solution depends on many factors, e.g.:

- simplicity of the solution
- extent of road charging,
- number of vehicles and categories of road charging,
- technical demands on realization,
- economical difficulty of the system for investment and operation,
- reliability and effectiveness of the system,
- experience with given technology,
- goal of implementation of the system,

- toll collection and affecting dodgers,
- application in future, interoperability,
- and such like [7, 8].

The chosen technology has to be appropriate for given purpose and technically, financially, publicly and legally realizable.

In this step, the town should familiarize with technological part of toll systems in towns and finally, chose a technology that it will prefer. Nowadays, there exist four basic technologies:

- system with manual payment and manual system of control
- system ANPR – based on camera control with automatic identification of register marks
- system DSRC – based on vehicles equipped OBU unit and communication on short distances
- system based on vehicles equipped OBU with receiving GPS signal with virtual points on the basis GNSS/CN.

**Enforcement** is an inseparable part of every system. It is represented by hardware + software equipment and human sources that are aimed at effective identification and affecting dodgers. Here, we can divide the system into two basic parts: manual and automatic systems.

**Back-Office** guarantees operations connected with the evidence of customers, realization of payments, helpdesk, management of the relations with customers, administration of documents, control of the whole ITS system, accounting process, invoicing, recovery of fines, and such like.

## 2.7. Cost model

It is desirable to make economic and financial evaluation of assets and costs. It is important to find out whether the toll system is a contribution for the town. In few years time, assets summary should be higher than the cost system.

The main outputs of **financial analysis** are the test results of costs and assets of the proposal. Moreover it is necessary to pay attention not only to technical costs and supplier's costs, but also to the costs for the information campaign, running costs etc.

It is vital to evaluate or rate **the socio-economic assets** for the following:

- Users of individual automobile transport (IAT) – for example decrease of congestion.
- Users of public transport – increasing transport reliability public mass transport (PMT), increasing quality of PMT, etc.
- The city – toll revenue, more attractive and more accessible the city centre, etc.
- Operator of PMT - higher number of passengers, increase of transport reliability.

- Increase of residents, visitors, employees who are not using means of transport in charged areas, also increase of air – pollution, noise, decrease of accident rate, etc.

**Economic** costs consist of following:

- Financial cost for the city – for example investment costs, operating costs, etc.
- Socio-economic costs for IAT users – toll, increase of time loss, accident rate, asset costs of vehicles, etc.
- Socio-economic costs for PMT users – reduction of waiting time at the station, less transport reliability of PMT on the border zone and outside the traffic peak.
- Socio-economic costs for residents, visitors, employees – increase of emissions, noise, accident rate on the border zone, etc.
- Socio-economic costs for businessmen in the charged area – higher costs for purveyance, decrease of amount of customers in the shops, etc.

Output should be the approach between the economic assets and economic costs of the proposal [8].

## 2.8. Organizational model, financing

In this part is essential to choose the successful set-up, implementation and keeping the toll system in **organizational structure**, which will define the key criteria of the given proposal. (the right type of communication, suitable contractual terms, sufficient expertness and etc.) Here are the main organizational parts:

- public submitter (mostly political and administrative parts of the city),
- coordinator or more coordinators,
- supplier of the system,
- operator of the system.

Unthinkable component of the toll systems are the financial options. These options are closely connected to organizational model. The designed toll system is related to large invested and operating costs. This is the reason for careful choice of the way of financing.

For financing large projects, which were financed by state sector before, are nowadays provided by a few basic types. In few of them comes to connection also with private capital – so called PPP projects. There are three basic types of financing:

### **Private investor and operator, public coordinator**

It is about a complex PPP project. This type is without initial property interest of the city and it works of the way of BOT – build – operate – transfer, let us say DBOT – Design – Build – Operate – Transfer. When is the project too demanding, it is easier for the city to choose the way of PPP project, to trust a public subject in terms of setting up and projecting operation.

### **Public investment and private operator/ coordinator**

In this case, in public competition, the city will choose a private subject, which will supply together with its sub-suppliers the running of the project. They also provide the creating and operating system using the money of the city ( e.g.: from credits gained from banks, or from free budget of the city – in respect of financial seriousness this way of gaining the money is way too much difficult for the majority of the cities).

### **Public investment and public operator / coordinator**

This type is a standard and the most common way of financing of the state (city) projects.

The city provides the creating of the system and its operation in a public competition. The city can use sub-suppliers from the private sphere. The operation of the system is then provided by city using its service organization [3].

## 2.9. Implementation

The city should manage this last phase about two years. It is depend on the complexity of the selection procedure. A faster procedure is possible but very risky. The main points in the implementation phase are:

- The choice of supplier.
- Creation of project documentation.
- Realization and testing.
- Operation.
- Trial period.

## 3. Conclusions

There are many other important steps, which have to be taken prior to successful realization of road charging system. Not less important is the question how the profit from the operation will be used. According to our opinion, the profit should be used for improvement of the traffic situation in charged area, because its users will be affected by the system. However it doesn't mean that we will build new roads and parking places at the expense of disruption green areas - we can rather focus on improvement of public transport. In Slovakia, there is not yet convenient situation for introduction of toll systems in cities. Together with some legislative steps it is necessary to inform the public about possibilities we have. By informing the public, we can reach our target – to increase the level of acceptance on road charging systems in cities and to show the benefits these systems can bring.

*This work was supported by project:*

*Centre of excellence for systems and services of intelligent transport, ITMS 26220120028*

*University of Žilina, Žilina, Slovak Republic*

## Bibliography:

- [1] KALAŠOVÁ, A., LATISLAV, R.: Introduction of road charging in city of Žilina - a tool for reduction of negative externalities In: Advances in transport systems telematics 2: Section I: Telematic transport systems. - Katowice: Silesian University of Technology, [2007]. - ISBN 978-83-917156-6-6.
- [2] ONDRUŠ, J.: Methodology of Acceptance Feasibility Survey of Urban Road Pricing. In: Transcom 2009, Section 1., University of Žilina, 2009, ISBN 978 -80-8070-692-0
- [3] ONDRUŠ, J.: Mýtné systémy v cestnej doprave a ich využitie v mestách, dizertačná práca, 2009
- [4] ONDRUŠ, J., PALO, J.: Selected applications of road charging in urban areas, In: Doprava a spoje [elektronický zdroj]: internetový časopis - ISSN 1336-7676. - Č. 2 (2007)
- [5] POLIAK, M.: Impacts of toll collection introduction on haulers, TRANSCOM 2009 : 8-th European conference of young research and scientific workers : Žilina June 22-24, 2009, Slovak Republic. Section 2: Economics and management - part 2 (M-Z), Žilina : University of Žilina, 2009. - 195 s. - ISBN 978-80-554-0040-2.
- [6] Project: Pricing Acceptability in the Transport Sector (PATS), 2000
- [7] Projekt FD ČVUT: Externality v dopravě, 2005
- [8] URBÁNKOVÁ, P.: Úvod do mýtného systému, (<http://www.telematix.cz/projekty/zav/index.html>)