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TRANSPORTATION COSTS AND SUBSIDY DISTRIBUTION MODEL FOR URBAN AND SUBURBAN PUBLIC PASSENGER TRANSPORT

ABSTRACT

Public transport (PT) subsidy provides the means to impose the optimal combination of fare and Level of Service (LoS) offered to passengers. In regions where one PT operator services multiple local communities on multiple lines it becomes hard to uniformly link the actual cost of a line and thus the LoS offered, to a particular local community. This leads to possible disproportions in the overall subsidy distribution that can result in being unfair to some local communities, mainly the ones that are sparsely populated or geographically isolated. In order to extricate this problem the appropriate level of PT subsidisation according to the average values in the European cities was investigated and the current subsidy policies in Croatia were investigated. Based on this research and the hypothesis that the offered LoS must be reflected in the subsidy amount a new subsidy distribution model was established that involves a series of analytical procedures and processes. This model introduces several factors used for the calculation of the actual share in costs. Thus, the amount of subsidies for individual lines in a region can be determined based on the actual service offered to the local community, The proposed model has been tested and successfully implemented in the Dubrovnik-Neretva County in the Republic of Croatia.

KEY WORDS

public transport; transportation costs; subsidy; cost allocation model;

1. INTRODUCTION

Local authorities and municipality administrations in most countries have the obligation to perform community services, and public urban and suburban passenger transportation is usually one of those services. Public passenger transportation is carried out based on licences that are assigned to carriers and are usually effective for a few years. In order to perform the task of passenger transportation, carriers may have special agreements with local authorities on the provision of transportation services that define their relationships, primarily in terms of the quality and level of service for the contracted transport tasks and tariffs. This takes into account the cost of transportation and possible subsidies for operations of carriers, subsidies for certain categories of passengers for whom the local government decided that they should be transported at preferential prices (so-called privileged categories of passengers). In this way, local governments impose policies and social equality for all citizens within their area.

Local authorities and municipality administrations shape, in accordance with their interests, the transportation tariff and provisions for certain social categories and thus the necessary subsidies to cover the operating costs and the necessary grants to cover the investment costs (vehicle and infrastructure). This process is not uniformly defined. Therefore, the model and the methodology used to define subsidising of public transport is not unambiguous and universal and local authorities and municipality administrations use different approaches in addressing this problem. The solutions differ according to local conditions and regulations that different communities have on public transport and are subject to a number of other influential factors [1–3]. In general, the problem arises in defining the actual partaking in subsidies provided by each local authority to an urban public transport carrier, particularly if the carrier operates between two different municipalities.

In order to fully understand the idea behind public transport subsidies, it is necessary to point out that cities and municipalities do not subsidise carriers but the actual public transport service that is being offered to its citizens [1, 4]. If there were no subsidies, the carriers would be forced to charge the full cost of the transportation service to passengers through the fare price, and that would lead to a significant reduction in transport demand and consequently to the reduction of transport offer. Given that every public transport has its price (which generally is not covered by the price of the fare) and that it operates according to the timetable agreed with the cities and municipalities, regardless of the respective transport demand (number of passengers), in all periods of the day and on defined days of the week/year, cities and municipalities choose to subsidise public transport in order to achieve goals set by the overall transport policy [5]. These goals are diverse and range from providing transportation options to all social categories to increasing the mobility of the total population. Implementing such a transport policy reduces the need for use of personal vehicles, which in turn offers the possibility for enhanced management of urban space and reshapes the environment for a sustainable development of urban communities [6, 7].

In the southernmost county of the Republic of Croatia the company Libertas - Dubrovnik d.o.o. covers the county transportation lines for passenger transport between suburbs and the City of Dubrovnik, as well as the internal transit in the area of 9 municipalities, including the city area. With defined tariff policy this transport brings losses that need to be subsidised in order to achieve the desired level of service. As maintaining such lines is beneficial for both suburbs and the City of Dubrovnik, the current model included divided subsidy shares based on measurement of actually realized transport work. Such division resulted in unfavourable position of the municipalities requiring more transport work (capacity/kilometres) due to unfavourable geographic and traffic characteristics. As such, the work does not reflect the service actually offered, a new model needs to be found to ensure fair and justified allocation of funds to all participants in the transport process according to their respective shares. A graphic illustration of this problem is shown in *Figure 1*.

Figure 1 shows the diagram of the spatial disposition of the municipalities where a single operator is providing public passenger transport services. Municipalities 1, 2, 3 and 4 are rural municipalities with low population density and low economic activity. Municipality 6 includes the city centre representing a functional centre and the centre of economic activity of the entire region. Municipality 5 is different from other municipalities, as suburbs developed in this area, so although it is independent in administrative terms, this municipality is functionally linked to the City (Municipality 6). If the public passenger transport lines on the territory of these municipalities are observed, the following line types may be identified:

- Line 1 – a line connecting two rural municipalities;
- Line 2 – a line primarily connecting Municipality 1 with the city centre, yet it passes through the terri-

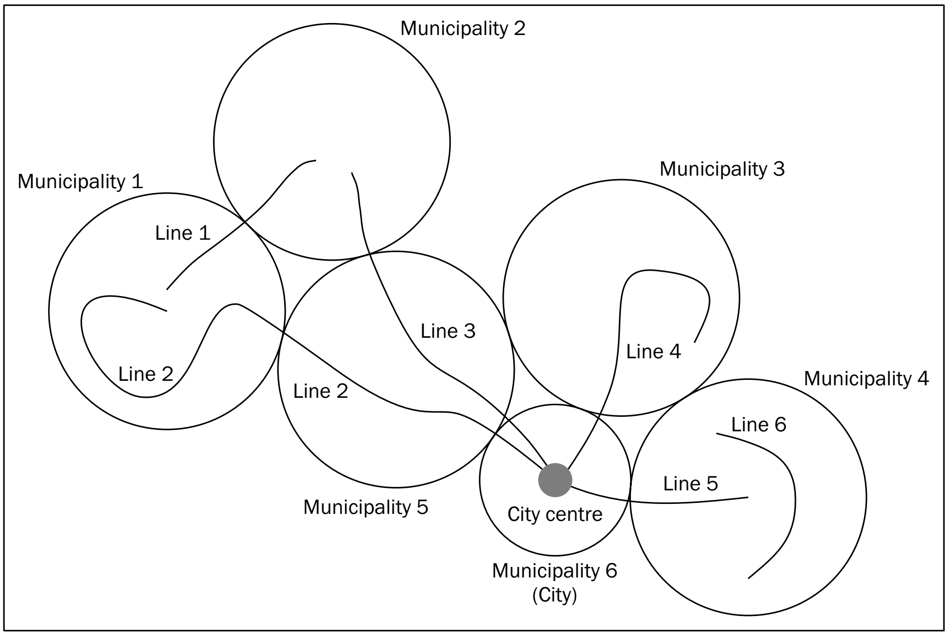

Figure 1 - Shematic presentation of the administrative territory of the municipalities and the distribution of public passenger transport lines

tory of Municipality 5 and through one section of the suburban area of Municipality 6;
- Line 3 – same as line 2, the only difference is that a small section of the line operates on the territory of Municipality 2;
- Line 4 - connects Municipality 3 with the town centre, but passes through the suburb in Municipality 6;
- Line 5 – same as line 4, the only difference is that a small share of transportation is taking place in the area of rural Municipality 4;
- Line 6 – transport is provided exclusively on the territory of one municipality.

Looking at these types of lines, it is clear that the existing model of equal distribution of subsidy shares across the lines depending on the capacity offered is unfair. Line 1 is equally important for both municipalities and the distribution of transport cost, i.e. subsidy may be fair. However, with line 2 the situation is complex on several levels: Line 2 is very important for Municipality 1, as this is the only line connecting the municipality with the centre of the city. On the other hand, the offered service (capacity) level is high due to the fact that this line also services Municipality 5 and a part of the suburbs of Municipality 6, which puts Municipality 1 into an unfavourable position. A comparison of lines 2 and 3 shows that the position of Municipality 2 is much better than the position of Municipality 1 due to the lower transportation mileage on its territory. Therefore, although in terms of functionality both these lines are equal, the transportation costs imposed on Municipality 1 exceeds by far the cost covered by Municipality 2 in the current subsidy distribution model based exclusively on the offered capacity, i.e. service. Here the specific feature of Municipality 6 should be mentioned – due to the attractiveness of this area and the vicinity of the city centre all inter-municipal lines operate on the territory of this municipality, which means that almost all traffic demand in this area is met. Another feature of this region is the fact that further development and expansion of the city is limited by physical land capacity. This in turn means that the city, too, has a functional benefit from suburban lines and should therefore be included in subsidising the transport.

2. EXISTING MODELS OF SUBSIDISING PUBLIC TRANSPORT

In order to provide adequate services and preserve the desired frequency and level of service in public passenger transport system, it is necessary to define and implement an appropriate subsidizing model. Previous researches in this field show that there are many different approaches for subsidization of public passenger transport in urban and suburban areas.

In recent publications, Van Reeven [8] developed a model aimed at showing that scale economies on user time costs would not provide a justification for public transport subsidies. In his paper he argues that the Mohring effect is not relevant to the determination of transit subsidies because a profit maximising monopolist would supply frequencies that are the same as, or greater than those that are socially optimal. Contrary to his claims, other studies have found that the Mohring effect is a valid argument for subsidisation [9]. According to analysis conducted in [10], it can be concluded that Van Reeven results depend on the reduction or elimination of the effect of fares on demand, causing optimal prices to be indeterminate within broad ranges.

Subsidies to public transport are common in developing countries and are often justified on the grounds that they make transport affordable, rather than on efficiency grounds. Given this justification, it is of interest to know how the benefits from transport subsidies are distributed. Policymakers should also care about the level of such subsidies: if the purpose of subsidies is to make transport affordable, the optimal level of subsidy will depend on the source of funds for the subsidy, on the income elasticity of public transport, and on the welfare weights that the policymaker attaches to different income classes. Determination of optimal subsidy distribution model for urban and suburban public passenger transport is particularly important.

An analysis of public transport services in Germany has shown that the quality, attractiveness and productivity of its public transport services over the past two decades have improved despite the fact that the subsidies were significantly reduced [11].

Currie [12] attempted to objectively measure the relative quality of public transport supply and its spatial distribution with respect to transport disadvantage in Metropolitan Melbourne. Their study has identified significant differences between the levels of service of public transport supply between outer and inner/central parts of the city. The study results show remarkably clear mismatch between public transport supply and social needs in Australian cities

An analysis of existing subsidy distribution model in India, Mumbai has shown that although the vast majority of poor citizens receive bus and rail subsidies, an even higher percentage of other classes of citizens receive subsidies, implying that subsidies are not well targeted [6]. Other scholars have stressed the importance of considering the impact of increased demand for urban public transport during the tourist season. Albalate and Bel [13] have used an international database of European cities to examine whether city planners respond to the additional demand for urban public transport by extending service supply. Their results confirm that tourism intensity is a demand-enhancing factor in urban public transport. However, cities do not seem to address this pressure by increasing services.

To our best knowledge the problem of fair subsidy distribution between different municipalities described in the introduction has not been well addressed in previous research. Thus, in order to solve this problem, an extensive transport planning literature review has been conducted, the existing subsidies in European and Croatian cities analysed and a new subsidy distribution model established.

2.1 Subsidising public transport in the European cities

There are different approaches to subsidising public transport in the European cities. Subsidies for public transport in the European cities are thoroughly covered in the study *Comparison of Subvention Levels for Public Transport Systems in European Cities* [14], which was based on the observed cost subsidies for public transport in cities at the national level. The source of data for the study was: *Janes Urban Transport System, Eurostat, US Bureau of the Cenzus, ELTIS, Wendell Cox Consultancy, Demographia*. The study covers selected European cities with the population between 0.25 and 3.5 million. The research indicates that in Europe four main groups of countries may be identified based on the share of subsidies in the total transport cost:

- Countries with a high percentage of subsidies which subsidise 60-70% of passenger bus transport operating costs, such as Austria, Belgium, Italy and the Netherlands;
- Countries with the medium high percentage of subsidies which subsidise 40-50% of passenger bus transport operating costs, such as Denmark, France, Greece, Sweden, Iceland, Germany and Poland;
- Countries with a lower percentage of subsidies which subsidise 20-40% of passenger bus transport operating costs, such as Spain and Israel, and
- Countries with low subsidies that covers 0-20% of operating costs, such as Luxembourg, Scotland, England, Ireland, Scotland and Norway.

Countries with medium high (40-60%) subsidies in total operational costs of public transport dominate the graph. The above study also shows the average percentage in the structure of operating costs for the PT system, indicating that there was no cause and effect relationship between city population size and the average level of subsidy.

The socio-economic and transport data for the public transport service in European cities has been published in the European Metropolitan Transport Authorities (EMTA) Report [15]. From this Report that exhibits the relation between subsidies and operational costs, the data for two relevant indicators have been extrapolated: The total revenue income from ticket sales and the overall operational cost of the public transport service. The indicators shown in *Figure 2* are denoted for a comprehensive public transport service of a city.

These indicators show that, on the average, the revenues for ticket sales cover 44% of the total operational costs of public transport companies. The range of revenues collected from ticket sales varies from 27% in Prague to a maximum of 60% in Stuttgart.

The other indicator shows the percentage of subsidies in the overall operational transport costs. On the average, 48% of overall operational transport costs are being covered by subsidies in these selected cities. This means that in general, one half of overall operational transport costs is being covered with sales revenues and the other half comes from different subsides from local, municipal or national level, depending on specific governmental organizational structure and local legislative environment.

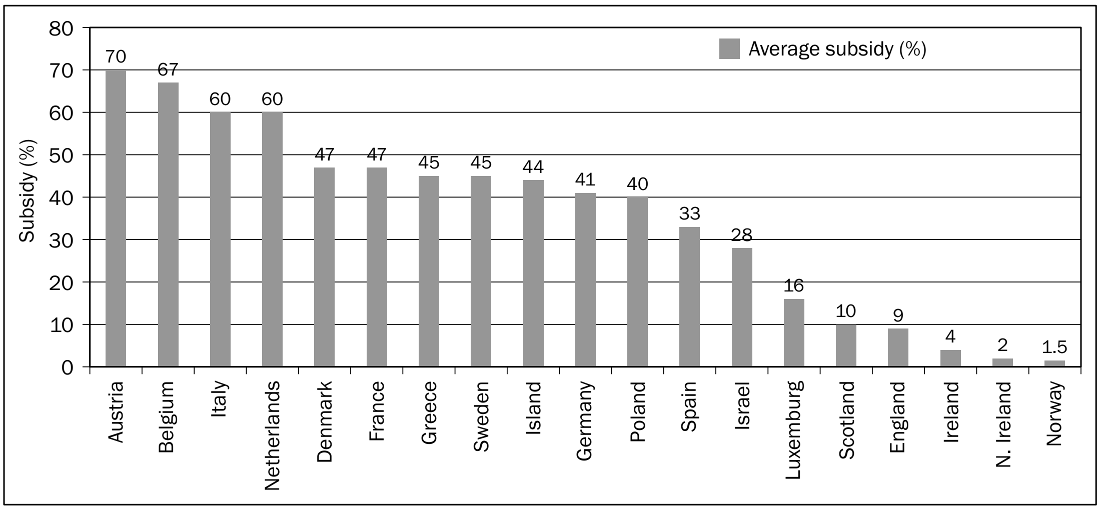

Figure 2 – Graphical presentation of the Subsidies percentage per country in the total operational cost of public transport [14]

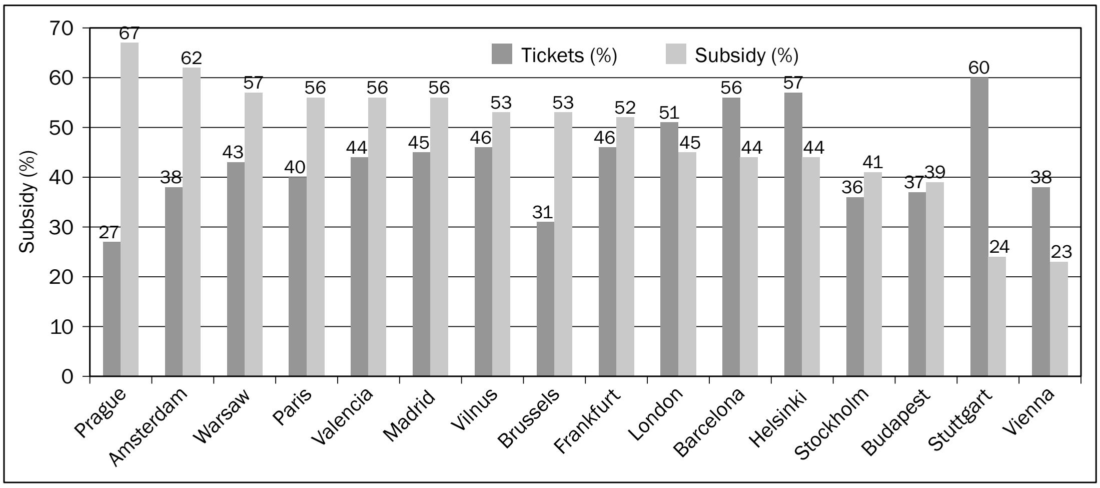

Figure 3 - Graphical presentation of total revenues collected and average amount of subsidies in overall operational costs in some EU cities.

Prepared from source: EMTA barometer of Public Transport in European Metropolitan areas in 2006 [15]

2.2 Subsidising public transport in the Croatian cities

It is common in public transport that the majority of carrier revenue is collected from the sale of tickets to passengers, and the rest through a subsidy in the amount which the carrier contracted with the local authorities [16]. Since PT is a public service and the carriers are often owned by the local government, carriers are not expected to have significant profits, but they should also not have negative return. In Croatia, as well as in other countries within the European Union, the role of local government is important as they are dedicated to the implementation of their respective social programs and thus willing to co-finance public transport within their capabilities [17, 18].

The experiences of cities in terms of subsidies to public carriers for the public transport service performed vary considerably from city to city. According to data published in 2011 [19] for nine cities in Croatia during the 2006-2010 period, the average percentage of income from subsidies in public companies for the public transport service was about 35% of total income.

The analysis of data collected in 2006 shows that the largest share of subsidies was awarded by the City of Zagreb (52%), followed by Sisak (40%) and (Pula 40%), while for the same period the lowest subsidy was awarded by the City of Split (17%), followed by Zadar (21%) and Rijeka (28%). In 2007 the share of subsidies has remained approximately the same compared to the previous year, noting that the significantly lower level of subsidy for the City of Zagreb in 2007 was due to increased revenue generated from the sale of decommissioned vehicles. In 2010, the order of cities in subsidising public transport has changed significantly compared to the previous year, compared to the period before 2008, due to the onset of global financial crisis. Thus in 2010 the largest share of subsidies was again awarded by the City of Zagreb (63%), Pula (50%) and Dubrovnik (42%), while the lowest subsidy to public passenger transport was paid by the City of Zadar (22%) and Rijeka (29%).

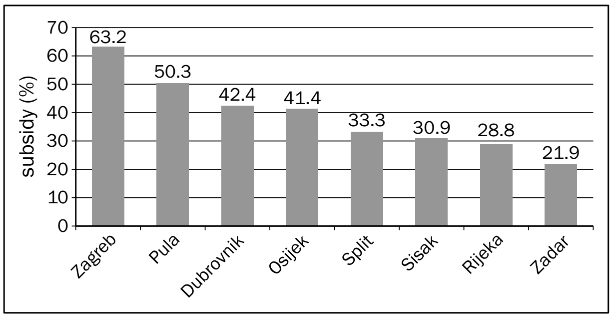

Figure 4 - Average percentage of subsidy in PT companies income in major Croatian cities during 2010

edited by authors from source: Association of Housing and Utility Services for Public Transport sector: Reports on the operations of carriers to local governments, 2011 [19]

The average maximum subsidy during the four-year observation period was awarded by the City of Zagreb (51%), Pula (46%), Dubrovnik (43%) and Osijek (41%), while the lowest average subsidy was granted in Zadar (22%), Rijeka (28%) and Karlovac (26%). The subsidies in the cities of Zagreb, Pula and Osijek significantly exceed the average subsidy in the Republic of Croatia.

3. LOCAL COMMUNITY SUBSIDY DISTRIBUTION MODEL

The objective of the local community subsidy distribution model presented in this paper is to provide a methodology to compensate for the insufficient funds for running PT lines within the required transportation level of service and the fair method of distributing the cost of transportation to all local government entities that are being covered by a single transport service.

Traffic demand and supply is a function of everyday human activities in urban areas. Each transport system consumer, regardless of whether they are using the system for private or business ventures, makes an individual decision in order to meet their need for transportation. Following the examination of available transport options and assessment of its limitations, the decision on the time and manner of transportation is made.

Public transport, as seen exclusively through market principles, is not always the optimal choice for everyone. The experience of developing countries shows that the rise in the economic power of the population reduces the number of users of public transportation and public transport generally becomes the first choice option only for the economically and socially vulnerable categories of passengers. This implies reduction of the number of passengers on the routes, especially the ones paying the full fare. This trend entails the need to increase subsidies to public transport in order to maintain its function, or even increase transport supply in an effort to change the modal distribution of travel in favour of PT.

Every public transport system, including the transport system of a city and its surroundings, is driven by demand that occurs as a result of human activities that generate travel. The method of theoretically describing generation of travel, used by transport planners and experts, is the so-called gravity model. This model - similar as with the physical force of gravity - describes that the force of attraction inducing travel grows exponentially with the proximity to the centre of gravity. Based on this principle a model was introduced that can be used to quantify the actual need for transport and its distribution in order to create a model of cost allocation to local governments.

3.1 Transport costs distribution model

The aim of the newly proposed model is to enable balanced and fair distribution of total subsidies necessary for proper function of a carrier, i.e. to define individual shares in subsidies to be provided by individual local authorities where the transport is operating. These shares need to reflect the actual expenses of respective lines, taking into consideration the actually performed work, i.e. service offered.

The transport cost distribution model described in this paper consists of a series of analytical procedures and processes which lead to a result in terms of a subsidy factor for the calculation of the actual value and the amount of subsidies for individual lines in an area. The model is divided in three separate modules. The first module implies data collection, while the second module delivers analytical procedures. The third module implicates application of the resulting subsidy factor and verification of the results. Since the first and the third module of the model mainly cover the already well-known analytical procedures, the actual methodology may vary depending on the specific circumstances of the study area. The emphasis of this paper is on the second module. A more detailed illustration of the overall model is shown in the flowchart in *Figure 5*, while the detailed description of the analytical procedures in the second module is presented in the following sections.

a) Trip generation and attraction factor and index

Trip generation models that take into account the individual characteristics of each traffic zone introduced by [23] or recently by [24], propose introduction of variable trip generation/attraction potential factors for different zones. In our model this different potential is represented in the form of trip generation and attraction indexes and factors, which are calculated for each local community separately. Considering local conditions in Croatia, this index has been extended with trips generated by tourists visiting the observed local community, in which case the model can also be applied in tourist destinations. Trip generation and attraction index is a function of the number of inhabitants and tourist arrivals in the area of local authorities, and can be calculated according to the following expression [20, 25]:

$$I_{NP} = \frac{N_S + \frac{N_T}{M_{TM}}}{P} \left[\frac{pop.}{km^2}\right] \tag{1}$$

where:

- I_{NP} – trip generation and attraction index;
- N_S – area population;
- N_T – registered tourist overnight stays per month;
- M_{TM} – effective tourist season in months (4-5);
- P – area (km^2).

In general, PT service area and travel demand can be put into relationship by taking the total number of travels and land use in the area where the journey is taking place into correlation [26].

$$T_{TRIPS} = a + b \cdot \ln(A_{AREA}) \tag{2}$$

In order to establish this correlation a regression analysis in Croatian conditions has been conducted [20] and a relationship between the Trip generation and attraction factor and index have been obtained. This analysis showed that this relationship can be approximately described with this logarithmic function:

$$k_{NP} = 0.3 \cdot \ln(I_{NP}) - 0.6 \tag{3}$$

Expression (3) is the result of the regression analysis conducted on the basis of available data for the population, land use and the number of tourist stays

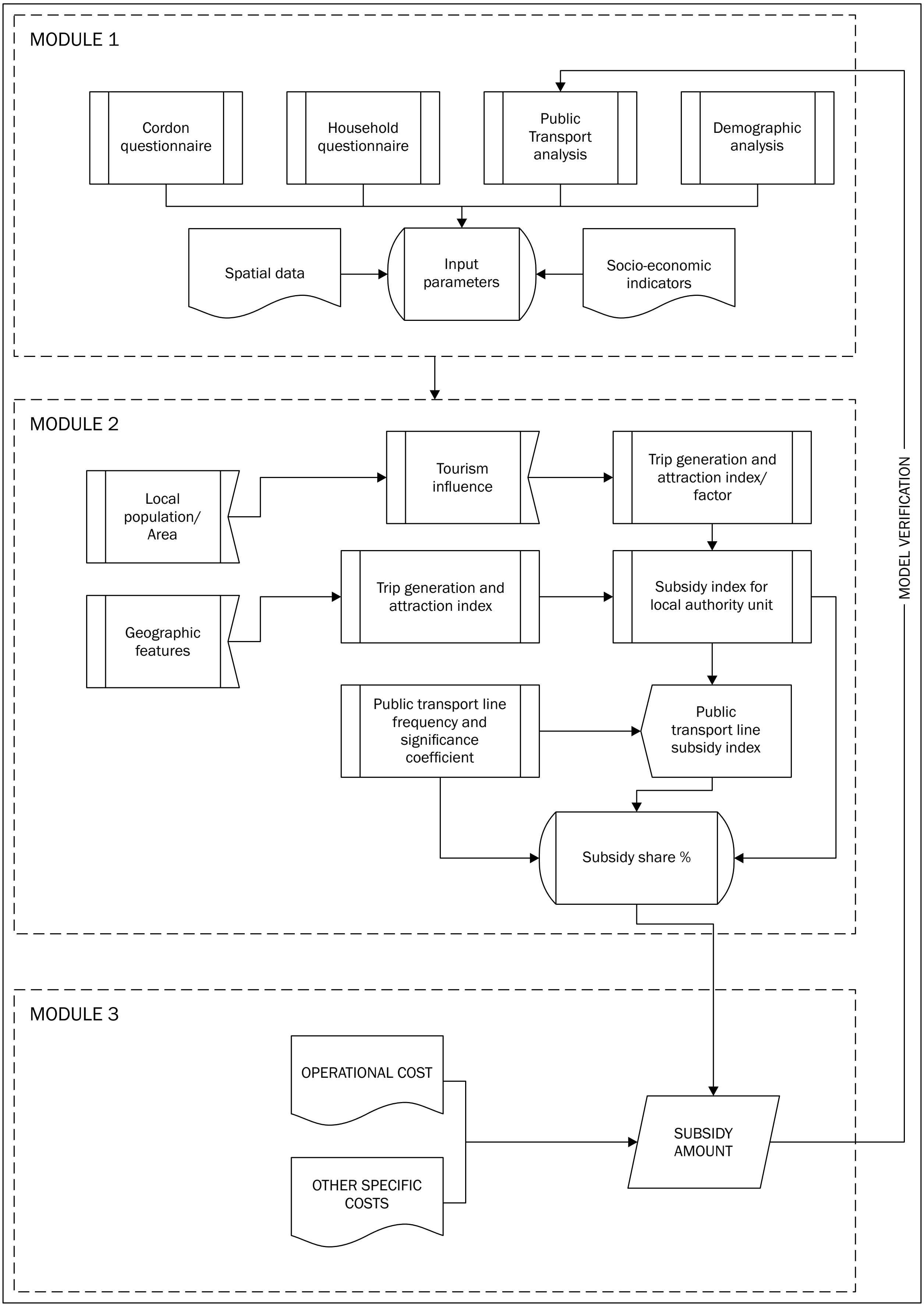

Figure 5 - Local community subsidy distribution model flowchart

in the Republic of Croatia [27]. Based on the above expressions the trip generation and attraction coefficients have been calculated. Approximate values of the calculated coefficient are shown in *Table 1*.

Table 1 - Trip generation and attraction factor values

Trip generation and attraction index value (INP)	Trip generation and attraction factor coefficient value (kNP)
25-65	0.4-0.6
66-130	0.7-0.8
131-250	0.9-1.0
251-470	1.1 -1.2
471-1,000	1.3 - 1.4
1,000-1,800	1.5 - 1.6
>1,800	1.8

The value of trip generation and attraction index is determined according to trip generation and attraction coefficient (*Table 1*).

b) Through traffic index

Trip generation and attraction index does not consider the geographic position of the local authorities. It is therefore necessary to introduce the through traffic corrective index that describes the position of local authority units in relation to the public transport network. This index considers the impact of service area position in relation to the full service area of the existing public transport network. Index values are determined empirically according to *Table 2*.

Table 2 – Corrective through traffic index value according to the geographic position

Description of geographic position (location)	Corrective transition index (kT)
Isolated / dispersed gravitational centre	1 – 0.9
Exceptionally non-transit / centralized gravitational centre	0.8 – 0.7
Suburban	0.6 – 0.5
Transit	0.3 – 0.4
Exceptionally transit	0.2 – 0.1
Completely transit (without stopping)	0

c) Subsidy index for local authority entity

Subsidy index for local authority entity is then calculated by multiplication of trip generation and attraction index with through traffic index according to the following expression [4, 20]:

$$k_S = k_{NP} \cdot k_T \tag{4}$$

where:

- k_S – subsidy index for local authority unit;
- k_{NP} – trip generation and attraction index;
- k_T – through traffic index.

d) Public transport line frequency and significance coefficient

Frequency and significance coefficient represents the relation between the performed and planned trips (departures) on all public transport lines in a local authority, and it is computed according to the following equation [20, 22]:

$$F_{UL} = \frac{N_{PL}}{\sum N_{PL1} \ldots N_{PL2}} \tag{5}$$

where:

- F_{UL} – public transport line frequency and significance coefficient;
- N_{PL} – number of departures on public transport line (from 1 to n).

Frequency and significance coefficient adjusts for the importance of the offered transport service, and thus the share in line subsidy for each individual local authority entity through which the line passes.

e) Public transport line subsidy index

Public transport line subsidy index is calculated as a sum of the products of all subsidy indexes and frequency-significance coefficients for all local authority units where the line achieves transport effect, according to the following expression [20]:

$$K_S = \sum (k_S \cdot F_{UL})_1 \ldots (k_S \cdot F_{UL})_n \tag{6}$$

where:

- K_S – public transport line subsidy index;
- k_S – subsidy index for local authority unit;
- F_{UL} – public transport line frequency and significance coefficient.

f) Subsidy share on the public transport line

Subsidy share on the public transport line for each individual local authority entity is calculated by dividing the product of subsidy index for local authority unit and frequency and significance coefficient with the public transport line subsidy index. Therefore, calculation of subsidy percentage for each local authority unit is performed according to the following expression:

$$U_L = \frac{k_S \cdot F_{UL}}{K_S} \cdot 100 \ [\%] \tag{7}$$

where:

- U_L – subsidy share on the public transport line;
- K_S – public transport line subsidy index;
- k_S – subsidy index for local authority unit;
- F_{UL} – public transport line frequency and significance coefficient.

Separate tests can be conducted for each observed public transport line to determine their individual costs. If there are any additional costs that are not included in the aforementioned equations, the calculated subsidy share can be increased by actual additional cost on the observed public transport line.

4. MODEL IMPLEMENTATION AND VALIDATION

In the area of Dubrovnik-Neretva County in the Republic of Croatia the proposed distribution model was applied. The model is based on the principle of traffic demand generation through gravitation effect of the City of Dubrovnik (coefficient of journey generation and attraction), taking into account the element of level of offered service (coefficient of frequency and importance of the line), both of which were sublimated in line with the specific geographical features of the area (through coefficient).

In the analysed area covering the territory of 9 municipalities, including the City of Dubrovnik, 16 lines are in operation, connecting the municipalities with the city centre and with each other, as well as three lines operating exclusively on the territory of a single municipality.

The cost-benefit analysis per line showed that the need for line subsidies in the urban area amounts to approximately 50%, while the suburban, i.e. county lines need to be subsidised with 2/3 or 66.6% of fare price. Furthermore, due to the specific geographic position of some municipalities, it is inevitable that some of the transport work is not justified with the traffic demand, but such transport work significantly raises the level of transport service provided to such municipalities, thus increasing their economic appeal. Also, the lines realising the transport work on the territory of a single municipality primarily provide benefits to this respective municipality, so it is the obligation of such municipality to cover any losses or to rationalise the offered service in a dialogue with the carrier, taking into account the organisational requirements of the offered PT system. The measures taking into account these and similar specific features are incorporated into the proposed model.

Some of the results of the application of the proposed model include the following:

- The total share of subsidies was redistributed between the City and the gravitating municipalities so that the City's share of subsidy was increased from 35% to 65%;
- Fairer distribution of external cost of carrier's operation across all lines instead of former equal distribution of such cost. The result is that on some lines the total share of line's participation in external cost was reduced from 15% to 5%, whilst on some lines this share increased from 2% to 10%
- The share of subsidy pertaining to single lines was reduced or increased, depending on the parameters of the proposed model. On one line, where the transport cost (and therefore the subsidy) was distributed in three approximately equal shares, the share ratio is now 15% to 35% to 50%, depending on the importance of this line for the respective municipalities.

More details on the results of model implementation have been published in [20–22]. The local authorities have accepted the model results and are applying them in developing the plans for subsidising the public transportation on the territory of Dubrovnik-Neretva County.

5. CONCLUSION

In order to solve the problem of unfair subsidy share distribution, this paper presents a model for cost reallocation in the public urban and suburban transport domain. Based on the past experience and former approaches in addressing this issue and the transport planning in general, the framework for the future model was determined. Research of subsidizing the public passenger transport in the European cities and in the cities in the Republic of Croatia has been used as the starting point in defining the relationship between the actual transportation costs, level of service and granted subsidies. In addition, the computational approaches to subsidies of public transport in relevant papers have also been critically analysed and processed in the elaboration of the framework for the model development.

Balancing on the predefined input data the model provides a unified calculation for the required subsidy distribution for public transport in urban and suburban areas. The model was proposed in order to fairly reallocate public transportation cost between partaking municipalities is primarily based on gravitational effects of transport demand centroids and the offered level of service. The model takes into account the individual characteristics of each traffic zone and introduces the variable trip generation/attraction potential factors for different zones. The transport cost distribution model described in this paper consists of a series of analytical procedures and processes which lead to a result in terms of a subsidy factor for the calculation of the actual value and the amount of subsidies for individual lines in an area. This model also simplifies the formation of tariffs in public transport and can be modified by the reduction of transport supply through the reduction of public transport lines. This could be achieved by reducing the number of departures or by further commercialization of lines (e.g. transport price increase), which will have direct impact on financial effects of the respective line. The model can be upgraded through detailed monitoring of the transport process; that is, by recording each individual travel in order to ensure fair allocation of costs between individual lines. This kind of monitoring would also ensure a detailed insight into the rationality of individual public transport lines and enable increased accuracy of the planning process. The prerequisite for such approach is the application of modern fare collection system, which includes significant investments in the existing technological process.

The proposed model has been successfully verified through the implementation in Dubrovnik-Neretva County in the Republic of Croatia [20]. The fact that the model has been applied and used confirms the appropriateness of the parameters used within the model and the applicability of the model itself. Therefore, it can be concluded that aforementioned model represents the unique way of subsidies allocation in order to achieve the planned transport service in the cities and suburban areas. Although the data used for model development through regression analysis and computation of correction coefficients were obtained from the information collected throughout Croatia, the model was applied only in one region. Therefore, additional research is necessary to confirm the appropriateness of the application of the proposed model in other areas. It is also expected that in dissimilar environments additional specific factors may be required in order to calculate fair subsidy distribution. These factors can be easily introduced to the model in the future.

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SAŽETAK

MODEL RASPODJELE TROŠKA PRIJEVOZA I SUBVENCIJA U JAVNOM GRADSKOM I PRIGRADSKOM PRIJEVOZU PUTNIKA

Subvencije u javnom prijevozu osiguravaju mogućnost pronalaženja optimalne kombinaciju razine usluge koja se nudi putnicima i vozarine. U regiji s više jedinica lokalne samouprave (JLS) na području kojih jedan operator usluga javnog prijevoza na više linija obavlja prijevoz, postaje teško jednoznačno povezati stvarni trošak linije, a time i ponuđenu razinu usluge, s određenom JLS. To dovodi do mogućih disproporcija u ukupnoj raspodjeli subvencija koja može biti nepravedna prema nekim jedinicama lokalne samouprave, pogotovo onim koje su slabo naseljene ili geografski izolirane. Kako bi smo riješili ovaj problem istražili smo odgovarajuću razinu subvencioniranja javnog prijevoza prema prosječnim vrijednostima u europskim gradovima i analizirali trenutne subvencije u Hrvatskoj. Na temelju tog istraživanja i hipoteze koja govori da se razina usluge mora odraziti u iznosu subvencija uspostavili smo novi model distribucije subvencije koji uključuje niz analitičkih postupaka i procesa . Ovaj model uvodi nekoliko čimbenika koji se koriste za izračun stvarnih udjela u troškovima. Primjenom modela može se utvrditi iznos subvencija za pojedine linije u regiji, na temelju stvarne usluge ponuđene na razini jedinici lokalne samouprave. Predloženi model je validiran i uspješno primijenjen u Dubrovačko-neretvanskoj županiji u Republici Hrvatskoj.

KLJUČNE RIJEČI

javni prijevoz putnika; troškovi prijevoza; subvencije; raspodjela troškova;

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