Impact of Public Transport Priority on Traffic in Chosen Part of the City of Martin

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Abstract. Urban public transport is a system of mass transit of passengers within the range of urbanized territory within a single municipality or city. Urban public transport operates in inhabited areas, most often in cities with more than 20,000 inhabitants and is indispensable in cities with more than 40,000 inhabitants. Urban public transport varies based on the size of the city, the location of the individual facilities in that city, the lifestyles of the city's inhabitants, the nature of the form of settlement and the size of the catchment area. Currently, there is a major problem of service failure mostly in city centres. Inappropriate conditions for the transport of persons cause congestion, and hence the time losses of all users of means of transport. For this reason, it is necessary to ensure quality, fast, safe and dynamic transport for people. There are several ways to achieve this and one is the public transport priority.

Keywords: Public transport priority · Microscopic modelling
Infrastructure redesign

1 Introduction

One of the main objectives of all larger cities is to ensure effective transportation of people. Urban public transport in the city of Martin is characterized by an annual decrease of performances, thus the decline of transported passenger [1]. There are two possible solutions to this problem – to build new infrastructure or be more efficient with the existing one. Because of the narrow streets and density of existing buildings within the city, in most cases extending current infrastructure is not possible. Hence, the latter way is the only possible solution in these cases.

There are several approaches preferred in the world. In some cities, some intersections are only partially opted for by, for example, modifying the signalling plan on light-signalling devices, but these, in fact, do little to relieve the pressure.

If public transport vehicles continue to drive in a shared area with the rest of the traffic, they lose the benefit from this preference [2]. This paper is focused on the traffic situation of the chosen part in Martin from the bus stop *Hotel Turiec* to the bus stop *Košúty Nadjazd* near the shopping centre Campo di Martin.

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2 Characteristics of the Chosen Part of the City of Martin

The P.O. Hviezdoslava Street and Jilemnického Street with the length of 3,531 m are some of the most important road communications in the city of Martin. This area starts at the junction of the streets – Sklabinská - Kohútova - Janka Kráľa near Hotel Turiec and ends at Jilemnického Street near the shopping centre Campo di Martin.

Currently, P.O. Hviezdoslava Street and Jilemnického Street consist of one-way two-lane urban roads and junctions at grade. Both of them are distributor roads of the urban roads of B2 category and together with the streets A. Pietra, P. Mudroňa, Kohútova and Jesenského create the first ringroad of Martin. In addition, nearly each public transport line leads to this street or, at least, crosses the street. Due to these facts this area's traffic solution has a decisive influence on the quality of public transport from the point of view of delay times and travel speeds.

There is an increasing number of cars in this part of the city of Martin [6], which makes it unsuitable for sustainability, safety and environmental protection. Currently, there are a number of new information technologies that can help in analysing traffic problems as well as modelling multiple alternatives without the need for investment. Traffic engineers have come up with new technologies – software that can better present the results of a traffic problem and model through a variety of methods and techniques [7]. Several studies [8, 9] have demonstrated the importance of microsimulation for the purpose of analysing the properties of public transport vehicles within the chosen part, and there are currently several software available [10]. In our case, the Aimsun modelling software was used [11] (Fig. 1).

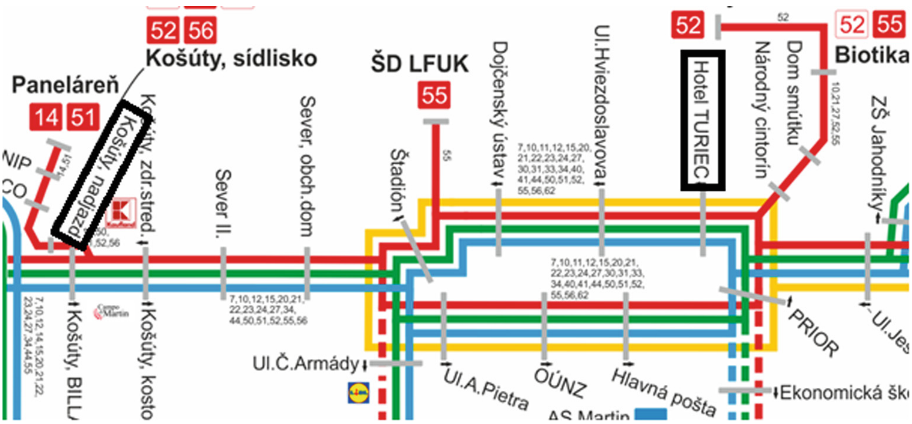

Fig. 1. Chosen part of map of urban public transport links in the city of Martin [3].

3 Microsimulation of the Chosen Part of the City of Martin

In order to determine the potential advantages and disadvantages of public transport priority in the centre of the city of Martin, the microscopic simulation of the chosen part of the streets P.O. Hviezdoslava and Jilemnického was carried out.

Three variations were investigated:

(1) Simulation of the current traffic situation with two-lane urban roads,
(2) Simulation of traffic situation with one lane for cars and one separate lane for buses and,
(3) Simulation of traffic situation with two lanes for cars and one separate lane for buses [2].

O/D matrices were created based on the measured data. We were interested in transit of cars and especially buses from the bus stop Hotel Turiec to the bus stop Košúty nadjazd near the shopping centre Campo di Martin. The total length of this section is 3,531 m. The following table shows the number of vehicles driving from Hotel Turiec to Košúty II. The values in the table were measured during a two-hour period (Table 1).

Table 1. Number of vehicles by category [5].

Category of vehicle	Number of vehicles (vehicles)
Car	1,770
Truck	21
Bus	50
Sum	1,841

Currently, there are 9 public transport bus stops and 15 junctions, 9 of which are 4-way and the remaining 6 are 3-way junctions. This information was taken into account when creating the model. We created two alternative proposals, which included the current number of bus stops (Fig. 2).

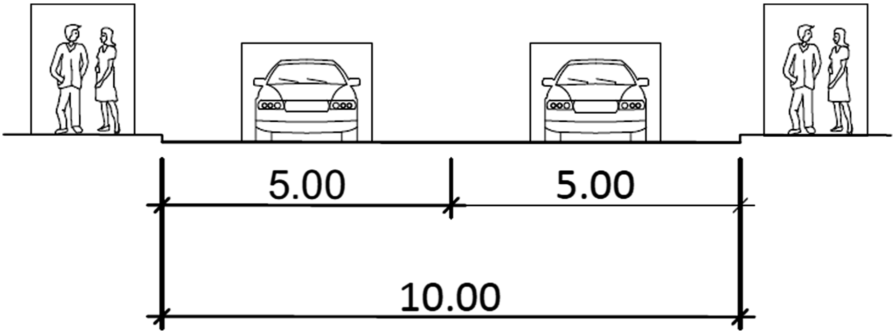

Fig. 2. Current status – road cross-section of P.O. Hviezdoslava Street and Jilemnického Street.

The first proposal included reallocation of road space in 50:50 ratio. One lane remained for passenger and goods vehicles. The second lane was reserved for public transport vehicles only and could be used as a mixed lane for buses and cyclists in the future (Fig. 3).

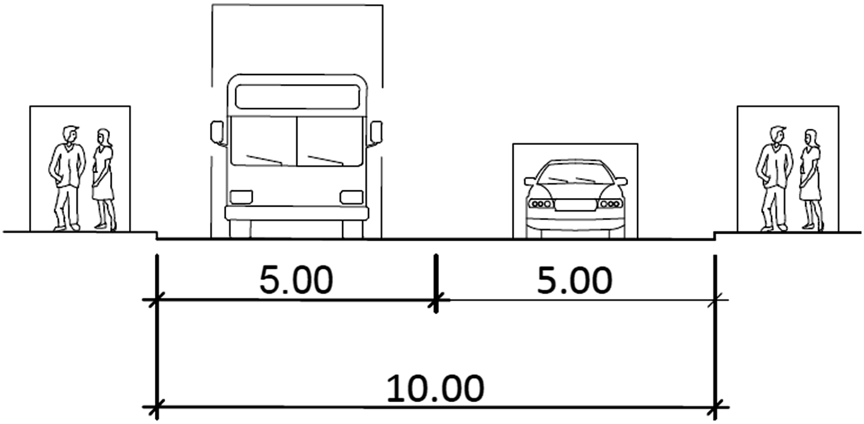

Fig. 3. Proposal 1 – road cross-section of P.O. Hviezdoslava Street and Jilemnického Street.

In the second proposal, the main traffic area of the streets is reorganized and a new lane is added to serve urban public transport only, with the possibility of making this a mixed lane for public transport as well as cyclists in the future and after further assessment. The width of two lanes in P.O. Hviezdoslava Street and Jilemnického Street is 3.25 m and the width of the reserved bus lane is 3.50 m. Currently the road width is 10.00 m, so it is possible to design three lanes in one direction (Fig. 4).

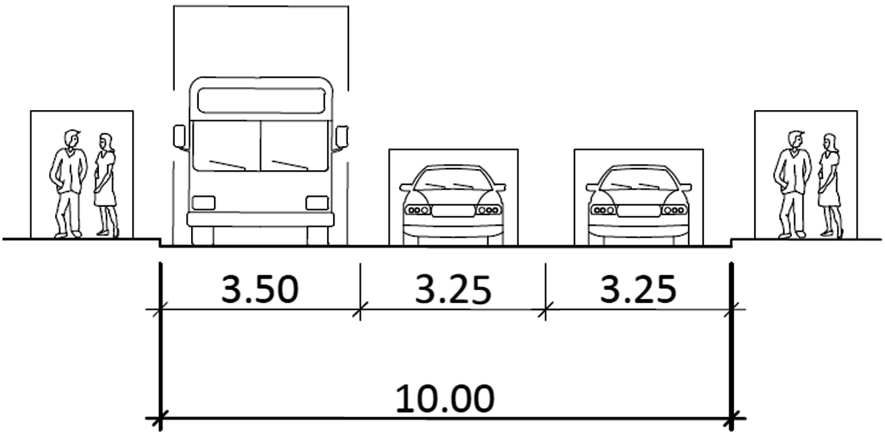

Fig. 4. Proposal 2 – road cross-section of P.O. Hviezdoslava Street and Jilemnického Street.

During the creation of this model, two individual urban public transport lines were also designed. One in the direction from the bus stop Hotel Turiec to the bus stop Košúty nadjazd and the other one from the bus stop Hotel Turiec to the Podháj-Stráne neighbourhood.

The capacity for each section of the road is set at 1,800 vehicles per hour. This value was chosen in accordance with the current technical standards TP 102. The speed for the whole network is set at 50 km per hour.

3.1 The Simulation

To compare the current situation with new proposals, we performed simulations in the Transport Simulation System – Aimsun software. The total number of simulations was 10 for each proposal, and the average was used for comparison purposes. The beginning of the simulation was set at 15:30 and end at 17:30. This time interval bears the daily peak of the traffic intensity [12].

The first simulation performed was simulation of the current situation. The simulation results confirmed the fact that the current status is satisfactory for the current traffic intensity on the given section. The following table (Table 2) shows the time of delay for each vehicle category.

Table 2. Time of delay for each vehicle category.

Situation	Category of vehicle	Delay time (sec)
Current status	Car	34,17
	Truck	27,23
	Bus	89,6
Proposal 1	Car	13,56
	Truck	17,82
	Bus	86,65
Proposal 2	Car	14,46
	Truck	20,7
	Bus	41,47

New proposals have shown the possibility of improving the current traffic situation in favour of urban public transport. Redesign of the abovementioned communications is a change in the layout of the lanes. Following figure (Fig. 5) shows the delay time of the various categories of vehicles on the section under investigation.

Other important indicators when comparing different proposals with the current situation is the travel time for each category of vehicles. It shows the total time necessary for the vehicles to pass given section. The retention time of public transport vehicles is higher mainly due to frequent acceleration and deceleration, which is due to pulling over at stops. In the simulations, we set the bus waiting time for passengers at the stop at 20 s. Because of these settings, urban public transport vehicles have the highest travel time compared to other vehicle categories. The following travel times for each situation are shown in the picture below [13] (Fig. 6).

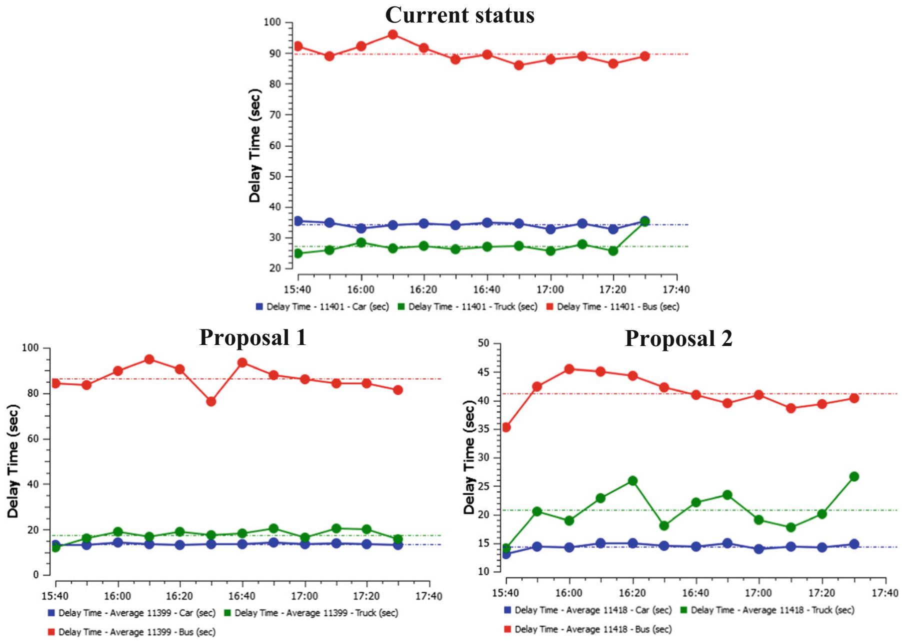

Fig. 5. Comparison of the delay time of the various vehicle categories.

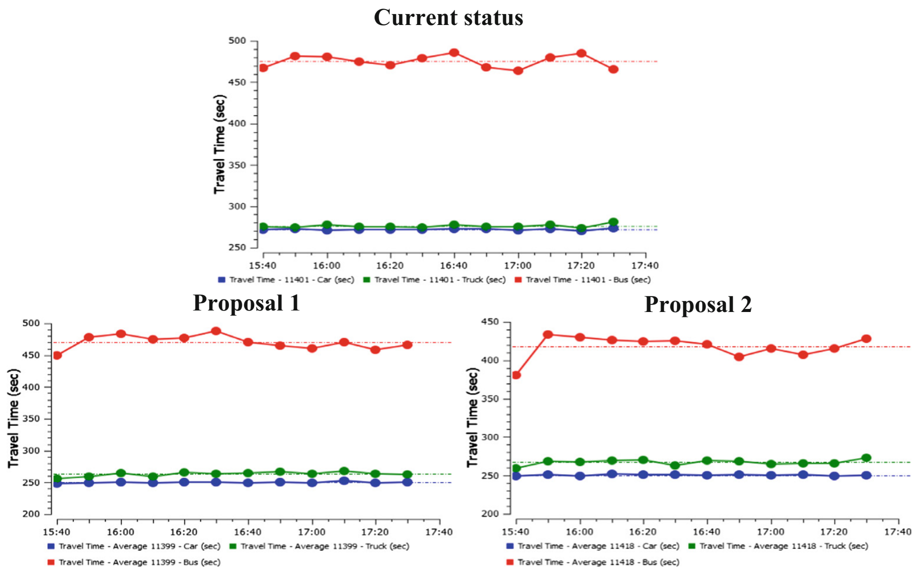

Fig. 6. Comparison of the travel time of the various vehicle categories.

An important indicator in the comparison was also the speed of vehicles. Due to the short length of the section, we did not expect big differences in speeds. However, simulations showed the following differences, which can be seen in the charts in the Fig. 7.

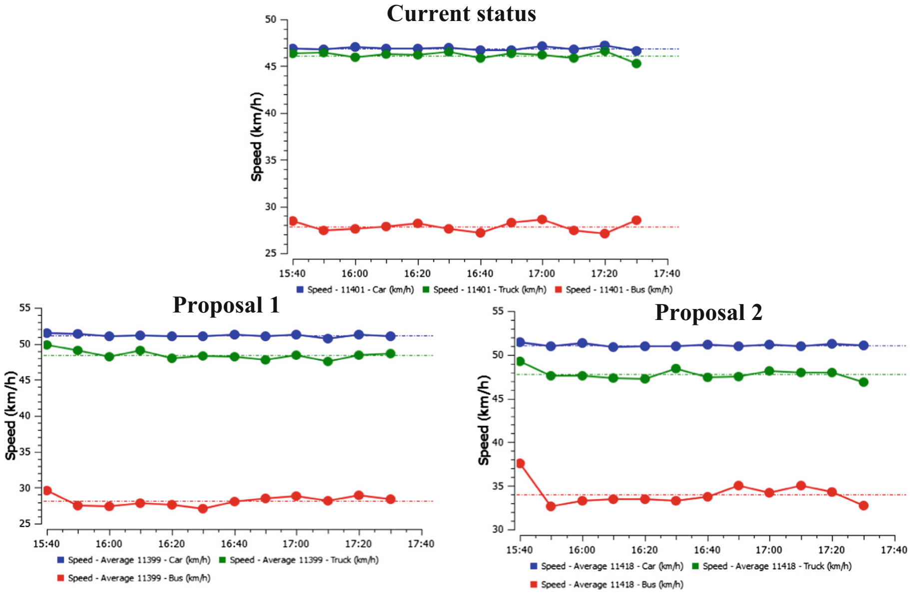

Fig. 7. Comparison of the vehicle speed of the various vehicle categories.

Total outputs from simulations are shown in the table below. For comparison, an extra indicator (traffic intensity) was selected in addition to the ones mentioned above. The simulation outputs were compared with the measured values of traffic surveys at given traffic intensity levels. Values in intensity vary up to 3 vehicles per hour in each category within each simulation. At this intensity the results can be considered nearly identical. The following table compares important indicators from the simulations [14] (Table 3).

Table 3. Comparison of the indicators obtained from the simulation.

Situation	Category of vehicle	Delay time (sec)	Speed (km/h)	Travel time (sec)	Flow (veh/h)
Current status	Car	34,17	46,89	272,03	729,2
	Truck	27,23	46,17	275,95	9,95
	Bus	89,6	27,85	475,33	40,65
Proposal 1	Car	13,56	51,16	250,03	727,15
	Truck	17,82	48,39	263,53	8,65
	Bus	86,65	28,09	471,21	40,5
Proposal 2	Car	14,46	51,11	250,59	728,9
	Truck	20,7	47,76	267,19	9
	Bus	41,47	33,89	419,37	43,4

The most important factor is the delay time of the various categories of vehicles on the investigated section. The differences in delay time between the proposed solutions are, on average, comparable. In spite of that, when comparing the proposed solutions with the current situation, there are significant improvements in delay time. The focus of our simulation, however, was the comparison of urban pubic transport, where the delay time in the simulated current situation is 89.6 s and in the case of the Proposal 2, it is 41.47 s. The delay time saved in relation to the movement of the public transport vehicle reaches 48.13 s.

A change in the speed of vehicles was also noted. In Proposal 1, there is a reduction in the number of lanes for cars and trucks, whereas in proposal 2 the number of lanes remains the same. However, in both proposals, we can see an increase in speed in this section of the road.

This increase can be considered both as positive and negative result. It is positive in a way that the passage time on a given section, but higher speed also means higher risks of accidents at pedestrian crossings. The difference is just above 4 km/h.

4 Conclusion

If cities want to prioritize public transport at their networks, they must create suitable conditions by pointing out all the potential problems connected with this prioritization. It is possible that while improving traffic in one area, new traffic problems may arise in other areas as a result and prioritizing one mode of transport may negatively impact other modes of transport. This is why a suitable transport modelling software must be used. This software should be able to visualise transport network and thus offer better explanatory value, especially for people who are not experts in this field [4].

This article is focused on the current situation of urban public transport in the city of Martin, particularly the section from Turiec Hotel to the shopping centre Campo di Martin located in Košúty II. Current situation was compared with two possible solutions. The outputs from the Aimsun simulation programme can be considered real to a great extent. For both proposals, we have found that it is possible to improve the movement of urban transport vehicles on the studied section of the road. The best solution is Proposal 2, where the delay time of buses decreased by 48.13 s. This is considerably affected by the increased vehicle speed, which is on average higher by 6.04 km/h. We can recommend this design to the municipality of the city of Martin as convenient and low-cost solution.

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