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## PARAMETERS OF RELATION BETWEEN PUBLIC URBAN TRAFFIC AND URBAN ENVIRONMENT WITH SPECIAL REFERENCE TO ZAGREB

### ABSTRACT

*The historical development of cities and urban transport inevitably implies a conflict between mass transit and the urban environment, regardless of the steps taken to influence (and the degree of such influence) the ratio of mass transit to private transportation in cities. In fact, both are to be found among the most important factors reducing the standard of urban living in settlements and cities. The positive effect of transportation in terms of its overcoming physical distances is associated with quite a few negative impacts on man and the environment; within this scope the negative effects of passenger cars on the urban environment are higher than those of mass transit.*

*A realistic approach to the urban-transit-to-environment relation would involve the identification of its relative parameters, their objective quantification, and the selection of steps to reduce or prevent the occurrence of negative effects.*

*The general transformation of the city – environment – transportation relation in Zagreb follows the same pattern. The assessment of the relation between mass transit in Zagreb and other elements of the urban environment is as negative as the relation of the former to the population (whether it involves pedestrians, transit users or passenger car drivers).*

*The range of possible steps which could improve this state of affairs in Zagreb covers a span from secular to short-term measures. Unfortunately, the relation of transit (one of the elements of the urban environment) and man does not seem to attract the interest of the main agents of the city's transportation policies.*

### KEY WORDS:

*transportation, city, public urban transport, environment*

### 1. INTRODUCTION

Since public passenger transport in cities is a younger historical phenomenon<sup>1</sup>, thus also the problem of

the relation between public passenger transport and the city (in this case the urban environment), occurred in the urban development at a relatively late stage.

The process of city development, supported by the process of urban traffic development (public and personal), has caused an essential change in the structure of the urban passenger transport. The city was transformed from the city of pedestrians and horse traction, via city of tramways and bicycles to a city of motor vehicles, mainly personal cars. In this historical development of the city and traffic, several phases may be noted, i. e. periods of their interrelations<sup>2</sup>.

1. *Phase of harmony between the traffic and the city;*
2. *Phase of disharmony between the traffic and the city;*
3. *Phase of dominant relation of the traffic over the city.*

The first phase, i. e. the phase which, as mentioned above, is marked by mutual harmony between traffic and the city, that is, urban environment, is characterized by a situation in which traffic is adequate (and parallel) to the built-up urban environment, as e. g. at the age of horses and carriages.

The second phase is characterized by the lack of harmony between traffic and the city (first of all – visually) and it was caused by subsequent appearance and development of traffic as urban element (tramways, urban rail, buses).

The third phase is determined by the fact that traffic is considered, or is objectively becoming a more important element than the built-up urban environment. This phase of the relationship indicates all the negative effects of traffic, such as e. g. noise, air pollution, visual intrusion, endangering lives and certain body organs, and in extreme cases even physical damaging of buildings and other elements of the urban environment.

The historical development and the achieved level of conflicting relations of traffic and the city undoubtedly speak about traffic, both public and personal, as precisely being one of the basic and most influencing factors in reducing the environmental standards in towns and cities. Positive effects of traffic in overcoming physical distances have been followed at the same time by an entire series of negative impacts on the environment and the humans. The negative effects of personal cars on the urban environment are, indeed, greater than the negative effects of public passenger transport. Therefore, the theoretical conclusion is that the fundamental improvement of environmental quality of certain urban zones (primarily downtown areas) could be achieved by the shift in transportation mode usage between public mass transport means and personal cars, in favour of the former.

It seems that the demand to own and use a personal car in the world will continue to grow, in spite of the increase in costs of its exploitation and objectively limited possibility of its usage, but still at a slower growth rate than up to now.<sup>3</sup> At the same time, the public urban mass transport system, in spite of improvements regarding its technical, technological and organizational aspects of operation, continues to lose its attractiveness.<sup>4</sup> Such a trend of personal car / public passenger transport relation is leading more or less all the cities in the world to traffic congestions, which result not only in deterioration of the relations between traffic and urban environment, but also has negative impact on the regularity, speed, efficiency, and overall on the quality of surface systems. of the public mass passenger transport.

It is obvious that the conflicting relation of public mass transport and urban environment has to be inevitably accepted, regardless of which measures and how efficient the influence on the shift in the relation between public mass transport and personal passenger transport in the cities can be.

The problem of the relation of public urban traffic and the urban environment undoubtedly represents a field of interdisciplinary approach of scientists and experts of various profiles. When, however, the interest focuses on the relation of public urban traffic as part of the overall urban environment and the human as traffic participant, then this problem has to be tackled primarily by the traffic experts.

Regarding the definition of the public urban traffic system, from the viewpoint of the problem of its relation towards the city and the environment, it should be defined as a complex dynamic system with highlights on the technical, technological-organizational and economic subsystems, which in turn represent again separate complex systems, regarding the strength of interconnections in the environment.

Technical subsystem comprises vehicles and all the infrastructure elements (all the elements of traffic network – turn areas, stops, upper and lower line of the electric rail system, all installations of the power system, rectifier stations, etc.), depending on the type of public mass passenger transport in a city.

The technological-organizational subsystem of the public passenger transport system has been determined by an entire series of technological procedures within a unique traffic-technological process, which, among other things, means by the form and wide extent of the network, connecting method of single network sections, i. e. line guidance systems, tariff system, ticket system and their selling and cancellation method, then by volume, quality and characteristics of the transport capacity offer per routes and times regarding regularity and frequency of transport operation, etc.

The economic subsystem is concretized by the expenditures of individuals (passengers) who have them if they want to use the services of public passenger transport, expenditures of the society for the functioning of the public urban traffic, i. e. investments, subsidies, etc.

In order to be able to define the relation in further observations, i. e. to identify some basic parameters of the relation between the public urban transport and the environment, it seems most suitable to accept the definition given by Joseph Priest on the environment.<sup>5</sup> He, namely, thinks that the environment needs to be understood as a combination of physical conditions that affect the growth and development of living organisms, with humans obviously representing the most important organism of interest in the environment.

Such definition of the environment implicitly suggests that public urban traffic as part of the overall urban traffic represents a part of the human urban environment (and even historical development has made it into an urban element!), which together with other environmental elements acts on humans (in the positive and the negative sense). Thus, in fact, a double conflicting relation may be observed which involves the public urban traffic of a city. Once it is its relation to the environment of the city, which means to all the other elements of urban environment (relation of a segment to the whole!), and the next time it is the relation of public urban traffic to the citizens (relation of a segment of the environment to humans).

In our opinion, the relation of the *public urban transport and the rest of urban environment* can be defined by the following parameters:

1. *occupying of urban surfaces and areas,*
2. *generation of noise and vibrations,*
3. *visual degradation of other urban elements,*
4. *air pollution and pollution of the rest of environment,*
5. *allocation of financial means for public urban traffic.*

These parameters can and should be quantitatively expressed for every form of public urban traffic system and for every city separately, with values of each of these parameters differing as one goes from the city centre to the peripheral zones.

When speaking of the surface, i. e. space necessary for the functioning of the public traffic system in the city, one should consider the extreme cases of aggressive occupying of the existing built-up urban facilities by the public traffic system, thus resulting in complete destruction of urban environment.

Noise, visual intrusion and pollution represent lower rank of adverse influence of the public urban traffic system on the urban environment.

Provision of the necessary financial means for the installation and operation of the public traffic system of the city is very often evaluated independently of other parameters resulting in the deterioration of the relation between the public urban traffic and the urban environment. On the other hand, this parameter occurs almost always, without exception, as a corrective to requirements set for the improvement of all the other parameters.

The realistic approach to the requirement of minimizing negative impacts of the public urban traffic on other urban environment elements consists in the recognition of all the parameters and their interrelation in its objective quantification and in the selection of measures which are to reduce the impacts or prevent their occurrence.

Regarding the relation between *public urban traffic and the citizens*, the parameters here depend on whether the citizen is considered in the function of a pedestrian, user of the public transport means (passenger) or user (driver) of the personal car, and sometimes this problem is tackled from the point of view of the public urban traffic operator, i. e. from the point of view of the requirement set by the traffic personnel on the so-called micro-environment (in fact the vehicle design).<sup>6</sup> Still in the latter case, in our opinion, the problem is only in the conditions of work and production, rather than the relation between the public urban traffic and citizens.

As *pedestrian*, the citizen experiences the existence and functioning of the public urban traffic completely negatively. The relevant parameters of the relation are:

1. *noise and vibrations,*
2. *air and other types of pollution,*
3. *traffic accident risk,*
4. *visual intrusion,*
5. *limiting of mobility.*

Some of these parameters can be quantified (noise, air pollution, traffic accident risk), and some, such as e. g. visual intrusion, are the subjective negative aesthetic experience of the public transport sys-

tem. However, if from the standpoint of pedestrians, the role of the public urban traffic is accepted as a negative but inevitable fact, then the aesthetic experience must also be evaluated as the counterpoint. In this context the blue tramway in the streets of Zagreb renders special identity to the city just as the London red double-deckers do to London.

The influence of public urban traffic (and overall motor traffic, of course) on the limited movement of pedestrians has double aspect. The limitation to the movement of pedestrians is stipulated on the one hand by the objective need to insure space for the functioning of the public urban traffic, but on the other hand, also by the introduction of new norms of behaviour in the pedestrian movement due to the traffic regulation and location of stops in the urban traffic system.

When considering humans as *passengers*, i. e. public urban traffic users, both positive and negative effects of public traffic are identified. Here, the positive effects necessarily have relative meaning. Public passenger transport allows humans to overcome space distances in a shorter time than on foot, bearing in mind that today's city would not have existed, nor could have the citizen actively participated in the city life if there were no traffic, i. e. public urban traffic. However, the passenger experiences the existence and functioning of the public urban traffic from the negative side as well, although due to the positive effects of public urban transport, this perception of negative may mean relatively negative.

The parameters of this relation are:

1. *noise and vibrations,*
2. *air and other types of pollution,*
3. *traffic accident risk,*
4. *visual intrusion,*
5. *limiting of capacities,*
6. *negative aesthetic experience due to design and construction of the transport means interior and stops,*
7. *riding in cramped space of the lowest comfort vehicle of all the transport means of passenger traffic.,*
8. *causing discomfort to passengers because they have to wait for the transportation vehicle at the stop, because of connections if there are no direct lines, conflicts with the traffic staff and other passengers, etc.*
9. *pricing and the tariff system.*

It may be noted that the first five parameters of passenger and public urban traffic relation represent, in fact, the parameters of the relation between the pedestrian and the public urban transport. When speaking of others, it should be stressed that some can be quantitatively expressed and thus can serve to evaluate the efficiency and attractiveness of various forms of public mass passenger transport.

As the *personal car driver*, the citizen has an absolutely negative feeling for the existence and functioning of the public urban transport. In this case the relevant relation parameters are the following:

1. *noise*,
2. *pollution of air and the rest of environment*,
3. *risk of collision and traffic accident*,
4. *visual intrusion*,
5. *mobility limitations*.

All these parameters are identified also in the relation between the pedestrians and public urban traffic and in the relation between passengers and public urban transport. In case of personal car drivers there is, however, special risk of collision and traffic accident and the limitation of personal car movements. The values of these parameters are determined by the type of the public urban transport means, characteristics of the traffic network, capacity and throughput of the urban traffic routes and intersections, characteristics and specifics of the concrete city, traffic regulation method, etc.

## 2. SPECIFIC PROBLEMS IN ZAGREB

General transformations in the relation of the city, environment and the traffic, can be traced with the same regularity in Zagreb. From the pedestrian medieval town on the hills of Gradec with Kaptol and the Vlaška Street, over the town of carriages and horse tramways on the turn from the 19<sup>th</sup> to the 20<sup>th</sup> century, the city of Zagreb stepped into the era of electric tramway in 1910,<sup>7</sup> only to be called, almost a century later, unfortunately but rightly, the city dominated by the tyranny of personal cars. The explosion of the motorization level in the last twenty years has now exceeded the critical decline of the destructive impact of automobiles on the Zagreb environment.

The public urban transport system of Zagreb is even today based on the electric tramway and buses, and, neglecting the quantitative growth and development of the traffic network and the transportation capacity of the entire system, these are still basically the classical forms of public passenger transport system which have not managed to counter the aggressive competition of the personal car even in other cities in the world. The changes in the structure of Zagreb urban passenger transport were significantly contributed by the fast development of the city that was not accompanied by adequate development of the public mass transport system. This was an additional, although not insignificant motive to own and use a personal car, which still, in spite of increasing restrictions in movement, allows higher-quality and more efficient satisfaction of individual transportation needs. Such relations of individual and mass transport in the city of Zagreb, tolerant (and necessary) in involving the

wider and narrower urban region, have concentrated with extreme power of attraction of the strict downtown area, the individual motor traffic to an area of only several square kilometres of the strict city centre, with the resulting complete traffic congestion. This narrower, i. e. wider urban region of Zagreb means the catchment area according to the General Traffic Plan. Here, the problem of precise definition of the scope of operation of the urban and the so-called suburban traffic needs to be stressed. The mentioned narrower and wider urban region according to the GTP basically represents the political-territorial division and cannot fully serve for the precise determination of the zones of urban and suburban Zagreb traffic. Indeed, the task of these considerations is not to solve this problem, so that the public urban transportation system here to a great extent comprises also the suburban traffic, i. e. the entire traffic of the ZET (Zagreb Electric Tramway), excluding the so-called suburban railway traffic and the traffic of other bus carriers.

The interdisciplinary approach to the relation of public urban traffic and the environment, in our opinion, should be more stressed in solving the problem of the relation between the public urban traffic and the urban environment than in the case of relation between the public urban traffic and the citizen. Therefore, this paper deals with the questions that result from the relation of the public urban transport of Zagreb and the passengers, since this relation is primarily the problem of the traffic policy of the city and its decision-makers.

Values of the parameters of noise and vibrations generated by the functioning of public transport system should be primarily considered as the function of type, i. e. form of the traffic system (underground, urban surface railway, tramway, bus, etc.), its quantitative expression (number of running units on the network, i. e. individual network segments), technical characteristics of transportation means (from type to their technical condition), technical condition of the traffic route (railway line and road), speed and methods of using the vehicle (driving regime).<sup>8</sup>

Electric tramway (as surface rail system) and buses represent the noisiest means of public urban transport system. The level of noise in the central urban zone of Zagreb is a result of high concentration of public urban transport vehicles in that area. Older types of tramway vehicles (motor cars and trailers) generate higher noise and vibrations than the new ones, and poor technical condition of buses results in noise generation which is greater than objectively necessary. An especially negative impact regarding increase in noise and vibrations is generated by the condition of tramway lines, almost without exception on the entire network, and the condition of city streets which accommodate bus traffic.

Considering air pollution, naturally, the first thing to bear in mind is the emission of exhaust gases from bus engines. The choice and orientation for using precisely the vehicles MAN and MERCEDES, among other things, have been made because of the excellent characteristics of their engines and the level of gas oil combustion. The pollution of the rest of the environment, caused by the operation of the public traffic system, depends on the tariff system, fares (passengers throwing away the used tickets!) and, of course, on the relation of passengers to maintaining the cleanness of the city in general, represents a special problem.

Statistical data on the number of traffic accidents involving vehicles of public urban traffic in Zagreb show a relatively high level of safety for passengers as well as for other traffic participants (pedestrians, e. g.). This is, indeed, in compliance with general relations, considered from the aspect of the safety level realized in individual traffic branches and transport modes.

The level of visual intrusion depends primarily on the fact whether overground, surface or underground public urban traffic system is considered.<sup>9</sup> However, the construction designs and vehicle design, location and architectural-construction solutions of traffic terminals, may have similar adverse effect on the aesthetic experience (as well as functioning) of the built-up and arranged urban environment. Like all the other cities, Zagreb has accepted the necessity of the presence of public urban traffic. The more so, since the typical blue colour of the tramways and buses is often highlighted as the symbol of the city (recently there are also some colourful tramways as well). However, some areas valuable for pedestrians, such as Trg bana Josipa Jelačića (the main Zagreb square), Trg kralja Tomislava, Kvaternikov trg, are aggressively occupied and turned into highest concentration of public urban transport vehicles and passengers. The contact points of tramway and bus networks e. g. on the Sava bridge, Heinzlova ulica and West Railway station not only fail to be designed well regarding their architecture and construction but are also questionable regarding their traffic function.

As surface means of public urban traffic, the tramway in the City of Zagreb acts extremely limiting on the free and undisturbed movement of pedestrians. The pedestrian areas (which does not mean pedestrian zones) are threatened by the passage of tramways very close to the pedestrian paths (such as in the streets of Ilica, Frankopanska, Jurišićeva and Vlaška, and at some places where the tramway line, due to the expansion of the intersection, passes through the centre so that pedestrians have to use the pedestrian island which can be reached only by fighting through a traffic flow (e. g. in the streets of Savska, Držićeva and Šubićeva).

The interior of the public urban transport vehicles, the design, and the seat arrangement as well as the used materials, certainly have to be adapted to a large number of passengers passing every workday through the vehicle. Therefore, naturally, no strict requirements can be set regarding the interior design of the public urban transport vehicles, except those that ensure their functional usage and maximally easy movement of passengers through the vehicle. Here, one considers first of all the position and height of the handrails on the very entry into the vehicle and in its interior, but also about the height of stairs and platforms. The problem of difference in height between the vehicle stairs and the platform in public urban transport of Zagreb has not been attended to with sufficient care, although this would not require any substantial financial means. Not only does this issue make the loading and unloading of passengers an extremely difficult task (especially in case of the senior and disabled persons), but also more time is required at the stops, thus reducing the speed of travelling and the general efficiency of the public transport system.

The reasons for internal business economy of the carriers (which are otherwise in conflict with all the requirements regarding the quality of carriage) have significant effect on the reduction of comfort in vehicles of the public urban transport, especially in the sense of space intended for passengers. According to the current standards, the vehicles of public urban transport should carry six (even eight!) passengers per one square meter of the vehicle interior. When calculating on this basis the necessary capacities to satisfy the traffic demand, then it becomes clear that every disturbance in the timetable results in the number of passengers exceeding the vehicle capacity, having as consequence drastic reduction of space meant for one passenger. In such conditions, there is naturally no mention of a qualitative and efficient public urban traffic.

The public urban traffic of Zagreb has failed to recognize sufficiently the requirements that in the passenger traffic in general (including urban traffic, of course) in the world have since long ago represented the basic principles of transport organization, such as: travelling speed, regularity, punctuality, frequency of transportation vehicle on the line, maximum number of direct lines in order to reduce the number of connections (changing vehicles causes extreme discomfort for passengers!) etc.

In designing the lines of public urban transport, the basic rule is to connect the origin and the destination of the passengers' trips by a shortest possible route (and method). Many relevant parameters need to be taken in the model and these complex problems are today solved by well-known mathematical methods. One should be aware of the fact that there are nowhere such simple conditions that provide achieving

the optimal effects "by heart", by simple intuition of the transport organizer. The more complex the conditions, the more justifiable it is to implement the well-known scientific methods in order to find the optimal solutions.

One of the major parameters of the relation between the public urban transport and the passengers are the fares and, in general, the tariff system. From the aspect of public urban transport attractiveness and its relation towards the individual traffic, this is no way a negligible parameter, although experiences in the world have shown that for the moment the essential change in their relation in favour of the public urban transport cannot be achieved by reducing the fares (i. e. by government, or municipal subsidizing of the public transport system). However, here we have in mind the simplicity of implementing the tariff system, as function of the transport price and ticketing system.

The existing tariff system of the public urban transport in Zagreb, from the passengers' aspect, is fairly simple. A larger number of connections is possible, and a special advantage lies in the possibility of connecting between bus and tramway and vice versa. However, this system for passengers also features many disadvantages. First of all, the basic fare (ticket price) is higher for the majority of passengers, especially for those travelling shorter distances since these have to subsidize the relatively lower prices for passengers travelling longer distances. However, the biggest disadvantage of this tariff system has already been reflected on the system of lines, i. e. the method of interconnecting individual points on the traffic network. Because of the connecting possibilities provided by the existing tariff system, a completely wrong conclusion has been made that the passenger did not care whether he/she reaches the destination by using one or several transport means, so that there is a tendency to shorten the bus lines, thus making the public urban transport an even more unfavourable transport method for a large number of passengers. The consequences of such a line organization policy may be expected also on the tramway network in reducing the number of direct lines connecting the two end points on the network.

### 3. INSTEAD OF A CONCLUSION

Public urban transport appeared, became part of the city and has been developing with it, with the task of satisfying the mass transport needs of the citizens. Its undoubtedly positive effects in overcoming the physical distances and providing normal functioning of the city were simultaneously accompanied by the occurrence and growth of an entire series of negative effects. The conflicting relation between the public ur-

ban transport and the citizens has been significantly increased, on the other hand, by personal cars.

It is beyond any doubt that the fact of the existence of urban traffic – both individual and public – needs to be accepted as a given necessity. One should also come to terms with the negative effects of traffic on the urban environment. However, negative effects do not necessarily have to be accepted as given values. On the contrary, these may be significantly reduced by well-planned and consistent policy.

This paper has tried to identify the relevant parameters of the relation between the public urban transport and the urban environment, in order to indicate the direction in which social activities should proceed. The mentioned parameters could not have been quantified since it is precisely here that the causes for insufficient attention paid to this problem have to be looked for. The problem of the relation between the public urban transport of Zagreb and the environment, namely, has not been studied nor evaluated from this aspect yet. However, identification of negative impact of the public urban transport on the rest of the urban environment, on the one hand, and the citizens (primarily passengers) on the other hand, implicitly indicates the measures that could be used to reduce them. The register of measures ranges from the so-called secular ones (construction of the underground railway or completely new systems of the future), which require long-term preparations, high investments and many years of construction, over the so-called mid-term measures, which include measures of traffic regulation, to the so-called short-term and relatively rapidly applicable measures with immediate effects, that do not require high investments, such as measures of transport organization (definition of line network, tariff system, etc.).

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#### SAŽETAK

#### PARAMETRI ODNOSA JAVNOGA GRADSKOG PROMETA I LJUDSKOG OKOLIŠA GRADA S POSEBNIM OSVRTOM NA ZAGREB

*Povijesni razvoj grada i prometa sa sobom neizbježno nosi konfliktni odnos javnog masovnog prometa i gradskog okoliša, bez obzira na to kojim se mjerama i koliko može utjecati na*

promjenu odnosa masovnog i osobnog putničkog prijevoza u gradovima. Očito je, naime, da je jedan od najutjecajnijih čimbenika snižavanja standarda u naseljima i gradovima upravo promet, i to kako masovni tako i osobni. Pri tom su pozitivni učinci prometa u smislu svladavanja prostornih udaljenosti istovremeno praćeni čitavim nizom negativnih utjecaja na ljudski okoliš i čovjeka, s tim da su negativni učinci osobnog automobila na ljudski okoliš grada veći od negativnih učinaka javnog masovnog putničkog prijevoza.

Realan pristup problemu odnosa javnoga gradskog prometa i ljudskog okoliša sastoji se u identificiranju relevantnih parametara toga odnosa te u njihovu objektivnom kvantificiranju i izboru mjera kojima će se negativni utjecaji smanjiti ili spriječiti njihovo nastajanje.

Opće transformacije odnosa grada, okoliša i prometa s jednakom se zakonomjernošću mogu pratiti i u Zagrebu. Ocjene odnosa javnoga gradskog prometa Zagreba prema ostalim elementima gradskog okoliša jednako su tako nepovoljne kao i ocjene njegova odnosa prema stanovnicima grada, bilo da se radi o njima kao pješacima, korisnicima javnog prometa (putnicima) ili pak vozačima osobnih automobila.

Registar mogućnosti mjera kojima se i u Zagrebu može utjecati na popravljivanje stanja kreće se od tzv. sekularnih pa da kratkoročnih mjera. Problem je, međutim, u tome što odnos javnoga gradskog prometa (kao jednog od elemenata gradskog okoliša Zagreba) i čovjeka nije stavljen u fokus interesa nositelja prometne politike grada.

#### KLJUČNE RIJEČI

promet, grad, javni gradski promet, ljudski okoliš

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