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ANALYSIS OF THE TRAFFIC AND TRANSPORTATION SYSTEM IN THE PLANNING PROCESS WITH REFERENCE TO THE EXAMPLE OF SARAJEVO

Keywords
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Transport modes
Urban mobility

Abstract
The oversaturation of the city itself and the problems of the already existing infrastructure, which cannot handle the sudden increase in traffic dynamics and the demands of modern transportation, require a solution that should be preceded by plans. The main goal is to most painlessly resolve conflicts due to various requirements that are imposed, and they cannot be resolved by reconstructing only individual roads, but it is necessary to optimize movement at the level of the entire traffic network. Since finding the optimal solution is very demanding, it is very useful for consultants to clearly define the expertise procedure for the analysis of the traffic-transportation system. On the concrete example of the analysis of the traffic-transportation system in Sarajevo Canton in the urban area of the Canton, aspects of the expertise methodology were analyzed with the aim of defining the best solutions for existing and planned areas, and according to the purpose of the same, defining the relevant traffic parameters for planning.

1. INTRODUCTION

Planning in traffic and transportation is a specific process that determines the necessary capacities to meet the needs of traffic and transportation in the future in a certain planning area. The planning process should be linked to the design processes of traffic systems in order to make the projects more efficient. The planning process is inseparable from the design process. As a result of the planning process, a plan is created, which, depending on the period for which it is adopted, is a relatively static category.

When planning the transport system, it is basically based on the transport needs and the way in which these transport needs are solved. Thus, the flows of goods and passengers, distributed over a certain area in time and transformed into flows of train units, represent a task that the transport system needs to overcome.

Of particular importance is the choice of methodology when preparing expertise that is the basis for planning, which should provide a proposal for resolving conflicts of all types of traffic and transportation in the area covered by the plan.

On the concrete example of the analysis of the traffic and transport system in the Canton of Sarajevo in the urban area of the Canton, with a special emphasis on the narrower urban area of Sarajevo, aspects of the methodology of expertise were analyzed with the aim of defining the best solutions for existing and planned areas, and according to the purpose of the same, defining the relevant traffic parameters for planning [1-3].

2. SCOPE OF ANALYSIS OF THE TRAFFIC-TRANSPORT SYSTEM

The analysis of the traffic-transportation (transportation) system should be based on the following two basic premises (the premise from which the court starts its reasoning process) [4]:

1. The global transportation system of an area should be viewed as a multimodal system
2. The analysis of the transport system cannot be separated from the analysis of the social, economic and political system of the region.

Therefore, in the analysis of the global transportation system, the following should be observed: All modes of transportation; All elements of the transportation system; All movements through the system including passenger, pedestrian and goods flows from any origin to any destination (traffic); The total journey from the point of origin (source) to the destination (destination) by all means and by all means for each flow separately.

3. BASIC CHARACTERISTICS OF THE TRAFFIC AND TRANSPORTATION SYSTEM ESSENTIAL FOR PLANNING

3.1. Place of traffic and transportation system

Understanding the place of the transportation system in the global system is extremely important for planning. From the aspect of functionality, it can be said that the traffic and transport system is only one of many systems that enable urban areas to exist [5].

Relevant issues of planning the traffic-transportation system in the hierarchy include:

1. What is the relationship of the traffic-transportation system with other hierarchical systems acceptable from the point of view of the community?
2. What is the cause and what is the effect of investment in traffic and transportation in relation to other infrastructure systems important for community development?

3. What are the demands placed on traffic and transportation systems during changes in the urban system?

3.2. Purpose, limits and components of the traffic and transportation system

The purpose of the system according to functioning, observing only the traffic-transportation function, is reflected through mobility and accessibility [4].
Since transportation systems are parts of other systems, planners often establish a system boundary that allows them to focus on key relationships within and across that boundary. The border itself can become an important part of the analysis by exploring entrances, exits and transitions.
Multimodal transport systems consist of numerous components whose interaction becomes a key factor for system efficiency. These components include: System users; Types of transportation; Infrastructure (networks, facilities and services); Intermodal connections; Interest groups.
The challenge for traffic and transportation planning is to ensure coordination and forecasting for all of the above components to function effectively together [6].

3.3. Performance of the traffic system

The definition of a system's service offering is related to its success or efficiency realized on the basis of its performance. With simple systems, it directly depends on the level of service quality: city traffic; city transport (space per passenger); signalized intersections; sidewalks and stairs; unobstructed cycling facilities. In more complex systems, the performance is extended in accordance with the impact of the production of the service of the system on the community and the environment. The performance of the system can be presented as (Table 1) [7].

Table 1. Performance measures for environmental and economic analysis (author)

Measures performance (measure of service) / Roads	Travel speed	Driving time	Delay due to regulation	v/c relationship	Queue length	Space	Delay	Speed	Obstacle	Events	Time spent tracking	Density	Vehicles per day	Interlacing speed	Speed without	Frequency of service	Hours of service	Entry of passengers	Reliability
City streets	+	+	+																
Signalized intersections			+	+															
Unsignalized intersections			+	+	+														
Pedestrians						+	+	+											
Cyclists	+		+						+	+									
Expressways with 2 lanes								+			+								
Expressways with >2 lanes				+				+				+							
Expressway facilities		+						+				+	+						
Basic segments of the expressway				+				+				+							

Measures performance (measure of service) / Roads	Travel speed	Driving time	Delay due to regulation	v/c relationship	Queue length	Space	Delay	Speed	Obstacle	Events	Time spent tracking	Density	Vehicles per day	Interlacing speed	Speed without	Frequency of service	Hours of service	Entry of passengers	Reliability
Interweaving on the expressway												+		+	+				
Ramps and hub ramp								+				+							
Interchange ramp terminals			+																
Public transport																+	+	+	+

3.4 Capacity of the traffic and transportation system

The capacity of the transport system (the flow of people or the flow of vehicles per hour is an important factor in transport planning. The transport policy, which aims to reduce the individual use of vehicles, has led to an increase in the application of capacity utilization measures. The capacity of individual facilities or services may depend on a number of different factors, most often included in the design of facilities or services. [8]

Network and system capacity is directly related to the capacity of the "weakest" link in the network. [9] So, in planning, a lot of attention is paid to improving the flow efficiency or increasing the capacity of the aforementioned bottlenecks. Similar bottlenecks can occur at intersections, city bus stops, cargo terminals and passenger entrance areas.

Terminal capacity can be an important factor in the overall performance of a transportation system [9]. In passenger terminals, capacity can be defined as the volume at which acceptable waiting occurs.

3.5 Traffic system management

A traffic or transportation system is usually planned, designed, built, managed and maintained by organizations and individuals with different goals, mandates, positions and defined problems.

The most important mechanism of feedback to the users of the transport system is the "cost" of travel, determined on the market of the interaction of supply and demand.

A change in the cost of transportation for the user can affect the choice of route, travel time, frequency of travel and connecting trips in the short term. In the long term, these changes could affect urban form through decisions about residential and business locations, car ownership and transportation technology.

Transportation service providers are increasingly using more sophisticated management systems and advanced technologies to provide traffic tracking, monitoring and control. These types of technologies are essential for the efficient

management of the transportation system, so they should be taken into account during the planning process.

4. TRAFFIC PLANNING MODEL

Forecasting traffic and transportation in the city is directly related to forecasting activities in the city. Those activities are e.g. work, shopping, recreation, selected from a set of demand activities. This set contains all city activities that an individual or household could claim and depends on socio-economic characteristics. E.g. the set of household demand activities depends on the size of the household, total income, number of employees, etc. [8]. For the travel forecast, a four-phase sequential-aggregate travel forecast model was used, consisting of phases or steps [4]: Generation of travel; Spatial distribution of travel; Visual distribution of trips - split mode; Load on the road network, i.e. assigning flows to routes.

5. APPLICATION OF THE MODEL IN AREA OF CANTON SARAJEVO

Analyzing the previous research on the road network in Sarajevo Canton according to the described procedure, the following can be distinguished [10-11]:

- The longitudinal shape indicates the need to build roads of greater capacity that will connect the city both longitudinally and along the river with the wider environment, that is, connecting with the network of European roads, an initiative of SEETO (South-East Europe Transport Observatory).

- Longitudinal roads (southern and northern) have not been completed in the area of Sarajevo Canton, so in certain parts of the city, there is a transition from longitudinal to transversal roads, which creates congestion at intersections.

- The lack of construction of primary traffic roads (longitudinal and transversal type) makes it impossible to efficiently connect all areas of the Canton into one unit.

- The discrepancy between the physical condition (dimensions, horizontal and vertical elements and condition of the roadway) and the functional characteristics of the network is also evident.

- Capacity, level of service and operating speeds are unsatisfactory on the largest part of the primary traffic network, so a good connection of several centers in the city cannot be expected.

- Intersections in the road network are mostly built on one level and are equipped with traffic lights. A special problem is the intersections built by longitudinal and transversal roads. Their capacity cannot meet the flows on the approaches to the intersection. Solutions are sought at roundabout intersections, which in certain cases can satisfy expectations for a shorter period. During the reconstruction of intersections on primary routes, it is necessary to analyze the construction of intersections in two levels in order to solve the problem in the long term.

- Road network services in Sarajevo Canton are at a relatively low level, which results in high traffic costs, loss of passenger time, traffic jams and negative impact on the environment.

The capacity of the network in Sarajevo Canton was analyzed on the cross-sections presented in (Figure 2).

Based on the analysis of the public urban passenger transport system in KS, guidelines can be given that should be taken into account during planning:

- It is necessary to optimize the routes of the lines and the location of the stops in accordance with the requirements of passengers and the standard of the maximum walking time to the stop.

- Determine transfer stops and terminals, and arrange them to provide the required level of service.

- Reconstruct the contact network of trolleybuses in parts where necessary.

- The existing public transport system needs to be: popularized; bring closer to passenger requirements; modernize; to optimize the costs incurred during the transportation of passengers.

It is important to point out that traffic parameters and norms for stationary traffic would be more reliable if a policy, plan, law and regulations related to parking in KS were prepared and adopted.

The car-restricted zone policy promotes car-free zones throughout the KS area, especially in the inner centre(s). There must be a regulatory change in the application of car-free zones. Clearly demarcated car-free zones can take the form of a complete and permanent restriction of certain streets and roads.

The offer of parking spaces should be optimized in order to meet demand and ensure the efficiency of management of parking spaces in central and commercial zones.

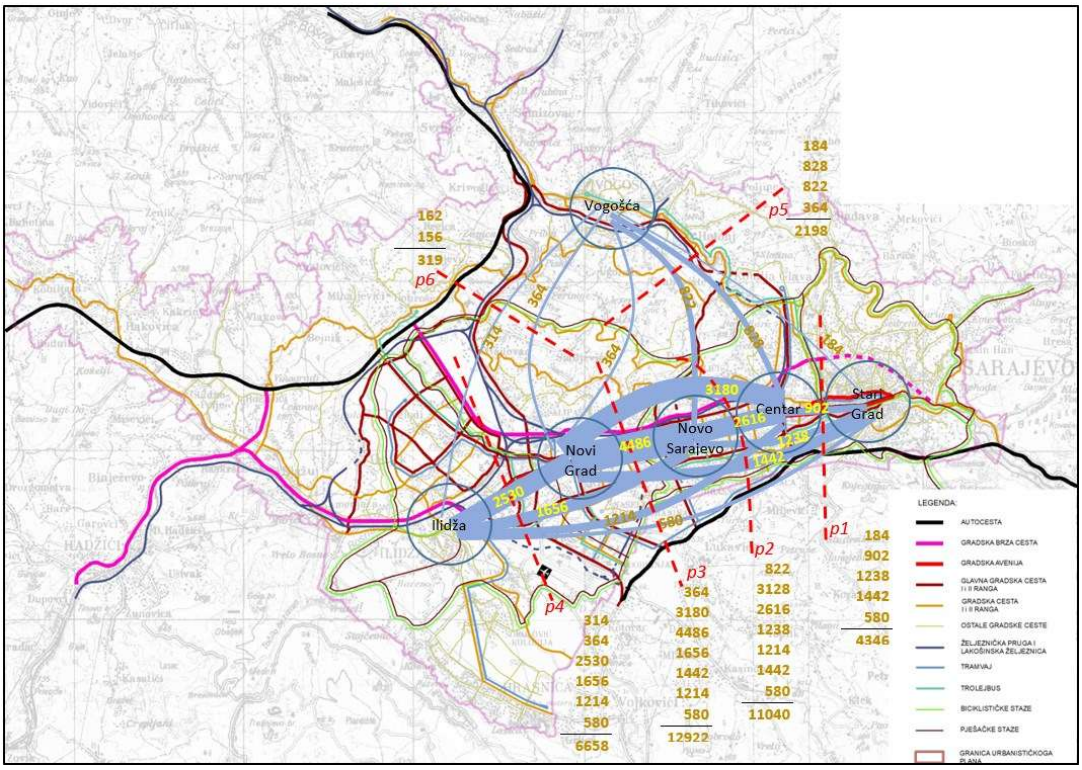

Figure 2. Analysis of the capacity of the road network in Sarajevo Canton

6. CONCLUSION

Planning in urban areas can be successful if all elements of the traffic and transportation system are included in the previous research. In doing so, it is of crucial importance to use the procedure and methods that give the best results of the analysis of the situation and assessment of the traffic and transportation demand, in order to design solutions in the area of the offer of traffic and transportation services.

For example, in the expertise for the preparation of the Urban Plan in Sarajevo, the proposed procedure gave results that lead to the establishment of a balance between demand and supply.

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