Small urban area transportation planning

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Abstract

Transportation planning and modelling of future demands is a challenging process for all transportation engineers. Collecting current network and travel demand data is elementary, but motorization level and population growth as well as physical and regional planning cannot be omitted. The paper describes the process of transportation planning for small urban areas respecting the town specific characteristics and regional growth trends. After data collection and modelling of the current situation, forecast procedures have been developed and future network solutions proposed.
Keywords: transportation planning, transportation modelling, forecast, small urban areas.

1 Introduction

Traffic planning of small urban areas is a comprehensive process which encompasses a number of successive activities directed to maximally efficient organization of traffic flows recognizing the future needs of the considered area. The starting point of every planning process is the analysis of the current state of the traffic system and the satisfaction level of the users' needs. Consequently, the nominal plan of the future design of the system is defined, followed by the feasibility study of the proposed solution (terrain inspection, solving of property relations, analysis of the availability of the necessary resources, etc.). If the feasibility study confirms the nominal plan, the system design process itself, the implementation of the solution and monitoring of the system growth can be started.

The paper provides the theoretical and practical study of the planning process and the performed activities for the planning needs of the traffic system in small urban areas.

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2 Data collection

Reliable recognition of the current situation in the traffic system, its satisfaction level of the users' needs and the level of quality of service represent the starting points for every form of analysis and planning of the future traffic organization. The approach to the data collection process depends on a number of objective factors such as the structure of the existing network, sizes of the analyzed area, etc. as well as on the subjective characteristics which are not in compliance with the planners' desires (available labour, resources, equipment, etc.). Therefore, it is of great importance to select among a number of available methods the one which will describe as credibly as possible the actual situation of the system, recognising both the tendencies and the current restrictions, and present a high-quality input into the modelling process using modern programming tools. The overview of data collection methods based on [1] is presented in Figure 1.

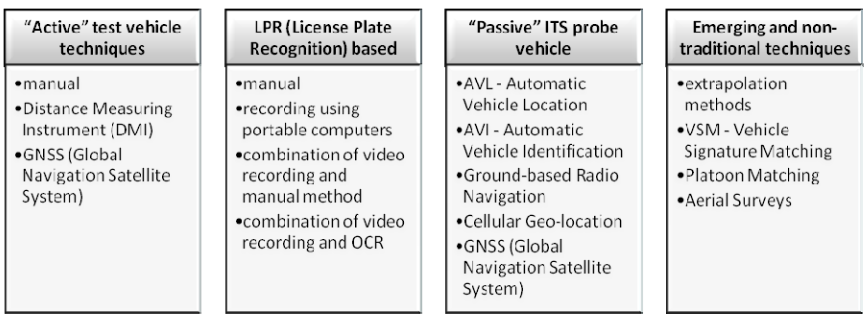

Figure 1: Data collection techniques.

The starting point is certainly the analysis of available databases and the existing documentation in order to determine which relevant data are missing and/or whether their upgrade/updating is necessary. Also, by analyzing the existing data an insight is obtained about the past undertaken interventions in the infrastructure and organization of the traffic system as well as their consequences, i.e. one may learn from the past system situation in order to achieve maximal effects in the next steps. After processing the existing data and the extraction of those necessary for further analysis (digital map of the existing network, urban and physical plan of the area, necessary demographic data) the traffic count in six time intervals at relevant locations was carried out in order to obtain an insight into the traffic flow distribution [2]. The considered traffic entities have been classified in five categories. Apart from the traffic count the occupation of parking places in the considered area has been analyzed.

Since traffic models are devised for future periods, the data collection phase should take into consideration also the data necessary for forecasting the future traffic load. The forecasts that refer to the traffic depend on the development policy of a certain country, physical planning, geographical position and the economic development. This shows that a large number of factors affect the future traffic demand, many of which are difficult to forecast. The traffic planner's task is to focus on the factors which have major influence and which can be forecast, and basically they are represented by the population, social and economic development, with the level of employment and the income amount, land-use and motorization level.

3 Traffic planning in small urban area

In the traffic planning context it is impossible to isolate a minor urban environment and to consider it isolated from the area which surrounds it. It is possible to identify three types of areas that contain smaller urban areas, and are considered in this paper. The first type is the Basic Rural Area and refers to the areas with dispersed cities of 5000 or more inhabitants. The population is mainly engaged in agricultural activities and the local traffic circumstances are in accordance with this. In such areas the population trend is constant or in slight decline, and there is a marked drain of young population due to education or employment. Because of the declining population trend the investments into the traffic infrastructure are reduced as well, i.e. the aim is to preserve the existing condition. Such areas are rarely or very poorly connected by other transport modes, apart from road, and there is high percentage of heavy cargo vehicles that significantly affect the routes conditions. Consequently, the mentioned traffic planning in such areas has to focus on maintaining the existing infrastructure and other traffic facilities, as well as on stimulating the economic growth of the region.

The second type is the Developed Rural Area which is characterized by several smaller cities with 5000 or more inhabitants, and urban areas of a minimum of 50,000 inhabitants. In urban areas the population is mainly employed in industry or servicing activities, whereas the rest of the region is mainly engaged in agricultural activities. The population trend is mainly stable or has an intention of growth and an essential characteristic of such areas is that they are mainly oriented to economic development. The traffic system is oriented to interconnection of the places within the region or county. The traffic planning in such areas has to be oriented to the planning in the inhabited areas, connecting of these places i.e. planning at the regional level, but one should take into consideration also the traffic planning at the level of the country itself although the latter has minor influence on the area traffic system itself. One of the essential characteristics of such areas is either the lack of or relatively poor system of public urban transit, but one should note the existence of public transport that connects individual inhabited areas.

The third type is the Urban Boundary Rural Area which usually borders on large urban areas and is characterized by the population growth as well as the economic development. The traffic system is directed to the connection with big urban areas. Apart from the traffic circumstances at the local and regional level, the traffic planning of such areas is influenced also by the traffic planning at the state level. In such areas there is mainly some form of public urban transport, but the emphasis is on public transport that connects big areas with the small ones.

In big urban centres the traffic planning is somewhat differently oriented than in the mentioned types of areas characterized by smaller cities. The population in big cities is much more mobile, i.e. there is greater demand for travel. The reasons for such trips lie mainly in business, recreation, shopping, and other activities of administrative or personal nature. The citizens can use several transport methods such as public urban transport (tram, bus, rail, metro) and, of course, travelling by passenger cars. Traffic planning is oriented to the solving of bottlenecks in the existing infrastructural networks and negative consequences (longer travel times, negative impact on the environment) and to the extension of the infrastructural networks of various traffic modes, all with the aim of increasing the mobility of people.

In the economic sense the Bjelovar-Bilogora County is the strongest agricultural county in the Republic of Croatia. It is divided into 5 cities and 18 districts. The county capital is Bjelovar which has about 42,000 inhabitants whereas the number of inhabitants in other county cities ranges between 5000 and 15000. According to their characteristics the mentioned county belongs to the type of the Developed Rural Area. For the needs of this paper a traffic model of the city of Čazma was developed as an example of a small urban area. The city of Čazma is 30km away from Bjelovar and 60km from Zagreb which is the capital of the Republic of Croatia. In the context of traffic planning these two big centres have a significant influence on the traffic situation of the city and its surroundings, but it should be mentioned that no major European and state traffic routes pass close to Čazma. During the historical development of the city, the road traffic expansion was not accompanied by adequate infrastructural construction. Two state roads, D-26 and D-43 pass through the very centre of the city, and they carry most of the traffic load. The key problem is the transit traffic which passes through the city centre including a high share of heavy cargo vehicles and buses.

4 Modelling of the current state

The considered input data used in modelling of the current state:

- infrastructural characteristics of the current traffic network (route category, direction, number of lanes, permitted turns) (Figure 2);
- data on traffic counts;
- demographic analysis (the average size of households in the considered area is 3.05 members, whereas it is somewhat lower in the centre of the city and amounts to 2.99 [3]) (Figure 3–4)
- organizational structure of the considered area (residential, business and servicing parts of the city);
- conflicting zones of different transport modes …

The result of merging relevant data and modelling of the current distribution of the traffic flows in the observed area is given in Figure 5.

Figure 2: Main traffic network.

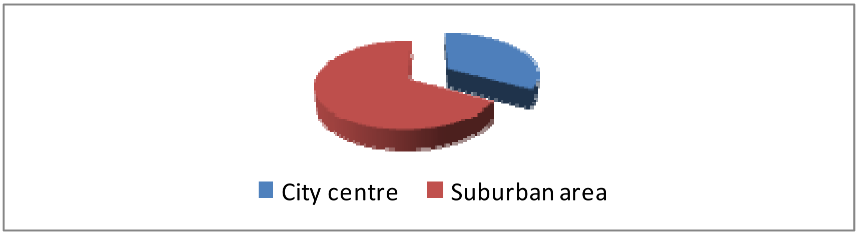

Figure 3: Geographic distribution of population.

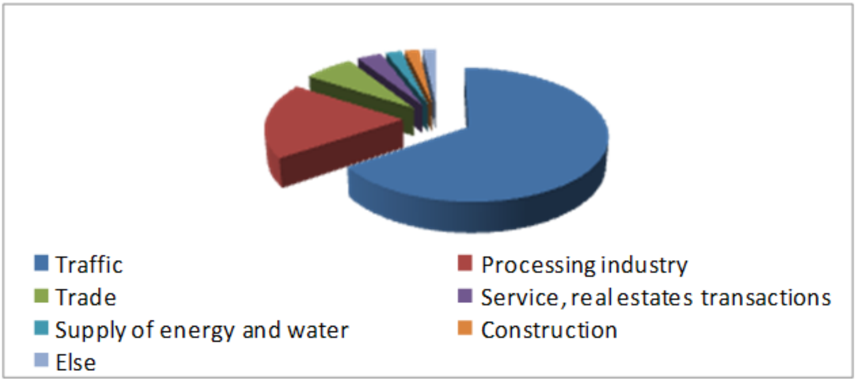

Figure 4: Structure of activities.

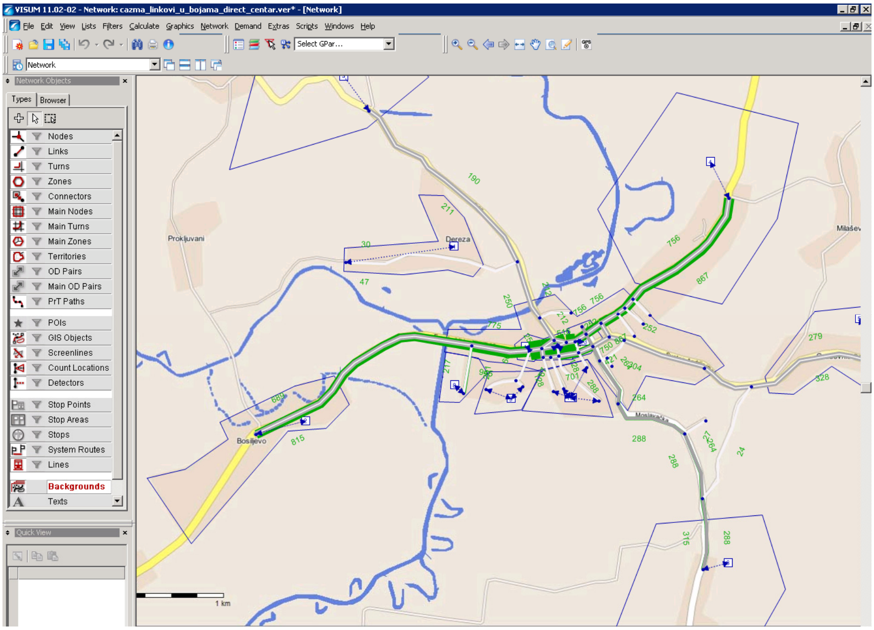

Figure 5: Modelling of the current state.

5 Forecasting of the future values

In evaluating the future condition of traffic flows attention should be paid to general factors which affect the development of traffic flows in small urban areas described in the section on traffic planning in small urban areas. However, one should also keep in mind the special characteristics of every environment that cannot be encompassed by general models derived at the theoretical level.

From the demographic data, especially the data on the number of inhabitants (Figure 6), data on the structure of activities (Figure 4), levels of motorization (Figure 7), and share of individual vehicle categories in total traffic flows (Figure 8), as well as knowing the traffic demand in the considered area, it is possible to make decisions on future loads of traffic networks. Also, knowing the cause-effect relations among certain values and placing them into a specific context of the considered environment it is possible to maximize the effects and increase the efficiency of the proposed measures in order to raise the level of the provided services.

Considering the flow in the number of citizens in the narrow urban, as well as in the total studied area over the past period, and respecting the prospects of small urban areas (Section 3) in relation to their geographic and social-economic position the future increase in the number of inhabitants at both levels is forecast (Figure 6).

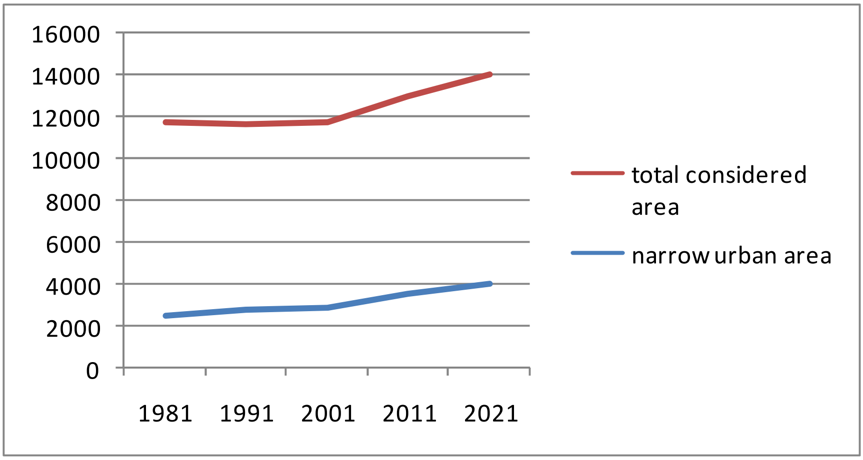

Figure 6: Fluctuation of the number of inhabitants.

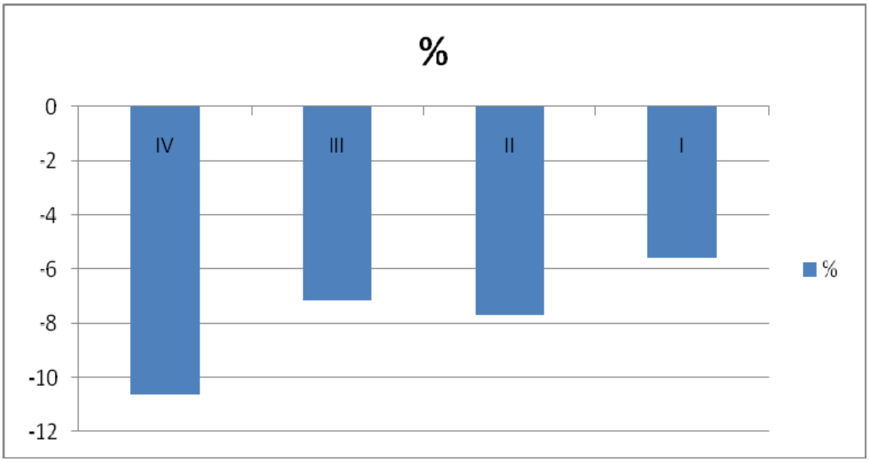

Figure 7: Motorization levels.

Considering the level of motorization through the past period one can see that it is in constant decline (Figure 7). Although the percentage of reducing the level of motorization in the past years is somewhat lower compared to the previous year (between 8% and 5.5%) than in the years in even farther past (> 10%) and its further decline is expected. This increase in the number of vehicles compared to the number of citizens will have a multiplicative effect on the increase of traffic network load.

The share of heavy cargo vehicles on traffic routes (Figure 8) has been obtained from the traffic count data. Taking into consideration the distribution of activities and the fact that one of the biggest transport companies in the region

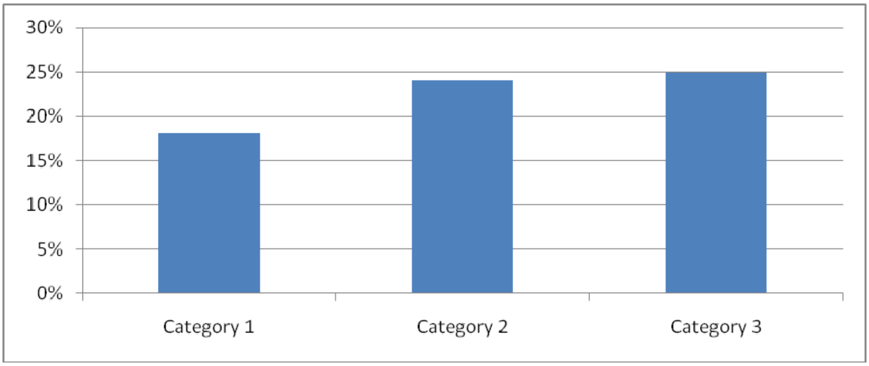

Figure 8: Share of heavy motor vehicles on traffic routes of different categories.

has its base in the considered city, as well as the structure of the surrounding rural areas indicate the reason for such big percentages. Understandably, the share of heavy vehicles is inversely proportional to the category level of the considered traffic route.

6 Proposal of new solutions

For establishing the optimal organization and the function of traffic system it is necessary to achieve a balance between the traffic supply and demand both in the transport by individual transport means as well as in public transport. Furthermore, it is necessary to increase the safety of all the traffic system participants and to implement the measures to protect the environment against harmful impact generated by traffic. The mentioned objectives need to be implemented respecting the priorities of the traffic system at the local, regional, and government level as well as available financial means.

When studying the traffic system in the urban area the following problems have been noted:

- transit traffic passes through the city centre,
- large share of cargo traffic;
- absence of cycling paths;
- absence of pedestrian walkways.

The construction of new traffic routes is a very expensive solution of the traffic problems, but sometimes it is necessary in case no adequate infrastructure is available. Before making the decision on the construction of new traffic routes it is necessary to study the organizational solutions of the traffic systems and how it would affect it. Since Čazma is an intersection of two state roads it is necessary to construct a by-pass in order to remove the transit traffic from the city centre. The by-pass route would pass along the south peripheral parts of the city as presented in figure 9.

The mentioned solution would remove a part of the cargo transport from the city centre. The next step is the actualization of public transport. In Čazma there is a public transport system which connects the suburban areas and the surrounding cities. The largest number of lines connects Čazma with the county centre and the capital of the Republic of Croatia. The problem of the existing public transport is the position of the bus stops and the schedule which is often subject to changes and fails to be in compliance with the current transport demand, primarily regarding its time aspect. For a more efficient public transport system it is necessary to perform a research in order to adjust the schedule and the position of stops to the users' requirements, but this is a topic of another study and will not be discussed in detail in this paper.

There are no cycling and pedestrian paths in Čazma, which is a significant drawback for a city of that size since a part of transport could use precisely these traffic modes. This has been included in the traffic model and the results of the traffic load are presented in figure 9.

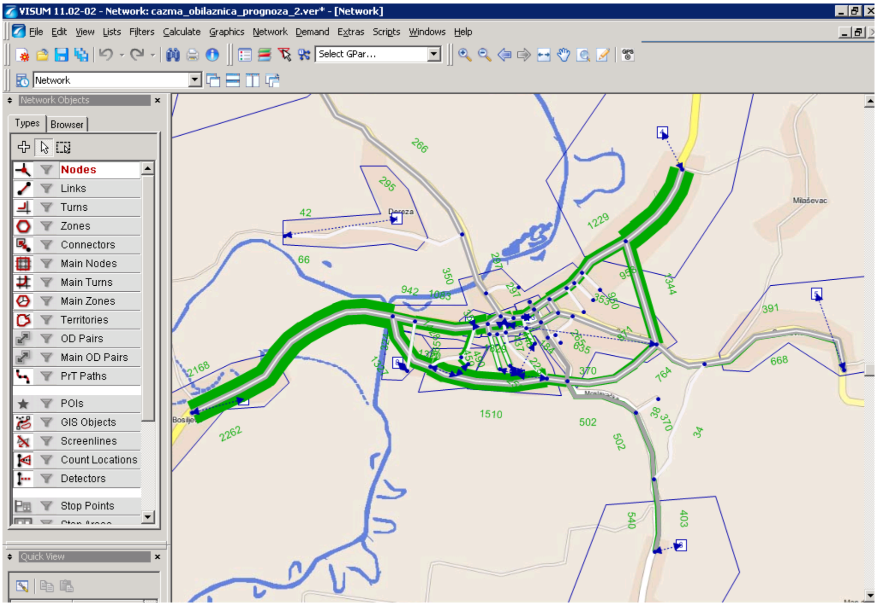

Figure 9: Traffic load of the new model.

7 Conclusion

Traffic represents a complex system with a large number of dynamic and statistic elements combined in a purposeful whole with the aim of performing transport/transfer of traffic entities according to pre-defined rules.

In order to improve the functioning of such a complex system it is necessary to continuously enhance the organizational structure of the system along with studying, developing and implementing updated scientific solutions. One of essential elements in traffic system planning is the balance between placing the considered area into a wider context, at a higher level of abstraction, in order to be able to direct further flow of planning to designs applicable for the given theoretical category of settlements and the ‘non-stereotype’ specific characteristic of every studied area which has a number of specific traffic features, characteristic for the respective area only and the restrictions which define the fields of possible solutions.

In every planning procedure the applicability of forecasting methods and of future system condition modelling play an important role. Knowing the wider spectrum of methods, their advantages and restrictions as well as the applicability to the necessary traffic variables determine to a large extent the efficiency of the entire process.

And last, but no less important is the quality of input data. The very selection of the input variables needs to be the result of carefully analyzed relations among variables. Maximal efficiency is achieved by the selection of variables that are the biggest carriers of variability of the objective function. The application of the correlation and/or factor analysis can largely narrow down the selection of variables and increase the efficiency of the model as well as rationalize the necessary resources, because it is known that the process of data collection (especially the on-site one) often requires substantial means.

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