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# THE BENEFITS OF THE INTEGRATED DEVELOPMENT OF SOFIA'S PUBLIC TRANSPORT

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***Abstract***

*One of the most important goals regarding the management and organization of public transport in the city of Sofia, in the context of building stable urban mobility, is the effective coordination of the functioning of individual transport types, in accordance with the capital's growth and citizens' transport needs. On top of improving the quality of freights and reducing travel time and passengers' transport fatigue, integrated development is also a prerequisite for the optimal use of vehicles along routes. The paper outlines the main guidelines and indicates specific technical and organizational measures aimed at providing more effective coordination of the functioning of individual types of public transport in the city of Sofia. The main benefits of that are indicated, as well as the perspectives for its future stable development which are summarized in the paper's concluding part.*

***Keywords:*** *the benefits of the integrated development of public transport*
***JEL Codes:*** *R40, R41, R49*

## INTRODUCTION

Despite the multitude of problems regarding the organization of Sofia's transport system, as well as the overall lowered quality of the services that the capital's public transport provides, the majority of citizens still use urban transport as the primary means of transportation, which puts the necessity for improving its quality and reducing travel time in particular on the agenda. This can be accomplished through the integrated functioning of public transport which, on one hand, will also guarantee easier and timely access to work places and services for all of Sofia's residents, and minimize traffic jams, air pollution and energy consumption, and generally improve the quality of life in the capital, on the other. The integrated approach in the organization of public transport and the implementation of effective measures and actions for improving the quality of transport services need to become part of the strategy for the development of

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the urban transport system. It should also be based on the good development practices and integrated approach in public transport management in other European cities. The effective coordination of the functioning of individual types of public transport depends on establishing optimal connections, reducing travel time and guaranteeing security, speed, comfort and urban mobility. This is the only way to fully satisfy citizens' travel needs and improve the quality of life in the city.

## GUIDELINES FOR IMPROVING THE ORGANIZATION OF PUBLIC TRANSPORT TRAFFIC IN THE CITY OF SOFIA

### *Improving the Configuration and Density of the Transport Network*

The conveniences of using urban passenger transport are largely determined from the configuration of the transport network. Sofia's transport lines need to follow the directions of the main passenger flows. The observation of this requirement allows the provision of citizens' transport needs with a minimum mileage of mass urban passenger transport vehicles, while simultaneously reducing travel time from the center to the city's outlying neighborhoods. The transport lines and the stops that service them are the main elements of Sofia's transport network. The transport lines in Sofia need to follow the directions of the main passenger flows. The observation of this requirement allows the provision of citizens' transport needs with a minimum mileage of mass urban passenger transport vehicles, while simultaneously reducing travel time from the center to the city's outlying neighborhoods.

An important guideline for perfecting the transport servicing of the city's population is determining the optimal density of the city's transport network. Said density can be determined from the total travel time, which includes: walking to the starting stop, waiting for the vehicle at the stop, the vehicle's travel time, and walking from the designated stop to the target destination. The indicated components, which determine the total travel time, are largely influenced by the qualities of the transport network. When the density is higher, the walks are shorter. Simultaneously, waiting time at the stops, which is considered equal to half the travel interval of vehicles, can be longer. When the transport network's density becomes too excessive, the travel interval becomes longer, which also increases the waiting time at the starting stop. The transport network's density can be considered optimal when the total travel time's values are minimal. When the length of the transport network is insufficient, the two walks become longer.

When the density is higher, waiting time at the stops – and travel time in individual cases – becomes longer.

### *Increasing the Transmissivity of the Transport Network*

The transmissivity of the transport network has a direct influence on the freight capability of urban passenger transport, hence why increasing it is one of the main goals regarding the improvement of traffic organization. The more rational use of urban passenger transport vehicles along separate routes involves the issue of increasing the transmissivity of transport junctions (intersections), stops and the transport network. In that regard, it is possible to undertake a number of actions regarding the realization of a significant social effect. Higher transmissivity of intersections can be achieved as a result of improving traffic light cycles, i.e. making the duration of the green signal longer along the lines that urban passenger transport routes pass through; perfecting the organization of vehicle passage; widening intersections' cross-points and allocating independent lanes for right turns; maintaining the good condition of all cross-points at intersections, etc. Increasing the transmissivity of stops along separate routes is especially important for the more rational use of urban passenger transport vehicles, which can be achieved at the expense of:

- Deconcentrating stops with high traffic frequencies and more significant passenger turnovers;
- Separating public transport stops from transport flow accumulation areas around intersections;
- Making stop grounds longer in order to widen the front for passenger boarding and disembarkation at points with comparatively large passenger turnovers;
- Prohibiting the stay of other types of transport in zones which are in close proximity to stops, so as not to impede or delay urban passenger transport vehicles from stopping and departing;
- Maintaining the excellent condition of the road cover in the positioning areas of stops, etc.

### *Selecting a Rational Route System*

The selection of a rational route system is one of the most important questions which help reduce citizens' travel time and upon which the quality of offered transport services depends. The direction and outline of urban passenger

transport routes are determined by factors such as: structure and outline of the city's street and transport networks; direction of passenger flows between separate urban regions; transmissivity of the transport network and separate intersections, etc. Tram and trolley transport routes can only be set up along directions with established rail-tracks and contact networks. The directions of bus routes have more possibilities for alteration, thanks to which routes that connect the primary points between which the most significant in terms of volume passenger freights occur along the shortest possible distance can be organized. From a practical perspective, it is appropriate that the development of routes be preceded by the study of passenger flows along the main directions in the city. The Thalonic method is implemented far too frequently for that purpose; however, it provides data for passenger flows along separate transport network sections. As a result of the study of passenger flows, the necessary route correction can be substantiated; however, it usually boils down to guaranteeing urban passenger freights along the busiest sections of the transport network. In cities where passenger flows are not studied, the correction of existing routes and the discovery of new ones are undertaken after the necessary data about excessively busy or insufficiently busy separate route sections from agencies involved in the commissioning of transport is received. In that regard, incoming written demands from citizens can be used as well.

### *Increasing the Speed of Transport Vehicles*

The main factor for increasing the speed of transport vehicles in the city is the organization of high-speed transport. This necessity is determined as a result of the possible saving of travel time. The possibility for using high-speed types of transport depends on the density of the transport network, as well as the traversed distances. If the distribution of passengers along the traversed distance, under a certain density of the high-speed transport network, is known, the number of runs carried out by high-speed transport can also be determined. The organization of high-speed passenger transport lines is only appropriate under the condition that the passenger flow is strong enough to provide a certain degree of filling-up and traffic frequency of transport vehicles. Larger intervals in the traffic of high-speed transport vehicles increase waiting time at stops, meaning that the total amount of time spent on traveling can exceed travel time with high-speed transport as a result.

High-speed transport in Sofia is represented by the subway, whose average speed is 38,84 km/h; for reference, the average speed of buses and trams in the

city respectively is 19,4 and 12,7 km/h. With its high freight capacity of 50 000 passengers per hour, the underground transport provides effective, fast and safe travel for citizens and visitors alike, acting as an alternative to a significant portion of Sofia's ground transport. With this type of transport, traveling from the city's periphery to the city's center can take up between 15 and 20 minutes, whereas with ground transport it could take hours and most likely a couple of transfers. Thus, the capital's subway system completely fits in with the European vision for developing intelligent, environmentally friendly and integrated transport.

### *Rationalizing the Operative Management of the Freight Process*

The purpose of the operative management of the freight process is to provide regularity in the traffic of urban passenger transport vehicles first and foremost. Traffic regularity is one of the main qualitative indicators for the functioning of passenger transport. Vehicle traffic along a certain route is considered regular when the following conditions are present:

- All vehicles depart from the route's starting point at the time established in the schedule;
- Equal traffic intervals for each individual stop are provided;
- All vehicles arrive at the route's final point in accordance with the established schedule.

Traffic regularity can be guaranteed when all runs planned in the route schedule are fully (100%) executed and all drivers are punctual when it comes to observing the schedule. A run is considered regular if the vehicle driver departs from the starting point precisely according to the schedule, passes through individual stops in accordance with the schedule (with no more than 1 minute of diversion) and arrives at the final point at the precise time established in the schedule. Runs that divert excessively from the schedule are considered irregular. On separate occasions, traffic irregularities could be due to objective reasons: vehicles being taken out of commission due to damage, hold-ups at railway crossings and intersections, etc. However, practice in separate cities shows that traffic irregularity more often than not is due to subjective reasons, especially unsatisfactory organization of the freight process, flaws in the operative management of passenger freights, declining driver discipline, etc.

## THE BENEFITS OF THE INTEGRATED DEVELOPMENT OF INDIVIDUAL TYPES OF PUBLIC TRANSPORT

In recent years, due to the increased number of travel necessities, larger European cities and all capitals, including Sofia, have been facing transport and traffic-related problems. The question of how to increase mobility while simultaneously reducing traffic jams, accidents and pollution is a common challenge for the entirety of Europe.

The urban passenger transport development policy holds a great significance for the EU. An effectively coordinated and high-quality public transport could make significant contributions toward reaching the community's outlined goals and achieving stable urban mobility in major cities. The success of the policies and their goals – for instance, the efficacy of the EU's transport system, the socio-economic objectives, energy dependency and climate changes – largely depend on the actions and undertaking of specific measures by national, regional and local authorities.

The effective coordination of the functioning of individual types of public transport in Sofia and improving its quality would be beneficial for present and future users alike. When the city's public transport becomes more convenient, more suitable and more understandable for everyone, the number of passengers who prefer it will grow, as will the number of people with disabilities and elderly people who will use it and become more socially active. The benefits of the intergrated development of the capital's public transport will be multilateral. First and foremost, the city's image will be improved; the capital will have a new vision – one of an innovative and future-oriented European city. The quality of life will be improved – the city will carry an emotional charge, involving the better public spaces, as well as safety for children. Urban mobility and access to urban zones and services will be improved. The achievement of better environmental parameters such as quality of air, noise and climate changes will improve the population's health status and reduce healthcare expenses.

## RECOMMENDATIONS FOR EFFECTIVE INTEGRATED DEVELOPMENT OF PUBLIC TRANSPORT IN THE CITY OF SOFIA

Effective management should be comprised of building optimal connections and high level of coordination between various types of urban transport, guaranteeing security, speed, comfort and stable mobility. The extremely urgent gradual reorganization of the tram and trolley transport

networks as the most environmentally friendly types of ground transport is crucial to the effective management and organization of the capital's urban transport. The goal of this restructuring should be adapting and integrating these types of transport to the available and pending design-basis subway lines. As the largest environmental pollutant, bus transport should service areas and connect zones that are not covered by trams, trolleys or the subway. Coordination in the functioning of various types of passenger transport can be achieved only under the condition that the city's route system is rationalized. This is determined by the circumstance that the routes of various types of passenger transport have points of contact, even concurrent areas. Sofia's subway system needs to become a leading and community-defining mode of transportation for large groups of people over relatively long distances due to its undeniable techno-economic characteristics such as environmental friendliness, high speed, large passenger capacity and effectiveness. The main goal of the future development of Sofia's public transport should be the creation of stable urban mobility through integrated development of individual types of transport, optimized ground transport route network in accordance with the new subway routes, and changes in the demand for transport services. A unified strategy for development should be developed, based on existing normative documents and conditions, as well as available and potential sources of funding; a clear and preliminarily outlined perspective for development should also be presented.

## CONCLUSION

The effective integration of the functioning of various types of public transport suggests the functioning of high-quality and stable urban passenger transport which will provide opportunities for attracting more people and fully satisfying their urban travel needs, thus reducing citizens's dependence on their automobiles, with all the resulting benefits for the environment. The quality of life for people with limited mobility and people who live in regions which have not been connected to the urban transport network in the past will improve significantly. Easier access to work places and services for all citizens will be guaranteed; safety and security during travel will be improved, as will the quality and comfort of freights, simultaneously reducing traffic jams, greenhouse effects and energy consumption. On the whole, the urban environment's appeal will be enhanced, and, through the high-quality services they offer, public transport enterprises will successfully convince citizens to use public transport, familiarizing them with its social effects.

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