

## OPTIONS OF TRANSPORT FOR KOSICE'S SURROUNDING IN NONSTANDARD TIMES

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**Abstract:** The contribution deals with a design of effective way to ensure the traffic in the Kosice-surroundings district even in the nonstandard and special times. The current status is analysed by a method of system approach. The current situation in the public transport is analysed according to transport timetables; nonstandard times and time spans of transportation lines are defined. The contribution points to the options to solve and presents a design of division of transport space into three parts that would be secured by separate means of transport. Routes are not firmly defined but they will be created dynamically, according to the needs and number of passengers. Hierarchical structure of the solution of problem of the ensuring of above standard transportation for Kosice - surroundings district is created by the system access for the design itself and solution of the defined problem.

### 1 Introduction

Several companies provide transport in the Kosice - surroundings district, but there also exists time spans in their extensive service, when there is no connection available for transportation from the Kosice city in any village of the district Kosice-surroundings or vice versa. Individual residents of the district are aware of the inadequate transportation lines appearing on individual routes. This problem is global; the lack of transportation lines is not only on one route, but concerns all the villages of the district. Problem time intervals, at which traffic in a given area is not ensured or is ensured only at minimum, will be defined in terms of identification of empty times. These deficiencies give space for business plans. Analysis of the problem of insufficiently ensured transport in the selected area will be required for the utilization of this space. The acquired knowledge is used for the creation of design solutions that will be benefits not only for the population of the district Kosice-surroundings, but also for the company that will take the project. Under the project it is meant security of transport in the nonstandard time intervals in a given area with financial gain for a particular company.

### 2 Transport

Transportation is one of the oldest and basic human activities. In many fields it manifests its importance, eg. for the development of the state, economy, development of population and culture. It plays an important role in the economy and is part of material production. It provides the link between the production spheres and connects geographically separated areas.

Transport, that has personal, useful value for each person, provides certain services to the people. People appreciate the usefulness of provided services according to specific criteria e.g. speed, comfort, economy and according to the purpose, on which transport is used.

Moving of persons and items is not the objective but only a mean, with the exceptions, and transport allows to the person to use and consume of a variety of material and spiritual values, which are the product of social, productive or non-productive activity, or that it is found in nature [1].

### 3 Analysis of the public transport in Kosice – surroundings district

Bus routes are more flexible, in contrast to the train tracks, therefore it is not necessary to fixate to the existing bus connections, but we may also think about potential new routes on the roads of the Kosice-surroundings district.



Figure 1 The structure of the road network in the Kosice – surroundings district

Figure 1 illustrates the structure of the road network in the Kosice-surroundings district. Blue points are for the better clarity - villages connected by just illustrative lines that represent real transportation links. The red point

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represents the centre of Kosice city. The red line shows the outer border of the Kosice-surroundings district.

**3.1 The time span of the public transport**

It is necessary to classified time endowment, i.e. real time in which it is necessary to ensure the transport, for needs of analysis and further processing of information. The main reason, why it is necessary to divide time endowment, is that the individual time slots are not homogeneous, they are distinguished by the different characteristics, which are caused by the external factors. The individual time slots may have different demands on ensuring of transport, on the basis of their characteristics.

The primary classification is division into weekends and working days. The secondary classification is division of one day into single sections according to the needs and frequentness of transportation lines as follows:

- 4:00 - 6:00 early morning lines
- 6:00 - 8:00 morning lines
- 8:00 - 12:00 a.m. lines
- 12:00 - 14:00 lunchtime lines (school)
- 14:00 - 18:00 afternoon lines (modified and schools)
- 18:00 - 20:00 evening lines
- 20:00 - 22:00 late evening lines
- 22:00 - 23:30 late evening lines (modified)
- 23:30 - 4:00 night lines

**3.2 Frequentness of bus connections**

Coverage of transportation links in the daylight hours in areas of Kosice-surroundings district is quite sufficient. Slovak Bus Transport (SAD) solves the situation within the possibilities. It provides transportation for villages to such an extent that the investment costs would be covered. Villages with bigger number of residents or villages situated on main routes to nearby cities have almost ideal situation with high frequented transportation links. Smaller fringe villages, which have a limited number of lines, are worse off, because companies do not invest in ensuring of higher frequented transport for a few passengers.

There are no bus connections for the time interval between 23:30 and 4:00. SAD does not provide night transport for any of villages of the Kosice-surroundings district. Even the train transport does not compensate for the lack of bus connections. Some of the villages do not have even late evening lines after the end of work shifts or some small villages have the problem with transport even at the earlier hours, where afternoon links operates as last.

**Potential travellers for the nonstandard times**

The nonstandard times represent an interval between 11 PM and 4 AM, when there are no regular traffic connections between Kosice and Kosice-surroundings district. Potential travellers are the inhabitants Kosice-surroundings district, who need to be transported from Kosice to their villages and vice versa. For the defined

time interval, the potential travellers are people, who want to get home from the town. The assumption of the inhabitants of Kosice-Surroundings comes from the following facts:

- afternoon shifts in industrial companies,
- night business in restaurants, bars and clubs,
- evening culture events,
- evening sport events,
- individual reasons (emergency drug store visits, late-night visits, etc.).

These factors cause, that people, who are in the town during the late-hours create the need of late-night traffic links. For the inhabitants of Kosice, there exists a night public transport secured by the Transport Company of Kosice. The only type of transport for the inhabitants of Kosice-Surroundings is secured by the taxi services, which represent an irregular and very uneconomic means of transport according to the public transport. A large number of potential travellers would prefer the economic advantages of public transport against the irregular means and if there were traffic connections, that would suit their time schedules, especially within the nonstandard times.

Besides the late-night hours, there exist other types of nonstandard times (which are not applied for the daily intervals, but for some chosen seasons throughout the year) that create more potential travellers.

Percentage of impact factor for the creation of potential passengers

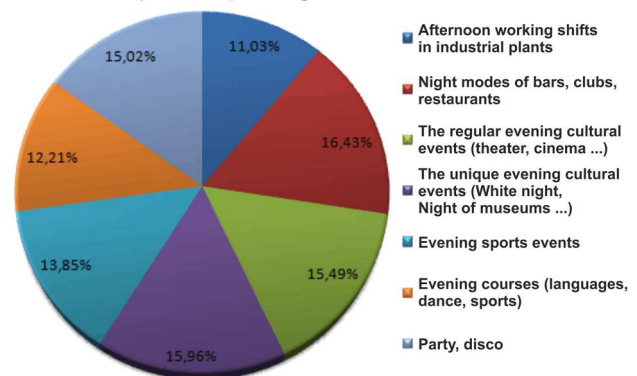


Figure 2 Effect of the factors on the creation of potential travellers

The graph (Figure 2) shows the percentage of effect of individual factors on the creation of potential travellers. From the graph applies, that the factors have rather the same effect of the creation of the potential travellers. Besides this detection, it is possible to point of one of the factors and set a significant conclusion. All of the factors besides special evening events occur regularly, therefore the traffic connections for special evening events will be treated as second-grade problems. The primary problem will be to secure the transport within the regular uncovered time intervals.

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**4 Transport suggestion – section model**

The main principle of the section model consists of the division of Kosice-surroundings district into smaller areas, for which the transport will be provided individually. These areas will be coupled with the means of transport of the needed capacity according to the potential of the individual areas. The times will also be fixed in order to fix the customer to a set location. In this case, there is no need to plan and manage the routes, because those will be reduced for the individual areas.

To divide the bigger units into smaller areas, there are several methods: Clarke-Wright method, closest neighbour method, method of distribution potentials, shot-beam method. For this particular case, it is necessary to choose the method that can be applied besides the giant number of villages within the area, which also represents a lot of input information for some of the methods.

The division of the Kosice-surroundings district, which consist of 112 villages and 2 towns, will be accomplished by the simplified method of distribution potentials, which is simplified for a larger number of elements [2]. The simplification of the method is based on the visual solution. Other places are not assigned to the place with the biggest potential according to the values of the attainability time – *CaDos* (time of radius - *CaDos*), but according to the visual assignment, with the help of a map. The distribution potential of the villages in the Kosice-surroundings district is set according to 2 criteria; number of inhabitants and the distance from Kosice. The distribution potential  $DP$  (1) is calculated flowingly:

$$DP = NI \times 1/dis \quad (1)$$

$NI$  – Number of Inhabitants

$dis$  – distance from Kosice

The inverse value of the distance is used because of the character of the distance, the bigger it is, and the worse is the distribution potential. The table 1 shows 10 places with the worst distribution potential.

Table 1 10 villages of Kosice – surroundings district with the biggest distribution potential

VILLAGE	Number of inhabitants	Distance from KE [km]	potential
Valaliky	4020	11	365
Moldava nad Bodvou	10142	30,7	330
Čaňa	5195	17,5	297
Družstevná pri Hornáde	2428	11,7	208
Sady nad Torysou	1785	8,7	205
Rozhanovce	2226	11,5	194
Veľká Ida	3218	18,9	170
Kecerovce	2989	21,9	136

Kosické Oľšany	1222	9,5	129
Geča	1556	12,4	125

The villages with the biggest distribution potential are assigned with other villages visually. The criterion was the road between the two places that should be the shortest. The goal of the visual assignment was to divide the area into smaller sections, which would have the smallest average distance from Kosice and also to create sections that would have the biggest number of possible customers. The visual assignment divided the area into three sections (Figure 3).

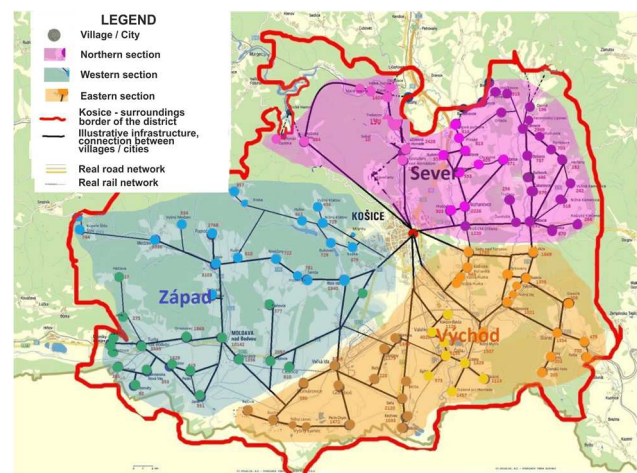


Figure 3 Sections defined by the visual assignment according to the method of distribution potentials

**4.1 Definition of the routes for the nonstandard times**

The individual sections consist of the villages with the total of 115 203 inhabitants and the average distance from Kosice is 22,8 km. The table 2 represents the basic data about the defined sections; East, West and North. Each section contains villages, which have one utility vehicle. The driver sells the ticket for individual destinations, while the destinations are automatically uploaded into the system and saved into the GPS, which sets the most appropriate route to the particular section. But, such a route will be a lot longer and will take much more time than the regular daily links, because the vehicle will turn to the villages that are not on the main route. The mileage will be individual for each route, depending on the demand.



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Table 2 Characteristics of the defined sections

Sections	Number of Inhabitants	Average distance [km]	Average dist. potential	Number of potential customers	MAX km from Kosice	Number of villages within the section
West	42 158	29,4	45,3	54,2	46,8	36
East	45 397	20	67	58,3	32,6	37
North	27 648	19	48,3	35,5	29,7	41

The section model requires three large-capacity vehicles, one for each route. The bus Arway 12,8m is suitable for the sections East and West with the number of seats being 56. For the section North, the most suitable vehicle is Mercedes Picardo SLM with the capacity of 29 seats and 7 places for standing + the driver. The figure 4 shows the vehicles for the suggested section model.



Figure 4 Vehicles for the suggested section model: Arway 12,8m [3], Mercedes Picardo SLM [4]

### Conclusions

The analytical part defined the times, within which the public transport is not provided. Then, it was found out, that there exists a significant interest of the public for extra transport links within the area of (Kosice-surroundings). The aim was not only to create a solution for the nonstandard times, but also to create the suggestion, that would be economically appropriate for the relevant realizing company. The suggestions contain the characteristic principles themselves, together with the suggested routes, pre-set times of transports and the possible car park. According to the unstable input parameter of the project realization, it is possible to use

the interactive budget calculator that allows to us adjust the suggestions to the requirements of the company and actual market. The section model is considered to be a better variant for the solution of the problem and its practical application.

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### Review process

Single-blind peer reviewed process by two reviewers.