INTEGRATION OF DATA FOR THE DEFINITION OF BI-LEVEL OPTIMIZATION PROBLEM IN INFORMATION SERVICE

PhD Pavlova K. T., PhD Vatchova B. E., PhD Paunova E. N., prof. Stoilova K.

Institute of Information and Communication Technologies, Sofia 1113, e-mail: Kristina@hsi.iccs.bas.bg, boriana.vatchova@gmail.com, eli_np@hsi.iccs.bas.bg , k.stoilova@hsi.iccs.bas.bg

Abstract: *The research part of the survey includes defining and determination the transport capacity in transportation graph where the potential of railway and bus transport in Bulgaria is rated.*

Keywords: NETWORK DESIGN, FLOW CAPACITY

1. Introduction

The paper concerns a practical problem for the estimation of needed data for the definition of an optimization problem, which is intended to be incorporated in the functionality of a web service [8]. The optimization problem is intended to be in a form of bi-0level one. This form allows to be achieved optimal solutions under more than one goal function and to respect increased number of constraint.[1,2]

The definition of the bi-level lacks of real data, which have to be defined by indirect assessments and calculations [4] . this paper makes an illustration for the indirect evaluation of data, needed for the definition of a bi-level optimization problem. Such an approach can be applied for wide real cases, especially for information services, where the estimation real data is not always available.

The paper applies its approach on transportation network for the estimation of the throughput of links. It has been given examples how to perform computational estimations for the throughput and links capacities, in a transportation graph. The transportation graph was established by taking into consideration two types of transportation: buses and railways. These throughputs will be used in bi-level hierarchical task for intensification of the railway transportation system. The approach is intended for implementation in information services, which support network of information flows.

2. Quantitative evaluation of the passenger throughput for transportation of the links in graph

The capacity of the throughput for separated links at the graph has to be evaluated and defined. One realistic approach for throughput links in the network is to be used data for the passenger flows which are defined using selling tickets for given direction. Unfortunately, the data are not available because there is no information system for selling tickets of the railway transport for entire country. Another limitation is missing data for a passenger flow form the private bus companies (coaches).

Because of limitation of the size and type of the output data for working regime using integrated transportation system, there are evaluated the throughput capacity for each link of the graph. These throughputs capacities are defined by the link capability and link potential of the graph for maximum passenger flow of the particular link.

The values of the “throughput capacity “ for different type systems are defined as:

- [volume liter/per unit time]- for the systems of fluid transfer;
- [number messages/per unit time] – by the communication systems;
- [number vehicles /per unit time] – for control of public transport.

The presented examples define that, the value [1/unit time] evaluates the value of conditional flow without measurement physical content of the flow. [3, 6]

In this paper is considered that for user criteria of travelling is used “minimum time for travelling” related to the bus and train transport. The criteria “minimum time for travelling” is accounted the distance for travelling and the velocity. The quantitative measurement for evaluation of the journey is accepted the following rule: the longer journey is equivalent of the smaller throughput capacity of the transport in this direction.

It is used the following rule:

Evaluation measurement: longer journey $\Rightarrow$ smaller throughput capacity of the transport in this direction. The quantitative, analytical evaluation for this assessment is introduce the equation:

Throughput capacity (conditional) = 1/unit time.

3. Evaluation of the throughput links capacity of transportation graph presented by railway transportation

Evaluation of the throughput link capacity for the railway is done using the example of the link presented by transportation graph in Sofia-Mezdra direction. There are used data from Sofia-Varna schedule.

The values for transport capacities on each link must be estimated and allocated on the graph. It will be beneficial if these capacities are related with the real public transport flows. Unfortunately such data are not available nighters to rail no to bus carriers. An alternative way for evaluation of the flow capacities on the links is suggested for this research. It has been taking into consideration the duration of the transportation per different links of the network. The customers of transportation services like the small duration of their travels. Thus the smaller time for traveling between couple of nodes gives more preference for traveling on this direction by the customers. Additionally the long travel time is a metric for low capacity for transportation per corresponding link. Thus the transport capacities per link in the network were strongly related with travel time per this link. For the current case it has been chosen simple relation between the travel time tij per link and the flow capacity vij:

$$v_{ij} = 1/ t_{ij} \qquad i,j \varepsilon N \qquad (1)$$

Relation (1) can be complicated, tacking additional consideration, for example cost of travel, but to simplify the numerical evaluations, this research applied simple form of (1).The numerical evaluations use the schedules of the train,fig.1.

Train information

Train	Date	Comment
2601	03/05/2017	

Station/Stop	Arrival	Departure
SOFIA	--	07:00
MEZDRA	08:26	08:27
CHERVEN BRJAG	09:04	09:05
PLEVEN	09:43	09:44
LEVSKI	10:15	10:16
PAVLIKENI	10:30	10:31
GORNA ORJAHOVICA	10:57	11:05
POPOVO	11:52	11:53
TARGOVISHTE	12:22	12:23
SHUMEN	12:54	12:55
SINDEL-RAZPREDELITEL	13:53	13:54
POVELJANOVO	14:02	14:03
VARNA	14:25	--

Coaches

Fig.1. *Schedule of trains Sofia – Varna*

The travel duration for the first two nodes on fig 1, link Sofia- Mezdra , is 1 hour and 26 minutes (86 minutes, from 7:00 till 8:26). Using (1) the link capacity for transportation between these two nodes of the network is: 1/86 = 0.011 relative capacity units. Taking into account from fig.2 that 5 trains support this destination the capacity for transportation on daily basis is: 5 trains x 0.011 = 0.055 relative capacity units. This evaluation considers that the total capacity value is a sum of the individual capacities, performed by the different travels of the trains, according to their schedule.

Applying this manner of evaluation of the link capacities for the different trains on daily schedule between Sofia and Varna it has been identified the values of the link capacities, where the results are given on fig. 4.

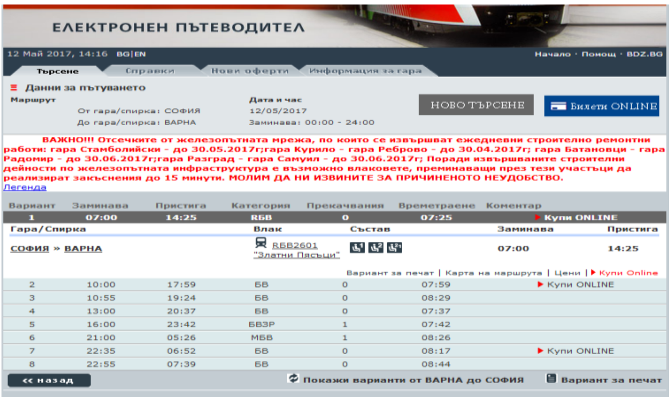

Fig. 2. *Schedule of 5 trains per day in Sofia-Varna direction (ГО)*

The total capacity of all lines on a given route is defined as the sum of the individual capacities. Using this way of assessing the capacity of the links for different trains on the daily schedule between Sofia and Varna, the values of the links capacity were determined.

4. The evaluation of the throughput links capacity for transportation graph presented by bus transportation

The evaluation link capacities, supported by bus transportation uses input data, presented in their time schedules, which are approved by the State Agency for transportation. These data are described in forms, given on fig.3

BUS ROUTE № 22201

bus line SOFIA - SILISTRA

Distance	Time			ROUTE	Time		
(km.)	Arraive	Stay	Leave		Arraive	Stay	Leave
			13.30	Sofia	14.12		
226.9	16.48	15	17.03	Veliko Tarnovo	10.39	15	10.54
74.6	18.43	5	18.48	Popovo	8.54	5	8.59
88.5	21.03	5	21.08	Isperih	6.34	5	6.39
31.7	21.55	5	22.00	Dulovo	5.42	5	5.47
40.9	22.42			Silistra			5.00

Fig.3. *Example for bus schedule*

The evaluation of the links capacity of transportation graph presented by bus transportation are used the following data, see the Figure 3.

For the example of Fig. 3 the bus schedule starts from Sofia and its destination is different from Varna. But this bus line from Sofia to Popovo carries passenger's transport, which is also performed by rail transport in the same direction from Sofia to Popovo. Therefore, the bus services are reported only in the part to which they cross the railway line of Sofia - Varna in one of the nodes. Consequently, the crossing capacities of the transport graph supported by bus transport are reported only to the parts of the network where the bus connections cross the train connections. For the case of Fig. 3 This intersection is the town of Popovo (line 3 in Figure 3). This means that from Sofia to Popovo there are two modes of transport: by train and by bus. Therefore, a connection from Sofia to Popovo, which is supported by bus transport, is added to the transport network topology. The transport capacity of this link is 5 hours and 18 minutes or 318 minutes (from 13:30 to 18:48) or the transport link capacity is 1/318 relative units. By integrating all capacities on the bus lines running on the same link of the transport graph, the total capacity of each link in the log is obtained. The calculations for the mean transport time of the transport link supported by bus transport, Similarly, schedules of three bus lines that cover the entire Sofia-Varna route are added. [5]

It has been added the schedule analogically for three bus lines covering the whole route between Sofia-Varna (GO).

5. Evaluation of throughput links capacities for the entire graph

The presented task has huge volume and requires significant calculations. The order of computational steps is the following:

There are defined all crossing points between the bus lines with railway nodes, see Sofia – Varna route.

There is calculated the time for all buses lines, which cross the railway nodes.

There is defined the general throughput link capacity for particular direction of bus transportation.

There have been analyzed 55 bus lines with their schedules and there have been defined the nodes with crossing points between bus and railway transport. In this way there are derived the mean values and it is evaluated the time travelling of all 55 bus lines over the whole transportation graph.

The results of throughput link capacities are given in Figure 4. These calculations are made using data from the schedules of the bus and railway transportation flows between Sofia and Varna for a year 2017 [5].

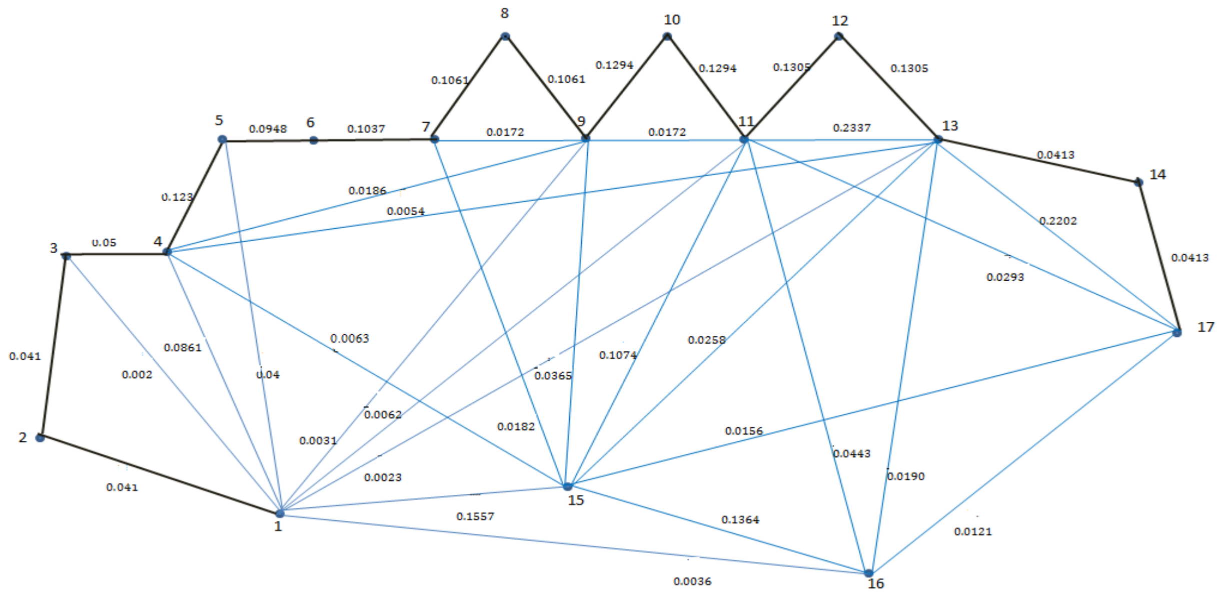

Figure.4. *Common graph structure of the railway and bus transport for a year 2017*

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The type of transportation graph and its throughput links capacities defines the transportation structure of passenger flow between Sofia-Varna (passing through Gorna Oriahoviza).

The research goal of this structure is to find out the maximum size of transportation flow between starting and ending point, from Sofia to Varna [2, 4, 8]. It is necessary for looking decisions where the railway transport is privilege. The intensification problem of the railway transport includes the maximum flow passing through transportation system, where is combined with bus and passenger transport and looking solutions are towards to privilege of the railway transport control.

The problem of intensification of railway passenger transport includes defining of maximum flow which can be passed through transportation system combining bus and passenger transport and to find out control where the railway transport is a privilege.

Solutions are looking using development of optimization hierarchical model, defining of bi-level hierarchical task for optimization where it is applied hierarchical model, it is solved the optimization task for compare the solutions with a classical optimization task. [6, 7]

Conclusions

The developed method has presented quantitative definition of hierarchical, bi-level optimization parameters for the case of lack of real measurements. The experiments made proves that network and information objects can be numerically estimated by indirect assessments of trheir qualitative parameters.

There are evaluated throughputs capacities of the bus and railway transport. The presented algorithm is developed in case there are missing output data for intensity of the bus and railway transport. The algorithm results leads to data, defining hierarchical, bi-level optimization tasks for controlling passenger transport, information and communication networks, systems and processes with network architecture.

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