

Tibor Schlossera,*, Peter Schlosserb

* Faculty of Civil Engineering, Slovak University of Technology, Bratislava, Radlinského 10, 810 05 Bratislava, Slovakia
b DOTIS Consult, s.r.o., Budatínska 1, 851 01 Bratislava, Slovakia

Abstract

In 2008-9 the first idea of mapping the situation in Petržalka - Bratislava from traffic planning point of view defined the possibility to create a new situation for development of tramway infrastructure across the river Danube. The paper is dealing with the tools of traffic engineering surveys observing the situation in modal split and capacity of bridges in Bratislava from which was created a complex transport model. The results from the transport model showed the future collapse by overflowed situation on the street network and found the way to start with preparing the new Carrying System of Integrated Public Transport using the multi-modality of rail tracks in the agglomeration of Bratislava. Nowadays Bratislava has its first section of new tramway infrastructure from the downtown of the city connecting the all radials of the city toward the southern largest housing estate Petržalka. This section is prepared for operation.

1. Introduction

In Bratislava has arisen an interesting project, which is advisable of remark, because from the definition of the base requirement up to finishing the realization has been passed 6 years only. The history of tramway operation in
Bratislava came from 1895. Even of the beginning of 20th century, there was an integrated rail track public transport in operation, where on 3 lines was operated a classical tramway on the gauge 1000 mm and to Vienna was possible to use another city tramway in a gauge of 1435 mm. This was in operation up to 1935. The thoughts of underground lines in Bratislava have been started in early 60ties of last century. And the administration has been kept it up to the year 2001. Finally, after stopping this philosophy covered by a huge design works they have been offered different proposals of railway PT, which ones finished with the design of TGV from Paris – Stuttgart – Vienna to Bratislava together with an underground solution under the river Danube and the city. This was postponed after a year 2030. The thought of city rail track as a modern infrastructure for tramway and tram-train with connection to the classical railway infrastructure has risen up only in the year 2008. In the end of the 1st decade of 21st century a huge traffic surveys were practised together with a solid traffic analysis together with creation of a special transport model. The transport model in many of scenarios declared the assured collapse of the transport system over the river Danube in 2020. Having dozens of rail track systems between the city Downtown and Petržalka – southern part of the city, it has been started to consider with a modern double gauge tramway using the historical Old bridge with the possibility of a strategy to connect the railway infrastructure. With this system will be ensuring the continuous open but integrated public transport system. Technical problem was the different gauges. In Bratislava is operated the tramway in 1000 mm gauge and the railway has the EU standard 1435 mm.

![Figure 1– New development plan of Petržalka (on top - orange) and the 1st phase of tramway line (red).](image)

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2. The base technical conditions of the new rail track system

Technical problems do not exist and not really are every time expensive, even though look like from the administration body point of view “too complicated”. Everything, from detailed descriptions of operation of different fleets (city tram - 2500 mm vehicle widths, railway tram-train – 2650 mm), as well as the construction details of rails and wheels were not identified. The technical descriptions of the stops with different widths or the overhead conductors and keeping the pantographs, or the stairs in tram train because of different high of platform stops (in the city 250-300 mm, on railway 550 mm) were solved with professional work. The examples of cities as Stuttgart, Krefeld, Karlsruhe, Lyon and others in Europe are enough positive solutions for decision making. For a solid decision making at that time, the city of Bratislava had not enough traffic and transport records for documentation of the mobility, modal split and capacity of transport relations between the southern parts of the city (Petržalka) across the river Danube to the down town of the city. In the year 2009 there was realized a broad traffic survey, which served the specific reviewing of the present critical situation. The whole mobility between the city borough of 120 000 inhabitants is done across the river on 4 bridges only by cars and PT buses. Years, the congestions and queues have already been a rule. Daily traffic volumes across the river Danube are more than 250 000 cars. Bratislava has only 450 000 inhabitants. The problem is the city through traffic between western part and eastern part and to this is bind the centric relation from southern part...
of the city to the downtown, as well as to the eastern and northern part. The transit traffic through the city of Bratislava is only up to 7% of the total ADTV. The transport infrastructure system is defined by the ancient urban development trends of the city from 70-ties of last century. There are on one side a mono-functional residential areas and on the other side districts with working and industrial opportunities. These above mentioned steps had created the first decision to create a new multimodal system oriented on rail track PT and to do with the professional traffic engineering and planning work in each detail.

3. Traffic engineering works and results of mapping the situation

The base traffic analysis was created on a wide traffic survey of parking in whole Petřžalka and a long term automatic counting on main roads in a time of 182 days in real time. Additionally, were organized, after a parking survey which was realized during the night, in a full day origin-destination survey to catching the licence plates of the moving cars on the whole street network.

3.1. Parking survey and results

From parking survey have followed, that on a parking places were registered 33 452 parking personal cars outside except of garages (see table 1). According this survey there absented on the whole area of Petrzalka more than 13 437 parking places. From the realized parking survey in the Petrzalka borough can be resulted as follows:

- There is a big “not controlled parking on sidewalks”, entrance roads, green areas, in sight triangles of junctions, blind curves of the streets, etc.,
- The city borough of Petrzalka has to solve, if can, the parking policy with a unique city residential policy to keep and/or enhance the resistance of residential zones against environmental a hygienic transport negativeness with active regulations (eliminates of noise on a source) and passive ones (eliminates of noise at the side of composition of the source movement - cars together with a composition of space, objects),

<table>
<thead>
<tr>
<th>Number Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute number of parking cars</td>
</tr>
<tr>
<td>Outside of parking places</td>
</tr>
<tr>
<td>Standing car all the day – No drive</td>
</tr>
<tr>
<td>Minimum one journey</td>
</tr>
<tr>
<td>Journey in AM time</td>
</tr>
<tr>
<td>Journey in PM time</td>
</tr>
<tr>
<td>All day movement – min 2 journeys</td>
</tr>
</tbody>
</table>

We have to optimize the modal split of operational services of personal cars because of the hygienically defect and spatially exacting role towards walking, cycling and PT services, what means:
- Corrections of proportions for organizational elements of residential measures,
  - Increasing of network density and intervals of PT services,
  - To identify the nodes – public areas and centres of residential areas together with parking (in vertical levels),

With a strategic advance and identification of urban skeleton together with pedestrian and cycling movement (Petrzalka is on a plain field).

3.2. Dynamic traffic in Petrzalka and on the bridges over Danube

For the detailed traffic survey in Petrzalka there was defined 68 counting stands (Figure 2 and 3), from which 11 were on the border of Petrzalka borough and 57 were directly inside of the area with together of 122 traffic lanes. The Petrzalka borough was split up on 33 zones for the traffic model. The detailed data from automatic counting (182 days) of vehicles from survey were recalculated on Average daily traffic volumes (ADTV) and from the origin-destination survey (Tab.2) from 12 h on 24 h. There were defined peak hours of traffic volumes for (max, 10, 30 a 50 hour). This was very important for determination and analysis of modal split for future tramway passenger volumes.
Table 2 – Number of unique licence plates vehicles according the daily time interval.

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Cars</th>
<th>Lorries</th>
<th>Buses</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 - 18h</td>
<td>131 053</td>
<td>2 418</td>
<td>1 009</td>
<td>134 480</td>
</tr>
<tr>
<td>07 - 11h</td>
<td>51 931</td>
<td>1 007</td>
<td>486</td>
<td>53 424</td>
</tr>
<tr>
<td>14 - 18h</td>
<td>51 462</td>
<td>560</td>
<td>399</td>
<td>52 422</td>
</tr>
</tbody>
</table>

The special analysis was done on bridges, which ones are the most loaded stands between Petrzalka and Bratislava down town. The values are shown in table 3 and figure 4. The capacity of bridges is on the level of saturation and after detailed examination were decided that in 2020 was a complete traffic collapse on bridges.

Table 3 – the most traffic loaded section in Petržalka – recalculation on ADTV.

<table>
<thead>
<tr>
<th>Stands</th>
<th>ADTV - 0024 (vehicles/24h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direction 1</td>
</tr>
<tr>
<td>Apollo Bridge</td>
<td>17 530</td>
</tr>
<tr>
<td>Port Bridge</td>
<td>28 330</td>
</tr>
<tr>
<td>Port Bridge – ramps</td>
<td>14 350</td>
</tr>
<tr>
<td>SNP Bridge</td>
<td>23 090</td>
</tr>
<tr>
<td>Lafranconi Bridge</td>
<td>22 980</td>
</tr>
</tbody>
</table>

Figure 4. Average daily traffic volumes for each day in a week on bridges.
4. Traffic model

The traffic model was created on the results and analysis from the surveys. The street network was created by PTV Vision – Vissum software which was risen up for the real state of the network with complete traffic organisation and control on each junction. The adjustments were done by ratios based on the typical curves from each control stands of automatic counters, (see figure 5), where the basement was defined 5 min interval/24 hours continuous measuring form 6 months. The assignment of typical curves was compared and recalculated from manual origin-destination survey (12 h) on an ADTV (veh/24 h). The results form testing the capacity on bridges were used in the modal split analysis, where was tested the level of passengers who change their behaviour for using a tramway infrastructure.

The test was used only for passengers using the cars. The complete PT bus transport with the volumes was not changed. Some results are shown on figures 6. For testing the stops was used a usual 500 m distance. The capacity of tram lines is 12 000 pass./hour and the model values using 3 tram lines in a peak interval of 2 min. The tramway has an absolute preference on traffic lights junctions with complete dynamic traffic control. The reached passenger volumes were defined from the model in a high of 8 688 pass/h for a morning peak hour on the strategic stop (top red circle on the figure 6 - right).

Figure 5 – Automatic counting results and typical curve assignment (the SNP Bridge section),
Traffic volume (cars/h) – 182 days’ overlap.

Figure 6 – Time accessibility to the tramway stops and results of increasing of passengers on a line in Petržalka.
5. Decision Making Process

The professional work guaranteed by a team of traffic engineers and planners could only bring a solid position for a decision making which was fulfilled by a classical system work. To administrate the negotiations in Brussels has brought a clear conclusion for realization this project supported by EU. The base reason was the philosophy of connecting the city with its region as well as with future possibility to use in as a cross border PT system to Hungary and Austria. Every time there are some misunderstanding which rise up from the bureaucratic false added value work, which can stop or put the work to other direction. But this is not a deal of research and system engineering work.

6. Conclusions

Nowadays after 6 years of complex works is possible to declare that Bratislava has its first phase of a new rail track infrastructure which can open a modern and sustainable development tools for a next decade’s urbanization possibilities for the Capital of Slovakia. What was the reason of a successful story?

1. The professional background has won against the administration and bureaucratic brakes which we have daily on the tables in a civil engineering plans and works. Argumentations covered by traffic engineers and planners and their systematic works has opened and fixed the defined steps and rules for a clear and complex decision making.

2. If we have a simple but systematic works covered by traffic engineering and planning tools than is possible to work with high efficiency in time and is possible to work operatively and systematically. To postpone the schedules is every time caused by bureaucracy on the side of administration body, where is a lack of technical staff and decision makers – engineers, there are only layers and economists and people without any experiences from the real life,

3. If the project has a real content of engineering results we can open than the field for observing and/or researching, never to do the things oppositely what is often a reality.

References


