

TECHNOLOGICAL STRUCTURE OF OPERATIONAL FILES IN REGIONAL BUS TRANSPORT FOR THE NEEDS OF THE TENDER FOR CARRIERS

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Abstract: *In the regional bus transport in the Czech Republic is currently ending a period, in which contracts with the bus carriers have been concluded directly - without a tender, before the effect of European Regulation 1370/2007. Main contractors of public transport are currently solving questions, how to define the structure of operational files in regional bus transport, so that these files were technologically functional, operationally homogeneous and that the price of transport performance in these files was economically viable. This situation requires new and innovative approach in the field of transportation technology.*

KEYWORDS: PUBLIC TRAFFIC, TRANSPORT TECHNOLOGY, BUS TRANSPORT, TIMETABLE DESIGNING, TRANSPORT EFFICIENCY, TRANSPORT PLANNING, TENDER FOR CARRIERS, VEHICLE CIRCULATION

1. Introduction

Regional bus services in the Czech Republic are currently ordered by 14 regions. The overall extent totals approximately 300 mil km / year. Total operating compensation payment amounts to approximately 5.5 billion CZK / year. Revenues from fares cover approximately 1/3 of the total cost.

Most of these 14 regions will end directly awarded contracts with carriers in period 2017 - 2019. The exception is the Usti Region, which all bus services have competed and with new carriers it runs from January 1st 2015.

According to European Directive 1370/2007 it is no longer possible to conclude a public service contract for bus transport directly and therefore will need to be given the full range of transport to compete.

For this reason, the issue is currently in the Czech Republic is highly topical.

In the first half of the 90s was privatized bus state enterprise ČSAD, which ensured all regional bus service. Through purchases of individual operation units by different owners and their transformation the situation has stabilized in the Czech Republic in a state where there are large carriers operating hundreds of buses, both on a national scale (e.g. ICOM, Autobusy Karlovy Vary), as well as in the field of international players, that operate in the Czech Republic (e.g. Arriva). Besides these major carriers there are hundreds of small operators that in regional transport run to tens of buses. In each of the regions it is also a division the performance among of large and small carriers distributed differently.

Because even the preparation and organization of the competition on the carrier requires considerable complexity (time, organizational and financial) on the side of the public service orderer, they are looking to such techniques and methods that are most effective and allow the orderer to profit from the effects of the competition.

2. Influence of structure and configuration of operational file

The authors of this article have participated in the preparation of the technological structure of the operational files in the Ústí and Olomouc Region. Among the key issues defining the structure of the operational file belong three basic areas:

- Operational file size (volume of transport performance)
- Configuration the operational file
- Definition the operational file

These points will be discussed in the following subsections.

2.1. Operational file size

Generally, the larger the number of contracts is associated with a higher demand of administration on the side of the orderer. At the same time, a greater number of smaller contracts mean potentially more competitive environment because of the smaller contracts are achievable to a larger number of entrants. For each contract size is by volume, financial performance generally required bank guarantee corresponding proportional amount of the financial performance for the duration of the contract. The smaller contract, the smaller bank guarantee and vice versa. Large contracts are a way for smaller carriers usually completely unachievable - not only in terms of bank guarantees, but also the opportunities and conditions for obtaining credits for the financing vehicles.

According to the positive results to now realized competitions in the Czech Republic experience shows that the appropriate approach is to define a greater number of smaller areas, respectively medium range transport performance. Such operating systems are of the ideal size around 1-2 million vehicle km traveled per year and cause the need for all-out 10 to 20 buses.

Each operational file is determined primarily by the volume of transport performance, but the investment required for the carrier is determined by the length of contracts and the required age and equipment of buses.

2.2. Configuration the operational file

In the particular regions there is very heterogeneous structure of transport performance. On one hand, the connection can be found, their peak occupancy amounts typically up to 100 passengers, on the other hand can be found connections whose peak occupation does not exceed the of 20 passengers. These extremes are going in principle across the whole territory of the Czech Republic. In terms of the size of buses required we move from the minimum size of a bus for regional traffic with a length of 8.5 meters to 3-axle 15 m buses or articulated buses.

It is obvious that a larger number of operational files (i.e. the areas defined by one contract) must be each operational file in a certain way homogeneous, graspable, coherent and compact. This homogeneity can be in principle regarded geographically or operationally.

Typical geographical clustering to the operational files would be necessary to copy administrative boundaries, eg. former districts, or there may be cases where the territory is geographically isolated by a natural barrier.

The advantage of the geographical clustering of the territory on operational files is high operational ability of the carrier (on all lines in this area operates just one carrier, any advances and operational vehicles can be concentrated in one "central" point etc.). Geographical clustering would have been 100% successful but only in such theoretical case, that the territorial boundaries were "impenetrable" by the regular public transport, ie. there would be no lines connecting neighboring regions. This principle was applied in many cases at a time, when organization of regular public transport fell under the district offices (very small regions) - in many places in the Czech Republic can be still on line planes seen, that the lines do not go behind the former district border and "ignore" aims on "other side". In many ways it is so apparent lack of connection quality between medium sized regional centers.

However, because often there are strong linkages between regional centers, is perfect geographic clustering not reachable. There will always interregional connection lines, which must be allocated in one or in the other operational file, and so there will be possible, that more carriers will operate in single areas.

Conversely, operationally perfect clustering of the territory would not be after lines, but after individual links, respectively groups of circulation plans of single vehicle types. Each operational file would have been formed by numerous circulation plans on the same type of vehicle. These circuits would be designed for maximum operating efficiency and maximum operating use of buses and personnel. Clustering into such operational files would be based on the assumption of a single bus-fleet, uniform technical background, identical vehicles and identical traffic backups. The maximum operating efficiency in many cases would be leading to a large spatial overlap between operational files, which would run at maximum driving time for drivers and limits on buses refueling. Strictly operational clustering would have the major advantage, that the vast majority of links would be ensured by such bus, its capacity meets real demand and would minimize excess of offered capacity.

2.3. Definition the operational file

Principle definition of the operational file was at the orderers, who have in bus transport already tendered, or are only preparing the tenders, primarily such, that they were primarily based on the geographical clustering. By the geographic clustering is generally easier to comply with local catchment area, transport links and axes of regular commuting.

When defining the operating files themselves, were in the proposals removed the obvious disadvantages of geographical clustering - i.e. primarily too high demand on the variability of sizes and types of buses. This clustering principle was so extended by two additional factors:

- the maximum allowable size of operation file
- limiting allowable number of vehicle types

In smaller operational files for lower number of vehicles is limiting of allowable number of vehicle types essential, because it reduces the real cost of uptime, maintenance of the fleet of buses and reduces the diversity of necessary technical background. Limiting the number of vehicle types can be solved either by lump sum (strict determination of the type of vehicle, which is required at the busiest link by passenger frequency on strongest line in the operating file), or by using the properties of the elements of operational clustering. The very strict definition of just one type of vehicle would lead to excessive overhangs of offered capacity on most of the connections in the area. The authors of this article recommended to the orderers of public bus services, to balance factors of geographical and operational clustering, by using of two types, as permissible limit of the number and types of buses operating in the file.

The result is a geographical clustering with the very high emphasis on operational efficiencies and with limited spatial overlaps.

3. Technological structure of traffic performance in operational file

The specific content of each operating file are concrete lines, their timetables and the resulting number of vehicles, which is necessary to ensure the required transport performance .

Before assigning single lines to single operational files it is usually appropriate to revise leading of lines, not only for transportation reasons, but also for operational reasons. In the current conditions of Czech Republic, there's line management in many cases "historic" and in many cases was in regional bus transport not changed eg. 30 years, regardless of economic, socio-economic and demographic trends.

Based on the review of known facts of the various transport relations should be applied methods of line-planning leading to maximizing of the number of direct-travelling passengers, with the following modifications:

- unification lines given to a balanced use of vehicle capacity (some lines were rearranged into another operational areas and vice versa), all busses in the area have newly the same passenger capacity
- with regard to the balanced use of vehicles was necessary to determine the permissibility of carrying of standing passengers; taking into account the sharpness of the morning peak hour is usually not possible to avoid deterioration of transport (regular standing

passengers) in school connections - account the vehicle capacity on the school board would lead to excess capacity for the rest of the day;

- increasing the number of diametric lines, diametrical line without mutual strengths transport relations between the endpoints are operatively mutually rerouting so, that the time-length of the line, including half turnover times in both endpoints, approaching an integer multiple of half of the period (interval)

After creating the line leading follows usually next step - forming a timetable. Within the framework of changes and modifications in operational concepts in regional bus services, there's slowly more and more enforcing principle of periodic (or integrated periodic) timetable (IPT). They are defined IPT-nodes, transfer / changing nodes and intended length intervals for the peak- and off-peak hours.

The standard follow-up step after creating a timetable would be to create cycles of vehicles and personnel. In this case, it is then also possible to use well-known optimization methods to minimize the number of deployed vehicles.

The author's team new approach is, that already when the timetable proposal is created, combines the operational concept with cycles of vehicles, in mutual repeating iteration steps.

After designing of the line-network and basic structure of the periodic timetable and IPT-junctions were made minor changes in the raster of periodic timetable. In the morning peak hours were separately taken into account the requirements of the local time (starting times by significant employers, beginning of school hours) and the structure of IPT was often partially deflected. At the same time, during the morning peak hours was usually a structure of IPT preserved primarily in the main transport directions and main change linkages, while in the opposite direction (contrary to a major transport streams) were used differing routes, atypical crossings between the lines, as well as pragmatic time positions, which led to the minimization of the number of vehicles in the morning peak hour of the workday. It is just a morning peak hour of the working day, which determines the number of vehicles.

Approach to the timetable creating is as follows:

- 1) defining IPT nodes and intervals, calculate the number of vehicles for "basic periodical operation"
- 2) defining a specific operation in the morning peak hours and minimizing the number of vehicles in this period; ideally for the number required in previous point 1
- 3) after the arrival of school busses, as soon as possible "timetable transition" to defined structure of periodical timetable
- 4) operational optimization and ensuring operational efficiency (breaks for drivers, refueling buses...)
- 5) adaptation of timetables in the evening hours (to minimize the number of vehicles, reduction of total working time of drivers)

The aim is to ensure maximum operational efficiency within a defined operational file.

The following figure expresses the fixed costs of the bus relative to the average daily performance.

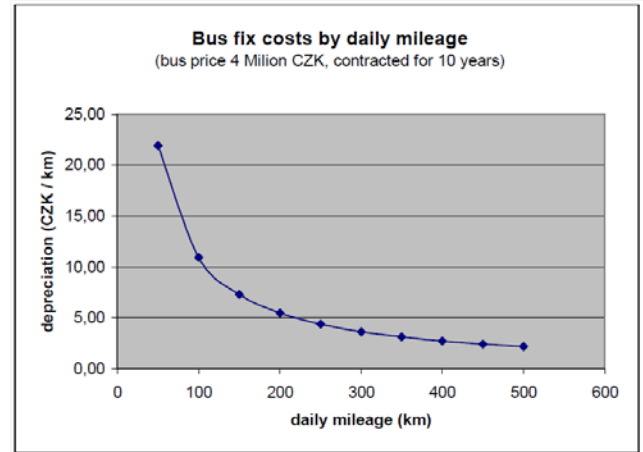


Fig. 1: Bus fix costs (depreciation) by average daily mileage

Currently, the regional bus services in the Czech Republic has held daily vehicle mileage normally about 60-130 km. From the above figure it is apparent, that the cost curve is broken in the space daily performance of 200-300 km, which corresponds to an annual mileage of a vehicle about 70 000 to 100 000 km.

In no operational file are these limit values reached in the beginning. It is natural, since the beginning sort of performance into operational files is usually made by current timetables, which has been usually no optimized before. It is certainly not without interest, that for example in Region Ústí nad Labem, where they are generally the most experience with tenders in regular public bus transport, there are always in all operational files reached values from 70 to 100 thousand vehicle-km annual mileage. The main subject of rationalization it is usually the maximum reduction of the number of vehicles necessary to ensure the demanded transport performance, and only after this step, at the optimized number of vehicles can be considered a possible rise in transport performance.

Currently, in conditions in the Czech Republic in the field of bus prices, fuel prices and the drivers' cost, we can very simply state, that if an operational optimization saves 1 bus in operational file, it is a cost equivalent of 60-70 kilometers daily transport performance, of which we can improve transport services.

In relation to how the orderers are increasingly understand the relationship between structure and scope of the transport performance in relation to its cost, there are requirements for structuring the prices of transport performance into fixed and variable components. By changing the traffic performance during the execution of the contract remains fixed component fixed and variable component reflects truly realized extent of the traffic performance

Application of these principles is fully reflected in the operation costs. For example, in the Region Ústí nad Labem, in the operational file "Dolní Poohří", have the authors of this article achieved continuously optimizing condition, that the number of vehicles has been reduced from 30 to 25 and the annual mileage of one bus currently amounts 90 000 km yearly mileage.

4. Conclusion

The necessity of holding tenders for the bus carrier in a regular public transport in the Czech environment, fundamentally changes the relationship between the orderer and the carrier in public transport.

The first major change is, that in the regional bus services the public orderer can not conclude a contract with a carrier directly, although this orderer is satisfied with carriers's services and pays the normal and usual price of transport performance, and under normal circumstances there would be not any reason to change the carrier.

The second, more fundamental change is the fact, that the public orderer by preparing a tender for the carrier, has to ensure a wide range of activities, previously carried out by the carrier. While the direct award of traffic performance rises in the interaction orderer - carrier, and the carrier himself watches operational productivity of the negotiated services, so at the competition is the situation different. The orderer of public services defines the operational concept and all requirements. Any technological error concerning in the tender documentation can not be removed in consultation with any carrier who wants to participate in the tender. Such error or hidden unproductivity increases the cost of transport performance, and orderer will it subsequently pay. Full operational optimization - timetables, cycles of vehicles, personnel demands etc. must be well thought out by the orderer already in the formulation of the operational file and operating requirements in the tender. In the Czech Republic, this situation ordering parties generally chew very slowly, and often have a tendency to underestimate the situation.

The situation is in many ways even for new by bus operators participating in the tenders too, because the demands on the operational concept and quality are predetermined from the orderer. The carrier has already no possibility to optimize (or partially) operational concepts according to its operational needs. The role of carriers in this regard is already seemingly passive - however numerous carriers orient already in the new circumstances and focus their activities on the rationalization measures that allow them to cope with the prescribed requirements at the lowest cost. After the carriers have no opportunity to enter timetable preparation and requirements during the tender, they are focusing on typical operating area (suitable dislocation vehicles and personnel for contract performance, minimizing of empty rides, placement of technical and technological background, optimal mode of refueling buses, reduction of personnel time losses etc.)

This current situation is a great challenge for us - academics - too, as we are by the orderers increasingly asked to perform a variety of operational and technological optimization of operational concepts in preparation of the structure of operational files, in order to achieve the lowest cost of transport performance by fixed transportation requirements

On the example of the Region Ústí nad Labem shows, that a good and thorough preparation of a tender in public regional bus transport can reduce the unit cost of transport performance by up to 20%, with a further price reduction due to a competitive environment. From the original average price of the transport performance of about 35, - CZK / km came the orderer after tender to an average value of about 28, - CZK / km transport performance. The Region Ústí nad Labem, as the orderer of public services, so could significantly extend the range of connections and improve the quality of public transport services -

while preserving and no increasing of the original level of operating compensation from public money.

REFERENCES

1. Janoš, V.: Using Gravity Model in Regional Rail Transport Planning. In *Advances in Applied and Pure Mathematics*. Athens: WSEAS Press, 2014, p. 436-441. ISSN 2227-4588. ISBN 978-960-474-380-3
2. Janoš, V. - Baudyš, K.: TRANSPORT PLANNING ON THE LIBERALIZED MARKET OF PUBLIC SERVICES. In *trans&MOTAUTO'14 XXII INTERNATIONAL CONFERENCE PROCEEDINGS*. Sofia: Scientific-technical union of mechanical engineering, 2014, ISSN 1310-3946.
3. Janoš, V. - Baudyš, K. - Sitora, D. - Coufal, L.: *Segregation of the Olomouc region for operational files for the needs of the tender for carriers in bus transport*. 2014
4. Janoš, V. - Baudyš, K.: Transport Planning of Public Services. In *Proceedings of the 11th European Transport Congress*. Praha: České vysoké učení technické v Praze, Fakulta dopravní, 2013, . ISBN 978-80-01-05321-8
5. Janoš, V. - Baudyš, K.: Development of Periodic Timetable in the Czech Republic. In *Road and Rail infrastructure II*. Zagreb: University of Zagreb, 2012, p. 869-873. ISBN 978-953-6272-49-5
6. Janoš, V. - Baudyš, K. - Vichta, F.: Financing the Public Transport in the Sphere of Regulated Competition. In *Sborník konference Euro Traffic 2006*. Praha: ABF a.s., 2006, s. 7. ISBN 80-86905-15-2.