TRANSPORT PROBLEMS 2008
PROBLEMY TRANSPORTU Tom 3 Zeszyt 3

Adam MOLECKI
Silesian University of Technology, Faculty of Transport, Department of Traffic Engineering
Krasińskiego St. 8, 40-019 Katowice, Poland
Corresponding author. E-mail: adam.molecki@polsl.pl

PUNCTUALITY OF TRAM DEPARTING FROM BEGINNING OF TRAMSTOP

Summary. The article presents results of researches of punctuality of tram departing from beginning of tramstops in Zagłębie Dąbrowskie. There were analyzed departures at classical tram lines, without light signaling of departing-time. There were inside of driver's cabs sound signaling of departure. The departure's punctuality problem from beginning of tramstops is very important to make tram traffic simulations. These ones let to optimalyze traffic engineering solutions.

PUNKTUALNOŚĆ ODJAZDU TRAMWAJU Z PRZYSTANKU POCZĄTKOWEGO

Streszczenie. Artykuł omawia przeprowadzoną analizę punktualności odjazdu tramwajów z przystanków początkowych w Zagłębiu Dąbrowskim. Badane odjazdy dotyczyły linii tramwaju klasycznego, niewyposażonych w sygnalizatory odjazdu. Natomiast instalacja wewnętrzna w kabinie motorniczego sygnalizowała godzinę odjazdu dźwiękowo. Zagadnienie punktualności odjazdu z przystanku początkowego jest bardzo istotne z punktu widzenia tworzenia symulacji ruchu tramwajowego. Mają one na celu optymalizację rozwiązań z zakresu inżynierii ruchu tramwajów.

1. INTRODUCTION

Nowadays, when almost everybody has an access to individual transport facilities, there should be made everything possible to attract passengers to public transport. It would be very profitable and life-comforting for all inhabitants.

One of the most important steps in knowing the arrival time in many places at tramstopsline (here: tram line) if we want the priority to make it effective. There were presented methods of tram freeway pass-time (without obstacles which forces them to drive slower or even stop) estimation in articles [1, 2]. There were also presented estimation methods of time which trams and buses spent at stops [3, 4]. Both of the problems have a one common feature – they are not determined by time-table. The correct time-table is made bases of time-long of every action – not the reverse.

The moments of departure from beginning of tramstop, almost every time, are not connected with time of passengers getting in or out, or actives of turning back. Usually these actives are much shorter than spent time at this stop. It is an effect of:

- time correction reserve – they are necessary to getting short the delay of previous course,
- coursing intervals – it is necessary to regular coursing (for example if interval is 12 minutes and the time of the whole course in both directions is 54 minutes, it is necessary to stop at both loops about 6 or 18 minutes etc.),
- refreshment breaks for tram personnel.

If actives are shorter then break time at timetable, moment of departure has to be estimated in a different way than on the line.

2. ANALYSIS

There were analyzed data from automatic recorder of vehicle work, which are installed in 98 tram cars coursing in 6 cities: Sosnowiec, Dąbrowa Górnicza, Mysłowice, Będzin, Czeladź and Wojkowice. These were the same devices that inform drivers about departure time. If so, data is completely coherent. Researches were based at 10 beginning stops. There were about 14,5 thous. records analyzed (fig. 1).

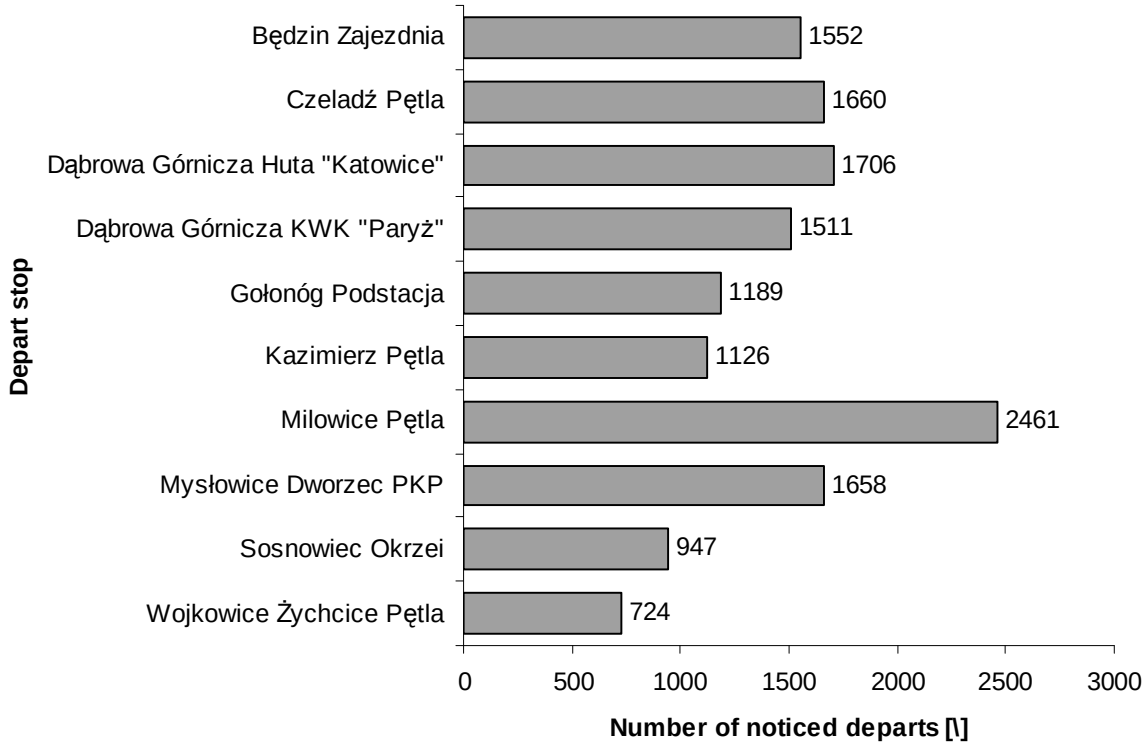

Fig. 1. Number of analyzed departure recorded for respective beginning tramstops
Rys. 1. Liczba analizowanych odnotowań odjazdów z poszczególnych przystanków końcowych

As the result of analysis was the conclusion that density functions for respective delay values was close to the same for different stops (fig. 2). It was also noticed that the earlier departure effect is imperceptible and practically has maximum value at 2 seconds.

To fix the universal density function, what could be used for making simulations of tram traffic, it was summed the result functions for all beginning tramstops. The result was empirical density function for respective delay values (fig. 3). It was very close to log-normal distribution.

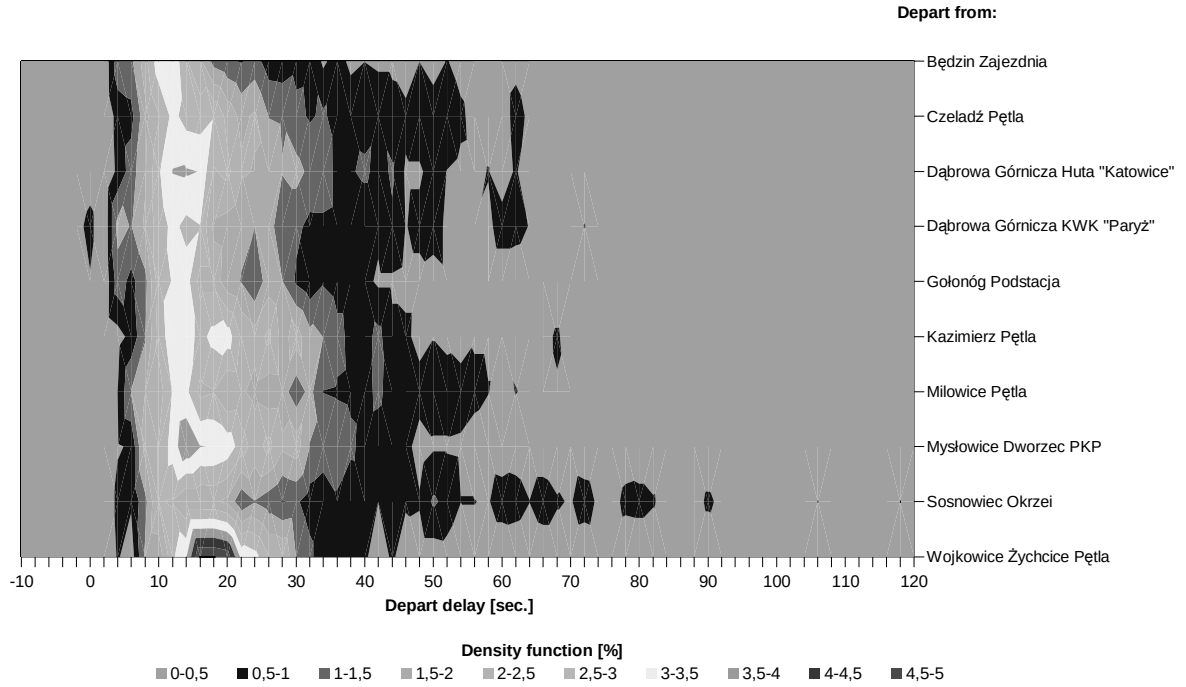

Fig. 2. Density functions for respective delay values for different beginning tramstops
Rys. 2. Funkcje gęstości prawdopodobieństwa występowania poszczególnych wielkości opóźnienia dla różnych przystanków początkowych

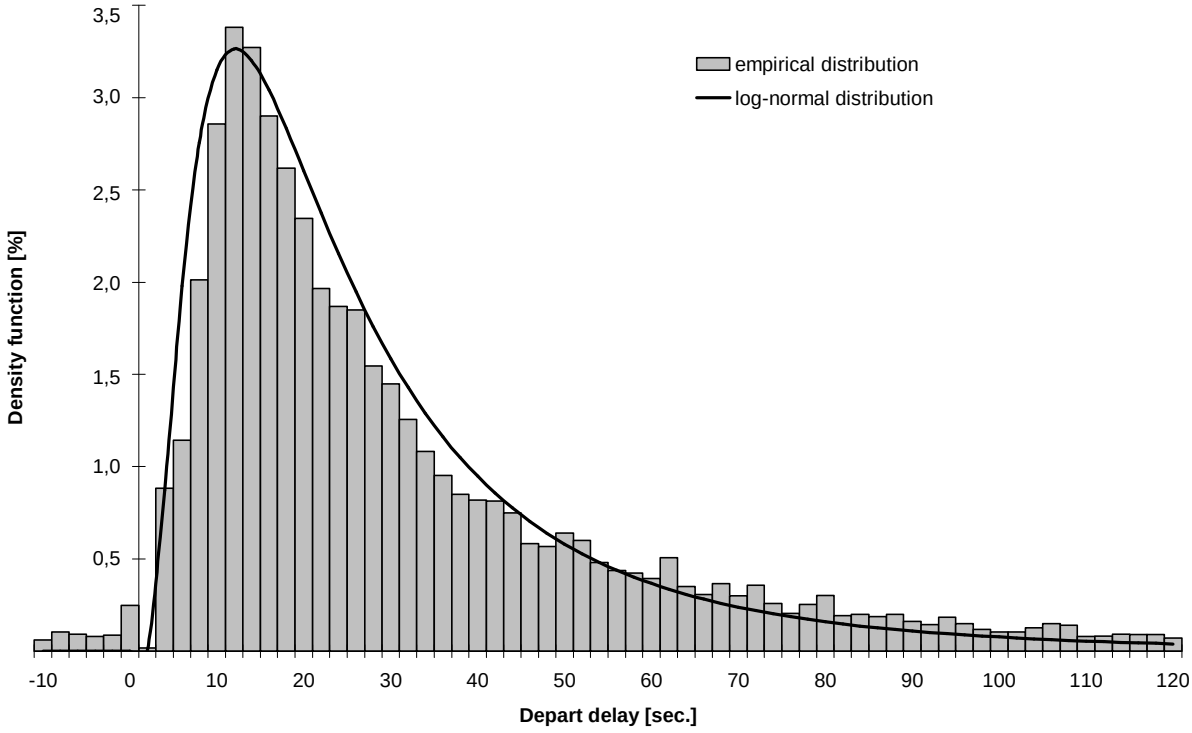

Fig. 3. Empirical density function for respective delay value and approximate to it log-normal distribution
Rys. 3. Empiryczny rozkład prawdopodobieństwa występowania różnych wielkości opóźnienia oraz aproksymowana funkcja rozkładu logarytmiczno-normalnego

In the next part of analysis estimate parameters' values of function of this log-normal distribution. Finally it was signed as formula (1), where are presented parameters of this distribution. It is also presented in shorter version as formula (2).

$$f_d(t) = \frac{1}{t \cdot 0.8 \cdot \sqrt{2\Pi}} \cdot e^{-\frac{(\ln(t)-\ln(21))^2}{2 \cdot 0.8^2}} \tag{1}$$

$$f_d(t) \approx \frac{1}{2 \cdot t} \cdot e^{-\frac{(\ln(t)-3)^2}{1.28}} \tag{2}$$

where: $f_d(t)$ – density function of departure delay, t – departure delay [sec.]

Using presented formula in tram traffic simulations, it is necessary to remember that, if tram loop is used by trams for more then one line, it is possible to notice conflicts. It has to be included in other dependence. They should include track occupancy, abandon switches etc.

3. CONCLUSION

Traffic simulations are very useful and chip device to resolve a problem of track capacity [5]. It concerns both – railroad traffic, which was presented in Janusz Woch researches, and also tram traffic, which was presented, among others in this article. These are incontestable in some way close problems. The differences between them are so large that, it is impossible to successfully simulate tram traffic using railroad traffic simulators.

Presented in this article resolve starting from beginning stop simulation problem, might be very useful, and let economize analysis, because of resignation of lasting natural inventory.

Bibliography

1. Molecki A.: *Jednotorowe linie tramwajowe – eksploatacyjne aspekty projektowania*. TTS – technika transportu szynowego, No. 12, 2007, p. 59-63.
2. Molecki A.: *Określenie rozkładu czasu przejazdu odcinka swobodnego trasy tramwaju konwencjonalnego*, Zeszyty Naukowe Politechniki Śląskiej, seria Transport, No. 61 (1704), Gliwice, 2007, p. 207-213.
3. Molecki A.: *Wpływ czasu wymiany pasażerów na przystankach na płynność ruchu tramwajowego*. Transport Miejski i Regionalny, No. 11, 2005, p. 35-39.
4. Molecki A., Sobota A.: *Zależność czasu wymiany pasażerów autobusu od liczby pasażerów korzystających z przystanku*, Autobusy, No. 4, 2008, p. 20-23.
5. Woch J.: *Narzędzia analizy efektywności i optymalizacji sieci kolejowej.(System Oceny Układów Torowych SOUT - opis podstawowego oprogramowania*. Wydawnictwo Politechniki Śląskiej, Gliwice, 2001.

Received 11.02.2008; accepted in revised form 18.09.2008