Development of Transit Time Parameter for Transportation Flows of Priority Mail

D. Salava[1], K. Pojkarová[2], L. Švadlenka[3]

[1]*University of Pardubice, The Faculty of Transport Engineering, Studentská 95, 53210, Pardubice, Czech Republic, E-mail: daniel.salava@upce.cz*

[2]*University of Pardubice, The Faculty of Transport Engineering, Studentská 95, 53210, Pardubice, Czech Republic, E-mail: katerina.pojkarova@upce.cz*

[3]*University of Pardubice, The Faculty of Transport Engineering, Studentská 95, 53210, Pardubice, Czech Republic, E-mail: libor.svadlenka@upce.cz*

Abstract

The paper is focused on estimation of transit time development for postal transportation services, namely end-to-end services for single piece priority mail. There have been defined requirements by European Commission on postal measuring systems (for Quality of Service) with possibility of independent end-to-end measurement. The aim of this measurement is to estimate QoS by transit time of end-to-end services for single-piece priority mail provided to customer by domestic mail in each European country and by cross-border mail among European countries. The main objective of this paper is to research possible development of transit time parameters following from mentioned independent measurements. This development could relate to changes in some other indicators connected with layout and organization of logistic network, capacities for processing of concerned postal items and naturally ensuring the whole process of postal service provision. Using of analytic tools for expression of potential influences or dependences could create important supporting step as well. Measurement system created by sample of test postal items flows is based on real traffic mail flows on fixed postal transportation network. The results respect measurement system specifications and analysis of postal transport network efficiency by mentioned procedure could help to find the most appropriate ways to improve the quality of postal services.

KEY WORDS: *transit time, priority mail, traffic flows, development, correlation, trend, prognosis*

1. Introduction

The basis for creation of acquis communautaire for postal market, i.e. uniform rules respected in individual EU sectors, is the Green Paper on the Development of the Single Market in Postal Services. On its basis Directive 97/67/EC of the European Parliament and of the Council on common rules for the development of the internal market of Community postal services and the improvement of quality of service (hereinafter the Postal Directive) was processed and on 15 December 1997 also approved. Objective of this Directive is to create a single European postal market under conditions of market economy.

This Postal Directive established universal postal service in such way that all member states shall ensure that all users can enjoy their right to this universal postal service. This contains permanent provision of this service in a specified quality and at all the access points in their territory at affordable prices for all users. It also describes that the member shall take steps to ensure that the density of points of contact and of the access points, e.g. mailboxes and post offices, takes into account the needs of users. This service must be provided every working day and not less than five days a week as a minimum. Universal postal service must include clearance, sorting, transport, and delivery of postal items up to 2 kg and postal packages up to 10 kg, as well as services for registered items and insured items. This universal postal service covers both national and cross-border services.

Each member state shall further ensure that in the frame of universal postal service all the users are offered an identical service under comparable conditions that are accessible without any form of discrimination whatsoever, especially without discrimination arising from political, religious, or ideological considerations. This service shall not be interrupted or stopped except in cases of force majeure, shall evolve in response to the technical, economic and social environment and to the needs of users [1].

The latest directive regulating EU's postal service sector is Directive 2008/6/EC of the European Parliament and of the Council amending Directive 97/67/EC with regard to the full accomplishment of the internal market of Community postal services. This third Postal Directive was approved 20 February 2008 and defines conditions governing the provision of postal services, provision of a universal postal service within the Community, financing of universal services under conditions that guarantee the permanent provision of such services, tariff principles and transparency of accounts for universal service provision, setting of quality standards for universal service provision and the setting-up of a system to ensure compliance with those standards, harmonization of technical standards, and creation of independent national regulatory authorities.

Each member state may designate one or more undertakings as universal service providers in order that the whole of the national territory can be covered. Member states may designate different undertakings to provide different elements of universal service and/or to cover different parts of the national territory. When they do so, they shall determine in accordance with Community law the obligations and rights assigned to them and shall publish these obligations and rights. The conditions, under which universal services are entrusted, must be based on the principles of transparency, non-discrimination and proportionality, thereby guaranteeing the continuity of the universal service provision, by taking into account the important role it plays in social and territorial cohesion [1].

2. Quality of Postal Services

Regarding quality of services, member states shall ensure that quality-of-service standards are set and published in relation to universal service. Quality standards shall focus, inparticular, on routing times and on the regularity and reliability of services. Independent performance monitoring shall be carried out at least once a year by external bodies having no links with the universal service providers under standardized conditions, using annually repeated methodology, and shall be the subject of reports published at least once a year. The Postal Directive lays down quality standards for intra-Community cross-border service, that within the time limit of *D+3* 85 % of items will be delivered and within the time limit of *D+5* 97 % of items will be delivered, where *D* represents the date of induction and the number represents the number of working days which elapse between that date and that delivery to the addressee.

In the quality area, not only regulations of Postal Directive need to be respected (such as meeting defined standards for intra-Community cross-border services), but also European standard EN 13850:2012 Postal services - Quality of service - Measurement of the transit time of end-to-end services for single piece priority mail (SPPM) and first class mail must be fully met. This regulation determines methodology for calculating transit time between the endpoints of national and cross-border priority letter mail cleared, sorted, and distributed by postal operators. The overall result of service quality can be expressed as a percentage of mail delivered within *D+n* days between the endpoints. This service quality indicator does not measure overall postal operator's efficiency and does not include any other service efficiency indicators, only those that are related to the transit time [1]. Service standard for SPPM in Czech Republic is given by Regulation Nr. 464/2012 Coll. Relevant part sets, that by measuring of transit times per calendar year there must be achieved result at least 92 % of postal mail delivered on the first working day following day of its posting [3].

At first, this regulation defines used terminology, which is followed by regulations related to calculation and expression of transit time, methodology, including the proposal of a representative sample, geographic stratification, geographic distribution group, estimates (accuracy, measurement results, calculation of accuracy), test items characteristics, reports, and audited quality management.

A similar regulation that needs to be fully met is a standard EN 14508:2016 Postal services - Quality of service - Measurement of the transit time of end-to-end services for single piece non-priority mail and second class mail. This standard follows the standard EN 13850:2012 and is compatible with its requirements. Additionally, it defines methodology for calculating transit time between the endpoints of national and cross-border non-priority letter mail cleared, sorted, and distributed by postal operators. This standard is not applied in Czech Republic because the postal operators do not provide second-class services [1].

3. Modelling of Transit Time Parameter Development

Quality is usually understood as speed and reliability of provided service as well as its availability. Service's speed is defined by time between posting and delivering the consignment, for express services it may be for example a matter of hours. Speed and reliability can be usually shown as a share of monitored postal consignments delivered the next day after their posting. According to monitoring since 2005 national postal operator (NPO) achieved a result about 90 % in previous years, which is a result comparable with the most advanced European public postal operators. Availability of NPO services is indisputable due to the number of post offices (actually max. 3200). The monitoring is carried out so, that a monitored letter post is thrown into a mailbox and the time, in which the mail is delivered into addressee's letter-box, is measured. For the following years, it is planned to monitor consignments delivered even into businesses or directly to the addressee only. The measurement results achieved in 2010 are better than the results of previous years and also the limit (92.5 %) based on original standard EN 13850 was easily met. However, the limit set for 2011 (94 %) NPO did not meet (achieved result of 92.15 %) and the same had been expected in 2012 with the limit 95 % [1].

The main objective of this paper is to research possible development of transit time parameters following from mentioned independent measurements. This development could relate to changes in some other indicators connected with layout and organization of logistic network, capacities for processing of concerned postal items and naturally ensuring the whole process of postal service provision. Using of analytic tools for expression of potential influences or dependences could create important supporting step as well.

At first there has been explored correlation between related significant parameters (values see in Tab. 1) as transit time – percentage of *D+1* on-time items x_1 and the number of post offices including sorting centers and other nodes processing postal items x_2 [4]. Real correlation has not been confirmed in accordance with results of testing *t*-statistics of independence. See following Eq. (1), (2), (3):

$$r_{12} = \frac{n \sum x_1 x_2 - \sum x_1 \sum x_2}{\sqrt{[n \sum x_1^2 - (\sum x_1)^2] \cdot [n \sum x_2^2 - (\sum x_2)^2]}}. \tag{1}$$

$$H_0: \rho = 0 \qquad H_1: \rho \neq 0 \tag{2}$$

$$t = \frac{r_{12}}{\sqrt{1 - r_{12}^2}} \sqrt{n - 2} \tag{3}$$

here r_{12} - correlation coefficient of above-mentioned parameters x_1 and x_2; n – number of particular measurements, thus scope of enter data; H_0 - null hypothesis of parameters independence; H_1 - alternative hypothesis of parameters dependence; t - testing statistics of importance [2].

Table 1

Parameter values

Parameter	2003	2004	2005	2006	2007	2008	2009	2010
x_1	93,51	94,87	96,01	94,06	89,15	90,6	92,09	93,19
x_2	3415	3405	3401	3387	3387	3392	3353	3322
Parameter	2011	2012	2013	2014	2015	2016	2017	-
x_1	92,31	94,37	93,11	93,99	93,78	93,91	93,44	-
x_2	3309	3277	3249	3162	3124	2984	-	-

Next step was regression analysis for transit time parameter. We search such function formula, which will have zero sum of residues (difference between real data y_i and smoothed value from regression Y_i, thus minimal sum of squared errors S. Regarding the fact that we work with one-year data, then exploration of individual components of time series including seasonability is irrelevant. See Eq. (4) below [2]:

$$S = \sum (y_i - Y_i)^2 \rightarrow min \tag{4}$$

On the basis of regression results there can be stated quadratic function for development of transit time parameter in D+1 in following form Eq. (5), concrete formula for regression is reflected by Eq. (6) [2]. Function starts in 2008 year because of dropped value in 2007, when one of big sorting centers within postal network was modernized and some problems occurred with introduction of new operational conditions due to extensive changes. The course of function is evident on Fig. 1. Determination index R_2 equals 0.78. Function including 2007 value see on Fig. 2, formula Eq. (7) with determination index 0.89, which is although higher than by previous function, but reflects extraordinary state of operational condition in 2007 year.

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 \tag{5}$$
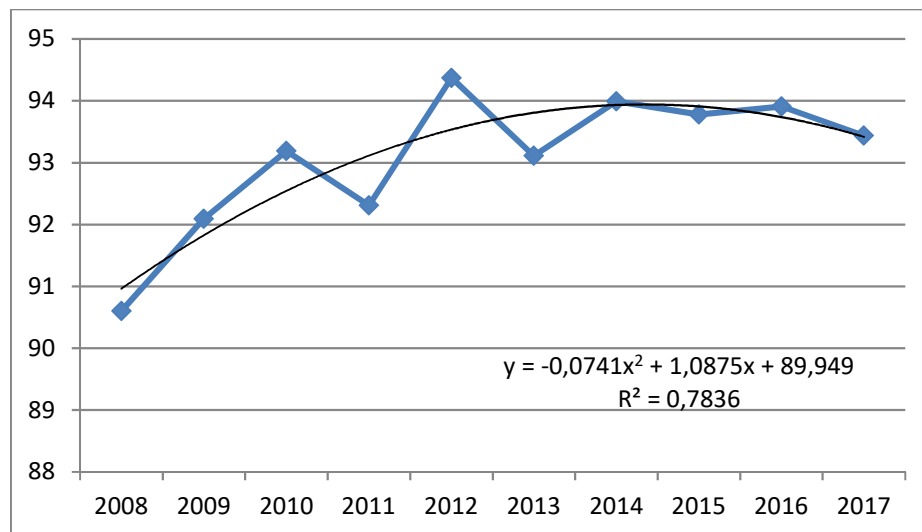
$$Y = 89,949 + 1,0875x - 0,0741x^2 \tag{6}$$

Fig.1 Regression from 2008 year

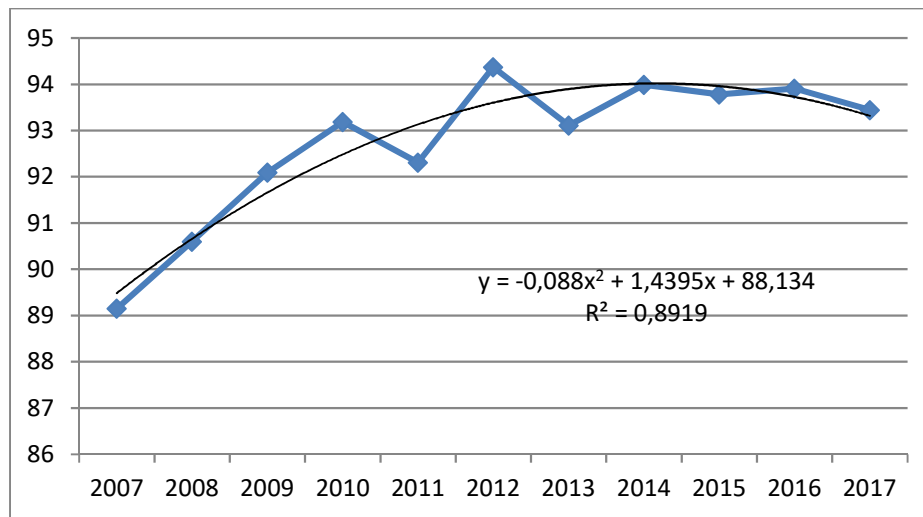$$Y = 88,134 + 1,4395x - 0,088x^2 \tag{7}$$

Fig.2 Regression from 2007 year

Theoretical consideration with regression function of all available data from 2003 year unfortunately does not give reliable result, even when 2007 year value has been released, see Fig. 3 and Eq. (8) with determination index 0.02. Prognosis of this result is evidently baseless.

$$Y = 176,36 - 0,0412x \tag{8}$$

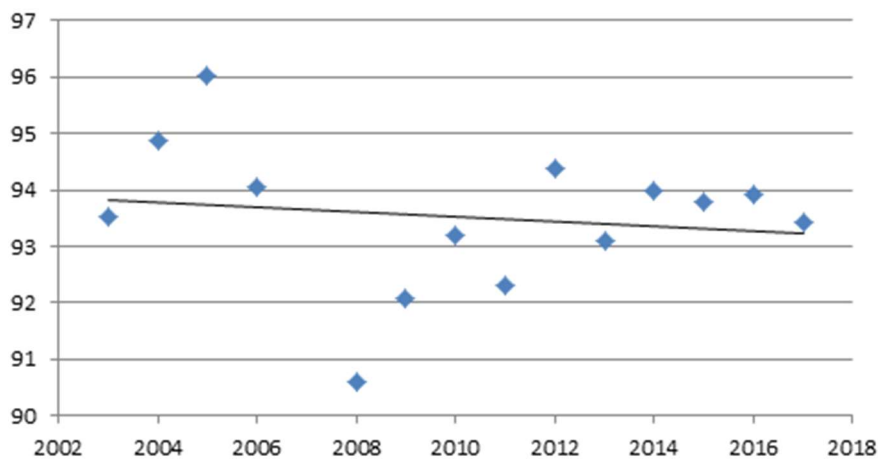Fig.3 Regression from 2003 year without 2007 value

3. Conclusions

The results of regression do not give unequivocal results. Considering all available data we do not rely on results due to relatively significant differences in levels of transit time parameter of on-time performance. In the course of time there have been realized important changes in postal network in relation to changes in structure of demanded services and their provision. Partially reliable function could be regression from 2008 year, but its course and estimations for next years have decreasing character (e.g. for 2018 and 2019 values 92.96 % and 92.34%). But this trend is not admissible – this fact alone due to mentioned obligatory service norm 92 % stated by Regulation Nr. 464/2012 Coll. Current situation reflects developing and adapting process of postal operator to new continuously changing market conditions and real possibilities of technological and operational upgrade.

References

1. **Švadlenka, L.; Chromcová, B.** 2014. Marketing in Postal Services. Pardubice: University of Pardubice, 105 p.
2. **Freedman, D.; Pisani, R.; Purves, R.** 2007. Statistics - Fourth edition. New York: W.W. Norton and Company, Inc. 576 p.
3. Reg. no. 464/2012 Coll. on Establishing of Specifications for Basic Services and on Basic Quality Requirements for Their Provision [online cit.: 2018-05-14]. Available from: http://www.mpo.cz/dokument142643.html
4. Annual reports of Czech Post, SOE [online cit.: 2018-05-10]. Available from: https://www.ceskaposta.cz/en/o-ceske-poste/profil/vyrocni-zpravy