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INVESTIGATION OF BUS AND COACH SERVICE QUALITY ON THE BASIS OF INFORMATION SYSTEM FOR RIGA COACH TERMINAL

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The objective of the article is to analyse data about quality of bus and coach transportation in Latvia. Regional, intercity and international trips arriving in Riga Coach Terminal are examined. Determination and analysis of punctuality indices for different operators, on the different routes of buses, on day times and days of the week and for terminal as a whole may be a basis for a decision-making on quality improvement of passenger services. A solution of this task is an inalienable part of the quality system supported on a Coach Terminal and will serve as a basis for forming the passenger logistic hub on Riga Coach Terminal base.

Keywords: *bus, information system, reliability, punctuality, descriptive characteristics, analysis*

1. Introduction

Nowadays the process of market regulation principles changing from the direction of the state is going on. Taking into account the EU standards the quality of travel is the important moment in determination for the transport operator or mode of transport.

The role of information system in transport is important from the point of view of the service quality for travellers. The development of the information system is an essential factor for coach terminals as passengers' transport infrastructure objects in their transformation into passengers' logistics centres [1]. The first realization of the coach terminal information system (IS) „Baltic Lines" was implemented in Riga Coach Terminal in 2003. From 2004 the system is being used in other cities of Latvia. Nowadays, plans to introduce it in some EU countries are discussed. The description of information flows, functions, technical decisions of the IS „Baltic Lines" has been described in [2] and the possibilities of using this system at the strategic and operative levels have been analysed in [3]. The current developing task in this system is the development of the quality indicators system on the base of sampled data from the IS „Baltic Lines".

2. Measure of Reliability of Bus and Coach Service

The quality of the rendered service is one of the main characteristics of public transport development, which is the necessary condition of demand for it.

There is the system of measures for the evaluation of city bus service quality in [4]. In this research one of these indices does not make sense, some of them must be calculated on the basis of other algorithms.

Measures of bus intercity, regional and international transportation quality can be classified in 2 groups: providing availability and providing comfort and convenience from the passenger's point of view by this mode of transport. Availability is foremost provided by a network, within the limits of which service is carried out by this mode of transport and time-table (by time and frequency, to the proper queries of users). Comfort and convenience are connected with reliability of service; first of all, it's joining with other modes of transport, passenger seating capacity.

As this mode of transport is in competition with railway (and private cars also) in Latvia the measures that represent comfort and convenience are of great importance. Railway is the mode of transport, which doesn't feel the influence of congestion or weather conditions, and that's why it is more reliable mode of transport and also is the winner in competition with bus by travel time. On the other hand, it yields to bus transportation by the level of availability (absence of network in some districts, foremost). In this competition, multiplying a comfort and service of bus transportation can play a solution role in the choice of this mode of transport. And if time of moving often differs insignificantly (example), reliability can become the problem for a bus travel. The exact observance of time-table becomes the important property.

In this research the main attention has been paid to measure the reliability of coach and bus service. Reliability is a measure determining bus service level from the viewpoint of users as well as operators.

One of the considered in [4] reliability indices is punctuality index. Punctuality of bus operation is a quantitative measure of reliability from the viewpoint of users. This index indicates the magnitude of time gap between actual and scheduled arrival times. Research of this index in combination with different factors influencing on this index and in an ideal development of the model for evaluation of punctuality is a difficult task, possible only at presence of enormous amount of information and its plenitude. The presence of the developed information system of Riga Coach Terminal makes possible the solution of such task in the decision-making designed module.

The task of exposure of different factors influencing this index stronger than others is important for top management first of all. To such factors potentially the following can be referred [4]:

- Traffic conditions,
- Road conditions (weather),
- Road length and number of stops,
- Operation control strategies.

3. Data Collection

The system solution of this task requires fixing of real arrived times at all intermediate stops. It is possible equipping GPS in all busses, that it is planned to carry out by the end of 2009. Information has been collected about times of buses arriving on the final bus stop in Riga bus terminal for July 2005, 2006 and 2007.

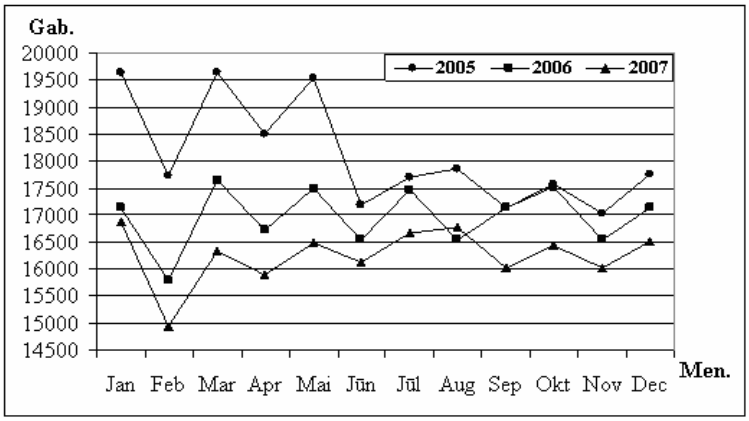


Figure 1. *Time series of the inbounding trips to Riga Coach Terminal*

In this research the data about delays on the last stop – Riga Coach Terminal in July 2005, 2006 and 2007 have been analysed. In 2005, Riga Coach Terminal executed 17703 inbound trips, in 2006 – 17470 trips, and in 2007 – 16680 inbound trips and in more than 70 directions (see Figure 1 and Table 1).

Besides, the decision of this task in relation to Riga Terminal is important also because the space of the terminal is limited and for today dissatisfies the tasks of providing comfort and safety to the passengers. Delay of arrival not only violates the plans of passengers but also often complicates the problems of placing for loading and unloading on platforms.

Assumption is accepted – to fix as a delay only delay for a time more than 10 minutes. On every delay a date, time, operator, trip and reason of delay have been recorded.

4. Results of Statistical Treatment

4.1. Descriptive Characteristics

In Statistica/Win package descriptive characteristics of delays of trips arriving at the Riga Coach Terminal (See Table 1) have been obtained.

Table 1. Descriptive statistics for the sample with trip delay in July 2005, 2006 and 2007

Year	N	Valid N	%	Mean	Median	Mode	Freq.	Min.	Max.	5%	95%	Variance	Std. Dev
2005	17703	1078	6.09	38.01	19.00	10.00	118.00	10.00	646.00	10.00	122.00	3175.82	56.35
2006	17470	1440	8.24	29.64	19.00	10.00	144.00	10.00	411.00	10.00	89.00	958.40	30.96
2007	16680	1129	6.77	27.07	16.00	10.00	159.00	10.00	447.00	10.00	80.00	1731.52	41.61

As it is obvious from the results of treatment of statistics on delays for July 2007:

- the delay of arrival in Riga is established at 1129 trips, that is 6.77% of the common number of trips;
- the mean duration of delay – 27.07 minutes;
- the most widespread delay makes 10 minutes (*mode*) and that delays compile 14% of total amount of delay;
- 50% delays exceed 16 minutes and 5 % delays make compile 80 minutes;
- the expected value of delay is covered by an interval (24.65; 29.50) with the confidence level 0.95;
- a maximal delay in 2007 compiled a bit less than 8 hours (447 minutes) (in 2005 – over 10 and a half of hours);
- deviation of delay – almost 42 minutes.

It is possible to establish a small increase in 2007 of both absolute number of delays and relative number (in %), if to compare these results to the indices for 2005. As a positive tendency it is possible to mark diminishing in 2007, if compared to 2005, average, maximum of delay and a median, and also characteristics of delay scattering. It is possible to establish a tendency to multiplying the number of small delays. Research of distributing of delays by duration also confirms it. On Figure 2 the distribution of delays by duration is presented. Predominance of delays from 10 to 20 minutes is confirmed in 2007. But at that a part of delays of trips for more than 20 minutes is rather large – more than 30%.

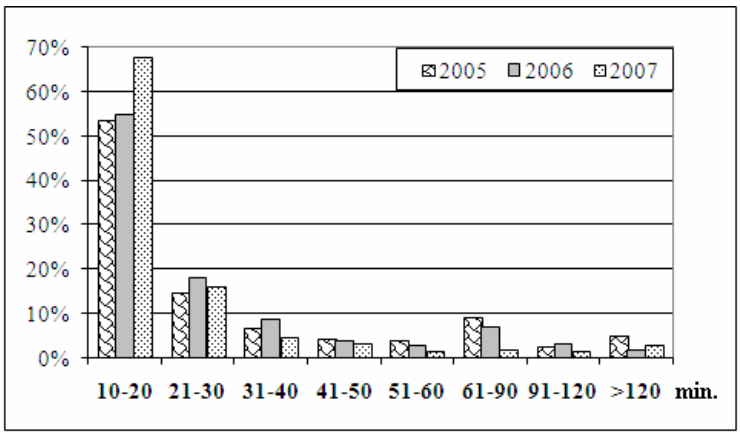
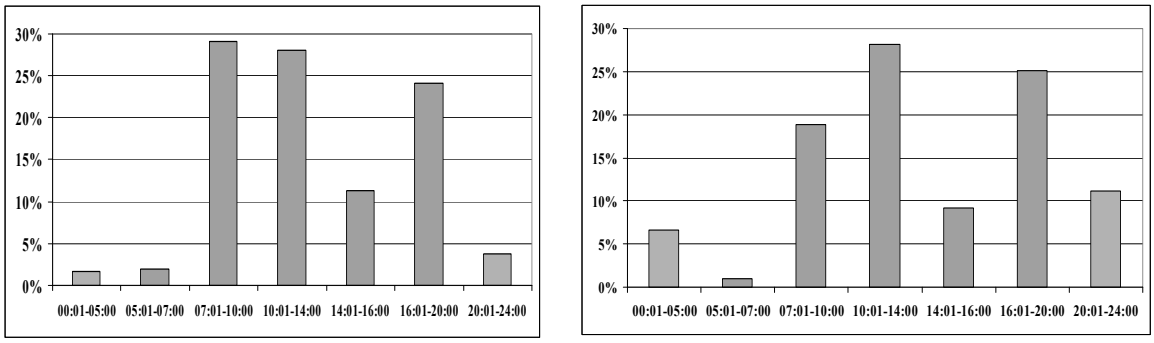


Figure 2. *Distribution of delays by duration (arriving at the Riga Coach Terminal)*

On Figure 3 the distribution of delays on arriving at the Riga Coach Terminal by the time of the day is presented. As it is obvious from the graph in 2007 most of delays is at hours 7.00–14.00 and 16.00–20.00, thus this tendency has become stronger if to compare to 2005. It is possible to suppose that one of the factors, influencing it, is connected to congestions in the streets of Riga during these hours. Certainly, this supposition requires a separate verification.



a) July, 2007 *b) July, 2005*

Figure 3. *Distribution of delays by time of the day*

We can suppose that the frequency of delays depends on the frequency of trips in these time periods (at hours 7.00–14.00 and 16.00–20.00) but it is known [6] that the amount of trips is approximately uniformly distributed between hours 10.00 and 21.00.

4.2. Analysis of Dependence of Delay on the Day of a Week

Distribution of delays by duration for the different days of a week is showed on Figure 4. Evidently, the most prolonged delays are more frequent at weekends.

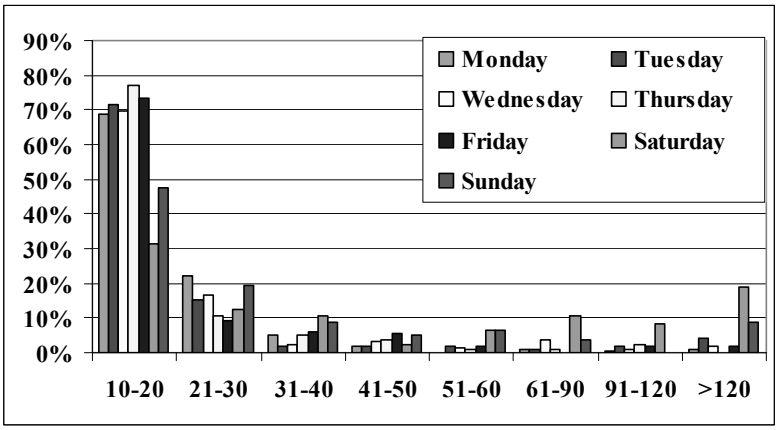


Figure 4. *Distribution of delays by the day of a week (July, 2007)*

In Table 2 the descriptive characteristics of delays by the days of a week for the examined time are presented. Evidently there are considerably less delays at weekends in 2007 if to compare with working days, although the amount of trips does not differ so meaningfully (see Figure 5). However mean value and scattering of delays is considerably greater at weekends.

Table 2. Descriptive statistics for trip delay in different days of a week in July 2005, 2006 and 2007

Day	Delay Time for 2005			Delay Time for 2006			Delay Time for 2007		
	Number	Means	Std. Dev	Number	Means	Std. Dev	Number	Means	Std. Dev
1	146	28.53	31.46	301	26.13	26.40	299	20.70	24.52
2	142	25.28	21.81	226	25.73	23.22	193	26.07	35.05
3	140	32.87	35.52	215	29.19	36.84	211	25.45	37.36
4	151	38.63	55.77	183	30.91	27.60	139	18.74	14.36
5	202	41.88	77.84	211	29.19	25.02	161	24.46	36.27
6	168	54.28	67.17	147	37.65	48.09	48	80.44	102.77
7	129	40.33	63.04	157	34.33	28.93	78	45.71	64.71
Total	1078	38.01	56.35	1440	30.45	31.2	1129	27.07	41.61

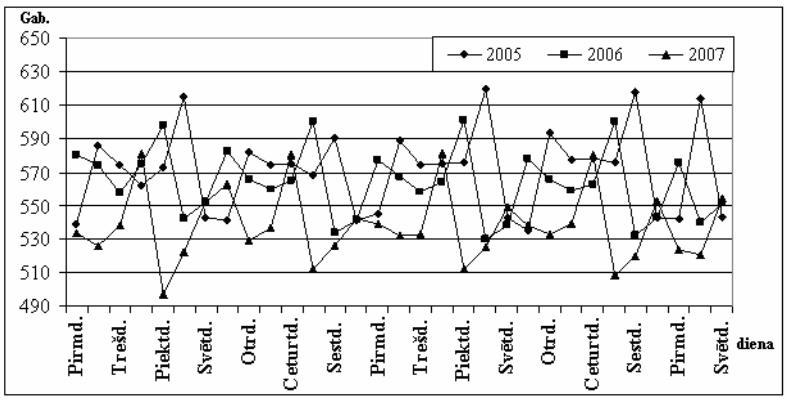


Figure 5. *Distribution of the number of trips by the days of a week (4 weeks, July, 2005 and 2007)*

During testing the hypothesis about insignificance of delay value dependence on the day of a week the value of F criterion is significant and, consequently, the hypothesis about insignificance is rejected for data of 2005, 2006 and 2007 (see Table 3). However, the distinction between delays at weekends and working days had been considerably increased to 2007.

Table 3. Descriptive statistics for delays sampling for July, 2005, 2006 and 2007

	SS	df	MS	SS	df	MS	F	p
2005	88095.83	6	14682.64	3332266	1071	3111.360	4.719	0.000094
2006	20426.35	6	3404.4	1358477	1432	948.66	3.589	0,001553
2007	187406.2	6	31234.37	1765744	1122	1573.746	19.847	4.00E-22

4.3. Analysis of Dependence of Delay on Direction and Trip

The supposition that the number and duration of delays are influenced by congestions in the streets of Riga has been done earlier. All trips have been divided into 4 directions, which determinates the gate of entry to Riga: 1 – Zemgale (Z), 2 – Latgale (L), 3 – Kurzeme (K), 4 – Vidzeme (V) (see Figure 6).

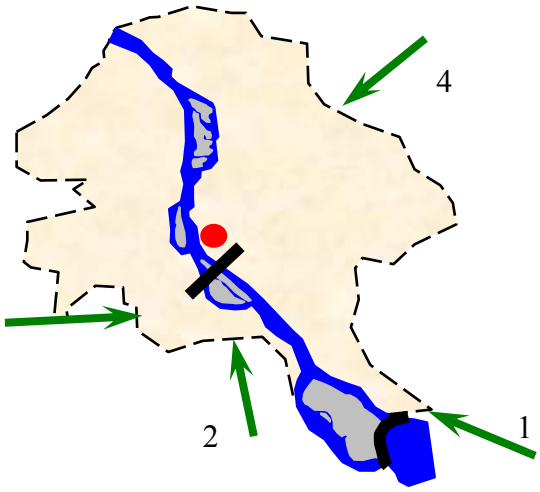
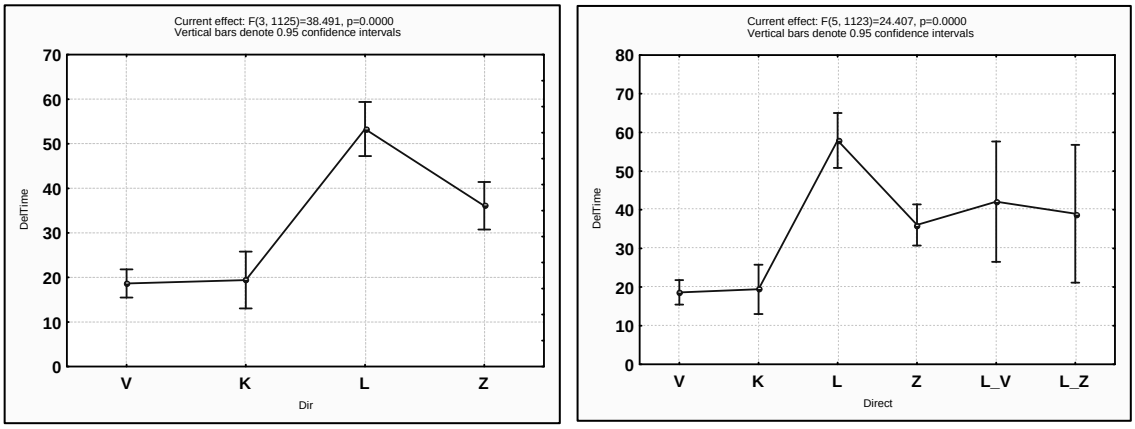


Figure 6. *Basic directions of buses entry to Riga*



a) 4 gates *b) 6 gates*

Figure 7. *95% confidence intervals for delay depending on directions (July, 2007)*

On Figure 7a) it is clearly evident that the value of the delay is considerably greater than in case of the Latgale's direction of trips. Changing of entry direction to the city is typical for four international trips. For example, trips from Minsk or Lvov can follow in Riga to the station through Latgale's or Zemgale's direction, and trips from Moscow and Saint Petersburg – either through the Latgale's or through Vidzeme's direction. On Figure 7b*)* this case of factor influence analysis is presented (6 levels – directions of entry and the duration of delay). Even in this case the Latgale's direction is meaningfully outstanding by the duration of delay. The F criterion is equal to 24.41 at critical level of F(3,1125) = 2.22. In case of 4 directions (without taking into account possible changing of direction) the F criterion is equal to 38.45 at critical level of F (3,1125) = 2.61.

Delays for over 2.5 hours in July 2005–2007 have been also analysed (see Table 4). Among them in July, 2005 the first place is occupied by Moscow with maximal value of delay – 625 minutes and in July, 2007 the first place is occupied by Odessa with maximal value of delay in July – 447 minutes.

Table 4. Distributing of delays of over 2.5 hours for July, 2005–2007

2005			2006			2007		
From…	**N**	**Max**	**From…**	**N**	**Max**	**From…**	**N**	**Max**
Moscow	11	625	Cologne	2	262	Odessa	4	447
London	8	388	Moscow	2	235	Tallinn	4	367
Cologne	2	288	London	1	313	Kiev	3	443
Warsaw	2	240	Truskavec	1	284	Kishinev	2	371
Paris	2	227	Stuttgart	1	212	Cologne	2	340
Roma	1	646	Vilnius	1	178	London	1	286
Kiev	1	339	Simferopol	1	171	Doneck	1	212
Vilnius	1	271	Tallinn	1	164	Truskavec	1	207
Stuttgart	1	258	Bonn	1	161	Bonn	1	205
Tallinn	1	228	Doneck	1	160	Berne	1	200
Lvov	1	207				Krakow	1	190
St-Petersburg	1	170						
Total	**32**			**12**			**22**	

It is clear that considerable delays showed in Table 4 relating to international trips are also connected to the problems of border crossing.

5. Conclusions

The task of estimating the quality of services from viewpoint of reliability is very important for the area of bus and coach operations. In the presented research delay time of arrival of buses at Riga Coach Terminal for July, 2005, 2006 and 2007 has been collected and analysed.

The conducted calculation and analysis of empiric descriptions of delay allows developing algorithms for realization of the proper tasks in analytical part of Information System with the purpose of decision of strategic and tactical tasks of terminal management. In addition, this information can be useful from |the standpoint of simulation model construction of bus terminal with the purpose of critical situation analysis during a day. Examining quality of information, one of the major terms of high-quality simulation model, the real information on delay will allow making the model more realistic [5].

One of the important results of this analysis is the discovery of the company being a leader by trip delays with the aim to improve the passenger service quality.

The realization of this task gives the possibility to analyse the reliability of the bus service and to improve the level of quality on the base of these results. Also, the possibility to analyse the factors, which influence on reliability of the bus and coach service is of great importance. The next step of investigation is to analyse the dependence between delay and the following factors: traffic and road conditions; route length and bus occupancy.

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