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THE EVALUATION OF FACTORS INFLUENCING FLIGHTS DELAY AT CZECH INTERNATIONAL AIRPORTS

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Abstract

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The main goal of this article was examination of factors influencing flights delay at three most important international airports in Czech Republic. Data of selected Airlines operating in Czech Republic, whose flights are mainly oriented to international airports in Prague, Brno and Ostrava, were used for needs of this article. Analysis of contingency tables including Pearson chi-squared test was used for data processing. Dependences were presented in graphical form by correspondence analysis.

Results from analysis showed that delay caused by technical reasons and maintenance is the most frequent in Prague as well as delay caused by high concentration of airspace, operational management and crew duty norms. Problems caused by departure delay from previous destination are significantly more frequent in Brno and Ostrava by reason of small number of alternative available aircraft. Delays caused by supplier (handling, catering, …) are mostly short, in particular by reason of potential penalty. Delays caused by technical problems and necessary maintenance service last mostly longer time and are more frequently on aircraft of type Boeing. Delays of borrowed aircraft of type Airbus are more frequently caused by rental and control of this aircraft by other companies which causes communication and planning difficulties.

Keywords: flights delay, airlines delay codes, international airports, Czech Republic, correspondence analysis, contingency tables, pearson chi-squared test

INTRODUCTION

The air traffic infrastructure has also significantly expanded since the Czech Republic joined the European Union. There are 91 civil airports in the Czech Republic today, which can be split into three groups: airports of nationwide importance (Prague-Ruzyně Airport – Václav Havel Airport Prague), regional airports of major importance (Brno, Ostrava, Pardubice and Karlovy Vary) and regional airports of minor importance, so-called aeroclub and sports airports. The regional airports of major importance include public domestic, as well as international airports, which provide passengers, tourists and entrepreneurs with access to regions, being equipped with the required navigation equipment and runway systems, and offering services to passengers and airlines (Czech ministry of foreign affairs, 2015).

The Czech Republic has the biggest international airports in the following cities: Prague, Brno, Ostrava, Karlovy Vary and Pardubice. We are oriented in our article only on three international airports with the heaviest traffic:

- Prague-Ruzyně Airport – Václav Havel Airport Prague – PRG

  This is the biggest airport in the Czech Republic, being used by the majority of foreign clients. It was built in 1933–1937. It is designated for international and domestic traffic, regular and irregular flights. It is 17 km from Prague's city centre, situated in the northwest outskirts of the city. The regular and irregular direct flights between Prague and 130 world destinations are operated by approximately

51 airlines and the airport checks in more than 11 million passengers a year (Czech ministry of foreign affairs, 2015; Prague Airport, 2015).

- Brno-Tuřany Airport – BRQ

  This airport was opened in 1954 and it is the second biggest international airport in the Czech Republic. In 2009, the Brno Airport checked in around half a million passengers. The airport is situated right by the D1 highway in the Brno – Olomouc direction, which makes it very easy to reach.

- Ostrava-Mošnov Airport – OSR

  It is situated about 20 km southwest of Ostrava, by the town of Mošnov. It was opened in 1959. The airport checks in approximately 300,000 passengers a year. The Ostrava Airport operates regular flights, as well as charter flights in the tourism season (Czech ministry of foreign affairs, 2015).

One of the airlines operating in Czech Republic was selected for this article. Fleet of this airline consists of Boeings 737-800, Boeings 737-700 and Airbuses A320-200.

Boeing 737 is two-engined narrow-airframe passenger jet for short and medium distances. It is the most common passenger jet in the world, which was manufactured in more than 8,000 pieces. This plane is nowadays manufactured in variants -600, -700, -800, -900 and new machines are developed.

Boeing 737-700, which is in fleet of the selected airline, is a basic type of new generation. Maximum capacity is 149 passengers. Boeing 737-700 has range of 6,037 km. Other planes of the fleet bear indication – Boeing 737-800, which is an extended version of Boeing 737-700. Maximum capacity is 189 passengers. Boeing 737-800 has range of 5,445 km. Boeings of both these variants have travel speed around 828 km/hour. (max. speed 959 km/hour.). Most of aircrafts have winglets at the end of wings, which may decrease resistance and save fuel (Airways, 2015; Boeing, 2015).

Airbus A320-200 is a civil transport aircraft for short and medium distances and is manufactured by Airbus Company. A320-200 is also a version from the fleet of the selected airline and has small winglets at the end of wings. Maximum capacity is 180 passengers and travel speed is around 835 km/hour (max. speed is 925 km/hour). Airbus A320-200 has range of 5,615 km (Airbus, 2015).

As cost effective operation as possible is a target of each airline. One of the reasons why to decrease delay is also an obligation to pay out a compensation to passengers, see European laws on air passenger rights – Regulation (EC) No 261/2004 of the European Parliament and of the Council. More detailed conditions for compensations are available at e.c. (European Consumer Centre Czech republic, 2015).

To mention only briefly how long the delay must be so that the passenger could be entitled to financial compensation from airline's side. They are – two hours in case of all flights of less than 1,500 km, respectively three hours or more in case of all flights within EU longer than 1,500 km and for all other flights between 1,500 and 3,500 km, or four hours in case of all other flights. And how much can passenger recover from airlines if the conditions are fulfilled? It is 250 EUR for all flights of maximum 1,500 km, respectively 400 EUR for all flights of more than 1,500 km within the EU and for all other flights between 1,500 and 3,500 km, or 600 EUR for all other flights (European Consumer Centre Czech republic, 2015).

The fact that delay is a problem not only for passengers but also for airport staff is described for example in an article (Wu, Truong, 2014). It deals with comparison IATA[1] delay data system and coding system developed by authors. More details in article (Hsu, Chao, Hsu, 2015) are offered by strategy for reduction of delays, for example setting scheduled times for completion of a process, increasing the number of service counters, and priority service for emergent flights.

The economics including possible optimizing is analysed for example in an article (Pan, Wang, Zhou, 2015). An article (Xing, Yu, Lu, 2014) analyses a model describing optimization of subsequent flights in order to prevent spreading and chaining of delays. Connection between delay and higher consumption of fuel is then described in an article (Ryerson, Hansen, Bonn, 2014), which came to conclusion that an inefficient flight plan is a significant cause of delay and thus also higher consumption of fuel. An article (Zou, Hansen, 2014) deals with impact of delay on flight tickets price and frequency of flights in USA. Authors found that proportionate airport delay reduction across the system can result in annual fare reduction in the order of billion dollars.

Dependence of flights delay on destination aerodrome was analysed in an article (Fleurquin, Ramasco, Eguiluz, 2014).

MATERIALS AND METHODS

For the purpose of this article we were focused on data from one of the airlines operating in Czech Republic. These primary data were examined in the busiest period for this airline (1. 6. 2013–30. 9. 2013). Data include information per flight, aerodromes and departure airports, types and registrations of aircrafts, time of departure and arrival, length of delay and reason for delay according to the airlines delay codes (in accordance with IATA). Substantial part of data is categorical.

In the categorical data analysis easy way to illustrate the data relations are contingency tables.

1 The International Air Transport Association (IATA) is a trade association of the world's airlines

With respect to the character of the data we use suitable tests of the independence. According to (Řezanková, 1997) in the case of contingency table of the type *r* x *c* (*r* is the number of rows, *c* is the number of columns) we usually use statistic:

$$\chi^2 = \sum_i \sum_j \frac{(n_{ij} - e_{ij})^2}{e_{ij}},$$

e_{ij} is an expected and n_{ij} observed frequency. We use the statistic χ^2 in Pearson's chi-square test with asymptotically $\chi^2_{(r-1)(c-1)}$ distribution and the presumption of the independence. For further details see (Hindls, 2003).

Expected frequencies must be more than 5, see (Hendl, 2006). In some studies this rule is not so strict, it is enough to have at most 20% of frequencies less than 5 but all of them at least 1, see (Agresti, 1990). According to (Anděl, 2005) if frequencies are too small, we can use Fisher's exact test or we can calculate simulated p-value of χ^2 statistic.

Correspondence analysis (CA) is a multivariate statistical technique. It is conceptually similar to principal component analysis, but applies to categorical rather than continuous data. In a similar manner to principal component analysis, it provides a means of displaying or summarising a set of data in two-dimensional graphical form (Zámková, Prokop, 2014).

All data should be nonnegative and on the same scale for CA to be applicable, and the method treats rows and columns equivalently. It is traditionally applied to contingency tables – CA decomposes the chi-squared statistic associated with this table into orthogonal factors. The distance among single points is defined as a chi-squared distance. The distance between *i*-th and *i'*-th row is given by the formula

$$D(i,i') = \sqrt{\sum_{j=1}^{c} \frac{(r_{ij} - r_{i'j})^2}{c_j}},$$

where r_{ij} are the elements of row profiles matrix **R** and weights c_j are corresponding to the elements of column loadings vector c^T, which is equal to mean column profile (centroid) of column profiles in multidimensional space. The distance between columns *j* and *j'* is defined similarly, weights are corresponding to the elements of the row loadings vector *r* and sum over all rows.

The total variance of the data matrix is measured by the inertia, see, e.g., (Greenacre, 1984), which ressembles a chi-square statistic but is calculated on relative observed and expected frequencies.

In correspondence analysis we observe the relation among single categories of two categorical variables. Result of this analysis is the correspondence map introducing the axes of the reduced coordinates system, where single categories of both variables are displayed in graphic form. Using graphic tools of this method it is possible to describe association of nominal or ordinal variables and to obtain graphic representation of relationship in multidimensional space. The aim of this analysis is to reduce the multidimensional space of row and column profiles and to save maximally original data information (Hebák *et al.*, 2007). Each row and column of correspondence table can be displayed in *c*-dimensional (*r*-dimensional respectively) space with coordinates equal to values of corresponding profiles. The row and column coordinates on each axis are scaled to have inertias equal to the principal inertia along that axis: these are the principal row and column coordinates. Software UNISTAT and STATISTICA was used for processing of primary data.

RESEARCH RESULTS

5777 flights in total were carried out in reference period from PRG, BRQ, OSR. For details about number of delayed flights see Tab. I.

It is obvious from the relative frequencies table (Tab. I), that the most of delayed flights are from Prague (36%), while at other airports it is only around 27%. This is probably a logical consequence of the airport size and number of flights.

Dependence of length of the delay on particular airports (PRG, BRQ, OSR) was monitored in Tab. II. It can be seen in this relative frequencies table that the length of the delay doesn't differ significantly on individual airports. Statistical dependence is not significant, $p = 0.31$. It can be only mentioned, that long delays over two hours are somehow more frequent in Ostrava (11% as opposed to 6% elsewhere), see Tab. II. This fact can be caused by the low number of available aircrafts in Ostrava, thus there is a smaller possibility to replace aircrafts operationally where necessary.

Furthermore the delay in dependence on month to month in reference period was monitored. It can be seen in relative frequencies table (Tab. III) and also in correspondence map (Fig. 1), that length of the delay differs from month to month. In June the most frequent delays range from 1:01 to 1:30, in July the delays of 1:31 and more outweigh, the short

I: *Relative frequencies: Number of carried out and delayed flights*

	TOTAL	PRG	BRQ	OSR
Carried out flights in total	5777	4266	783	728
Delayed	1946	1536	216	194
Percentage	33.7%	36.0%	27.6%	26.6%

Source: own calculation

II: *Contingency table – Column relative frequencies: Dependence of length of the delay on particular airport in Czech Republic*

	PRG	OSR	BRQ
0:15–0:30	44.27%	40.21%	43.98%
0:31–1:00	28.78%	30.93%	32.87%
1:01–1:30	14.00%	11.34%	11.57%
1:31–2:00	6.64%	6.70%	5.09%
2:01 and more	6.32%	10.82%	6.48%

Source: own calculation

III: *Contingency table – Column relative frequencies: Dependence of length of the delay on reference period*

	June	July	August	September
0:15–0:30	45.38%	41.23%	46.26%	42.11%
0:31–1:00	26.72%	30.87%	33.07%	26.97%
1:01–1:30	15.52%	11.63%	12.99%	13.60%
1:31–2:00	5.89%	8.25%	4.33%	7.68%
2:01 and more	6.48%	8.03%	3.35%	9.65%

Source: own calculation

delays up to one hour are the most frequent in August and the long delays over two hours prevail in September. The reason for this fact is decreasing number of aircrafts in September. Airlines borrow aircrafts only for three months (June, July and August). Maintenance of aircrafts is also carried out in September, which causes difficult elimination of delays by operational replacement of aircrafts. Delays in August are short, because all processes are already established and familiar and at the same time airlines dispose of the same number of aircrafts like in the previous months while the number of flights is lower overall. There are the most of flights in July therefore the delays are apparently the longest.

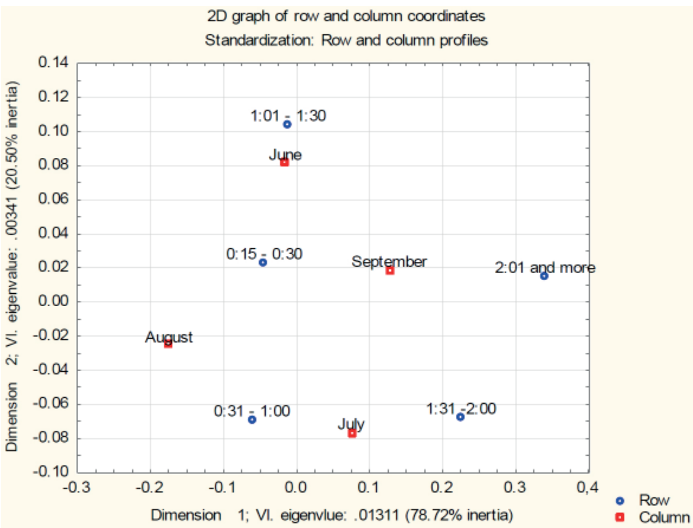
In determining of dependence of length of the delay on the aircraft type statistical dependence was not proven $p = 0.51$. Nevertheless it can be seen from the relative frequencies (see Tab. IV), that there is the smallest representation of aircraft Boeing 737-800 at the short delays up to 30 minutes. These short delays can be partly eliminated at this type of aircrafts 737-800 by a high number of these aircrafts and possible replacement by another aircraft of the same type. This solution is not possible in case of longer delays, because the aircraft is needed somewhere else.

It is apparent from the relative frequencies table (Tab. V) and correspondence map (Fig. 2), that length of the delay depends on time of departure from monitored airports, $p < 0.001$. Short delays up to 30 minutes are significantly more frequent at night (0:01–6:00), it counts 58% of delays overall, in other parts of day it is only around 40% of these short delays. The situation is more or less balanced at longer delays up to one hour. Delays over 1 hour are more frequent in the afternoon and in the evening. Longer delays over one hour occur equally during the day, but they occur only rarely (5–8% of all delays) It is obvious that during the night the downtime between flights is longer and therefore there is

IV: *Contingency table – Row relative frequencies: Dependence of length of the delay on aircraft type*

	0:15–0:30	0:31–1:00	1:01–1:30	1:31–2:00	2:01 and more
B 737-700	50.78%	29.69%	9.38%	4.69%	5.47%
B 737-800	42.82%	29.50%	14.05%	6.75%	6.87%
A320	48.37%	27.45%	11.76%	4.58%	7.84%

Source: own calculation

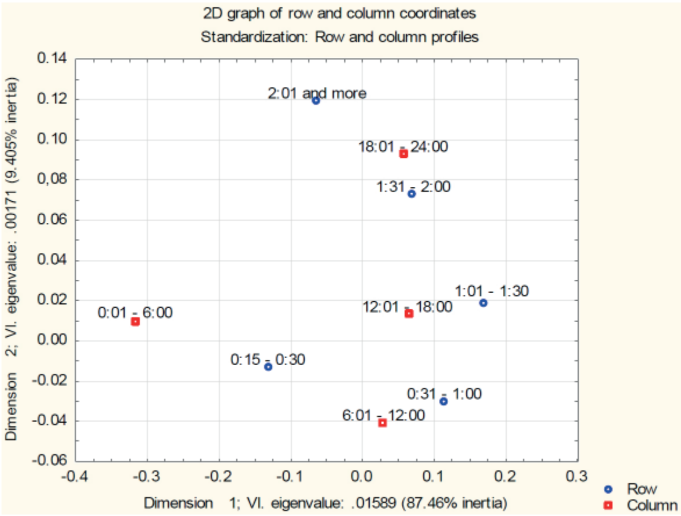


1: *Correspondence analysis: Dependence of length of the delay on reference period*
Source: own calculation

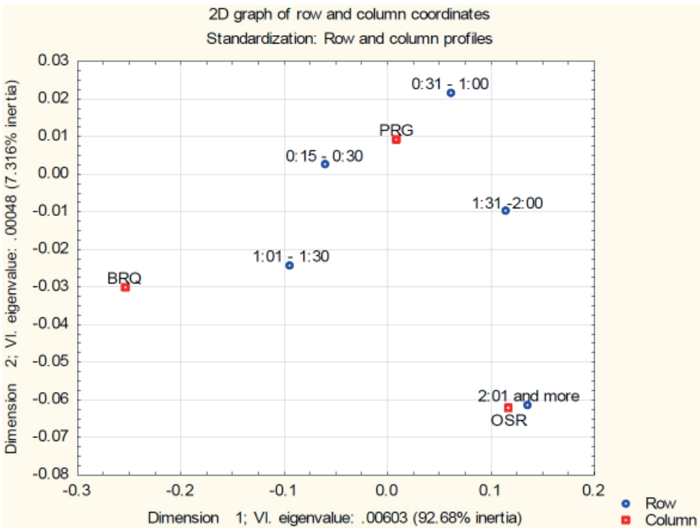
V: *Contingency table – Column relative frequencies: Dependence of length of the delay on time of day*

	0:01–6:00	6:01–12:00	12:01–18:00	18:01–24:00
0:15–0:30	57.99%	43.13%	40.42%	40.09%
0:31–1:00	20.82%	31.09%	31.33%	28.63%
1:01–1:30	7.81%	13.73%	14.83%	14.98%
1:31–2:00	5.20%	6.35%	6.15%	8.37%
2:01 and more	8.18%	5.70%	7.27%	7.93%

Source: own calculation



2: *Correspondence analysis: Dependence of length of the delay on time of day*
Source: own calculation



3: *Correspondence analysis: Dependence of length of the delay at arrival on particular airport in Czech Republic*
Source: own calculation

enough time for maintenance and the delays at night are short. At the same time the airspace capacity is not limited at night, because there are generally less flights at night.

Furthermore dependence of length of the delay at arrival on particular airport PRG, BRQ, OSR was monitored, see Fig. 3. Significant statistical dependence of length of the delay at arrival on particular airport in Czech Republic was not proven ($p = 0.061$). It can be only stated according to relative frequencies that shorter delays up to 30 minutes are slightly more frequent in Brno. Long delays over two hours are then the most frequent in Ostrava, the situation is thus similar to departures.

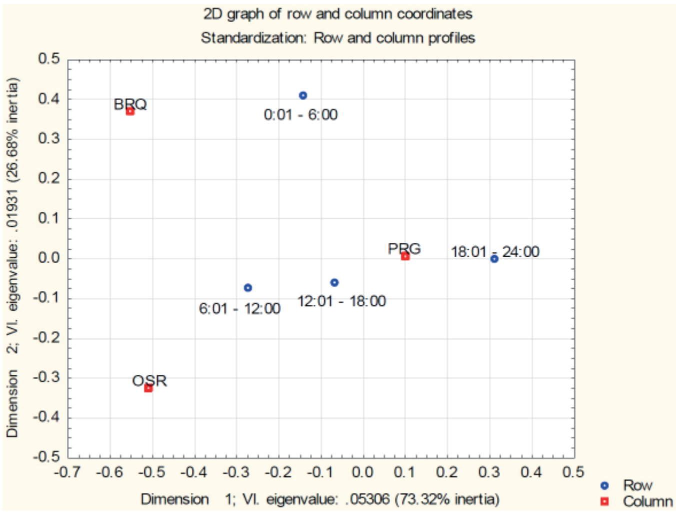
VI: *Contingency table – Column relative frequencies: Dependence of delay of arrival at destination aerodrome on time of day*

	PRG	BRQ	OSR
0:01–6:00	9.57%	24.26%	3.50%
6:01–12:00	20.80%	34.32%	42.00%
12:01–18:00	32.76%	33.73%	44.00%
18:01–24:00	36.87%	7.69%	10.50%

Source: own calculation

Subsequently dependence ($p < 0.001$) of delay of arrival at destination aerodrome on time of day was proven. Delayed arrivals at night (i.e. 0:01–6:00) significantly exceed in Brno (24%) compared to other airports (3–9%). The least of delays of arrival in the morning are in Prague (21%) compared to Brno and Ostrava (34% a 42%). The most of delays of arrival in the afternoon are in Ostrava (44%), other airports range around 33%. The most of delays of arrival in the evening (18:01–00:00) are in Prague (37%), at other airports up to 10%. (see Tab. VI, Fig. 4) This dependence is probably caused by the composition of fleet. In Prague there is a possibility to replace aircrafts operationally in the morning which decreases length of delay also on arrivals. Delays collected during the day are then accumulated in Ostrava in the afternoon. The reason is concentration of Airbus aircrafts in Ostrava, which are mostly borrowed and operated by other companies which accumulates delays of arrivals and departures. Delays in the evening also increase in Prague which is also caused by the accumulation of delays during the day.

It is evident from further analysis which reasons for delays (see Tab. VII, Tab. VIII) prevail at each selected airport. The reason AIC appears significantly only in Prague (20%), elsewhere only negligible. The reasons PB and ARH appear only rarely in general. There are almost no problems with passengers and their baggage at particular airports in Czech Republic. The reasons TAE, FOC and AGA are the most frequent in Prague. These reasons are less frequent at other airports. There is a technical base in Prague; therefore repairs of aircrafts are carried out particularly at this airport and therefore the delays caused by technical maintenance appear here the most frequently. In PRG there are also



4: *Correspondence analysis: Dependence of delay of arrival at destination aerodrome on time of day*
Source: own calculation

VII: *Airlines delay codes*

Codes	Explanation
AIC	Operational reasons of airline
PB	Delay because of passengers and their baggage
ARH	Delay caused during the aircraft handling by suppliers – handling, fuel, catering
TAE	Delay caused by technical maintenance or aircraft defect
FOC	Delay caused by operational control and crew duty norms
ATFMR	Delay caused by air traffic control
AGA	Delay caused by airport limitation
R	Reaction codes – Delay caused by delay of previous flight
MISC	Specific delay, can't be included to categories

Source: Eurocontrol, 2015

VIII: *Contingency table – Column relative frequencies: Dependence of delay reason on particular airport*

	PRG	BRQ	OSR
AIC	19.79%	2.78%	0.52%
PB	2.41%	0.00%	1.55%
ARH	1.63%	0.00%	0.00%
TAE	10.03%	3.24%	4.64%
FOC	6.12%	4.63%	2.58%
ATFMR	10.16%	8.33%	8.25%
AGA	5.99%	0.46%	1.03%
R	41.47%	76.39%	80.93%
MISC	2.41%	4.17%	0.52%

Source: own calculation

IX: *Contingency table – Column relative frequencies: Dependence of delay reason on length of the delay*

	0:15–0:30	0:31–1:00	1:01 and more
AIC	12.66%	15.71%	21.73%
PB	3.28%	2.09%	0.19%
ARH	2.70%	0.17%	0.38%
TAE	5.98%	6.98%	15.19%
FOC	8.32%	4.36%	2.50%
ATFMR	14.54%	5.41%	6.73%
AGA	7.97%	3.66%	1.15%
R	40.68%	60.21%	50.96%
MISC	3.87%	1.40%	1.15%

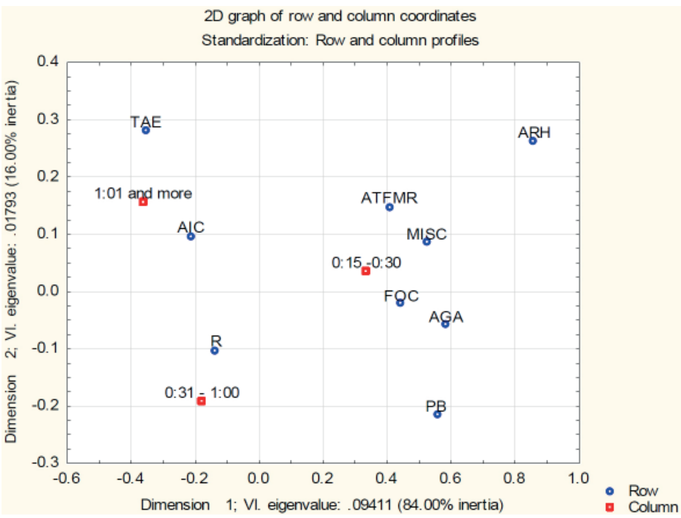
Source: own calculation

the most frequently delays caused by operational control and crew duty norms. It is probably caused by the highest number of flights in total. The reason AGA can be explained by intensity of traffic at Prague airport. Situation with the reason ATFMR is similar, more frequent in Prague. The reasons are probably over-filled slots – air space around Prague is much more concentrated than around other airports. The reason R appears generally very often, significantly more frequently in Brno and in Ostrava, around 80%, in Prague only 41%. Optimization of delays is more easily implemented in Prague because of the higher number of aircrafts.

It was not possible to carry out neither Pearson test nor correspondence analysis by reason of small frequencies in contingency table.

Dependence ($p < 0.001$) of length of the delay on delay reason of selected airline's aircrafts was proven by consequent analysis (see Tab. IX, Fig. 5). The reason AIC predominates according to the carried out analysis at longer delays over 1 hour, 22%. It can be stated, that frequency of this reason increases with the length of the delay. The reasons PB and ARH occur generally very rarely, they are a little bit more frequent at short delays. Suppliers obviously try to minimise delays caused by them, otherwise they can penalised. The reason TAE significantly predominates at longer delays over 1 hour (15%). It is logical, that solving of technical defect mostly requires more time. The reason FOC predominates at short delays up to half an hour (8%) and it can be stated, that frequency of FOC reason decreases with bigger length of the delay. The crew also tries to ensure timely departure. The reasons ATFMR and AGA are significantly the most frequent at short delays up to 30 minutes (15% and 8%). It is evident that the airspace is regulated by central operation, which seeks to ensure fluent and cost effective traffic. The reason R occurs very frequently in general, it ranges from 40 to 60%.

Dependence ($p < 0.001$) of length of the delay on aircraft type was proven by consequent analysis. (see Tab. X, Fig. 6) The reason AIC significantly predominates at Boeing aircrafts (around 17%) compared to Airbus (6%). The reasons PB and ARH appear very rarely in general, they are little bit more frequent at aircraft B 737-700. The reason TAE predominates slightly at Boeings. The airline



5: *Correspondence analysis: Dependence of length of the delay on delay reason*
Source: own calculation

X: *Contingency table – Column relative frequencies: Dependence of delay reason on aircraft type*

	B 737-700	B 737-800	A320
AIC	17.97%	16.73%	5.92%
PB	3.91%	1.89%	1.97%
ARH	2.34%	1.16%	1.32%
TAE	11.72%	8.76%	7.24%
FOC	4.69%	5.66%	6.58%
ATFM	9.38%	8.33%	25.66%
AGA	6.25%	4.99%	2.63%
R	41.41%	50.67%	46.71%
MISC	2.34%	1.82%	1.97%

Source: own calculation

company disposes of more aircrafts of this type, that's why they are used more intensively and that's the reason they have to be maintained more often. Airbus aircrafts are then used at airports with lower traffic intensity – BRQ, OSR. The reason FOC occurs at all types of aircrafts equally, which is logical. Crew duty norms are not dependent on aircraft types. The reason ATFMR is significantly the most frequent at Airbus aircrafts (26%), Boeing aircrafts only around 9%. Airbus aircrafts are rented from other airlines; the flight plans are set up and maintained by dispatching of the airlines which the aircrafts are rented from. That's the reason why communication and re-scheduling of flights take more time. The reason R occurs very frequently in general (41–51%) but differs only a little at particular type of aircrafts, which is logical.

DISCUSSION

Whereas in the article (Fleurquin, Ramasco, Eguiluz, 2014) there was proven dependence of delay on destination aerodrome, in our analysis for destination aerodromes in Czech Republic there is similar dependence on the materiality threshold ($p = 0.061$), so this dependence is not so strong, nevertheless it can be stated that short delays up to 30 minutes are slightly more frequent in Brno and long delays over two hours are the most frequent in Ostrava.

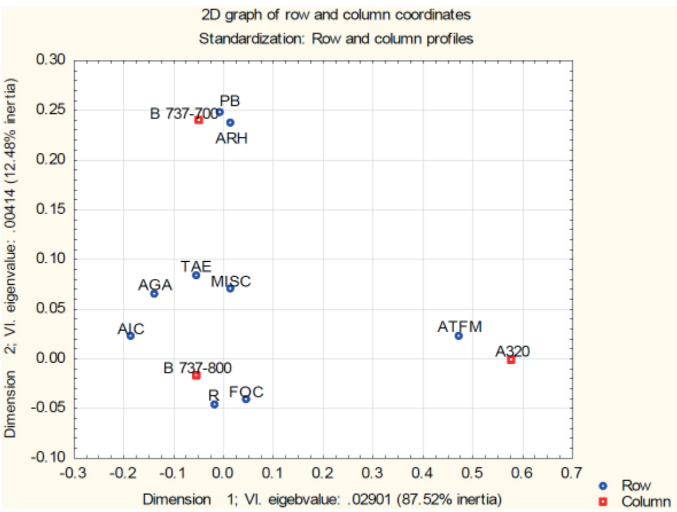
The fact that delay is a problem not only for passengers but also for airport staff is described for example in an article (Wu, Truong, 2014). But the problematic is seen from another angle in this article and the article deals with more appropriate coding of delay than is used by the airline we monitored.

The article (Hsu, Chao, Hsu, 2015) similarly offers different variants of strategy for reduction of delays, but again from another angle, the author recommends for example increasing the number of service counters during checking-in. However delays caused by passengers and their baggage occur very rarely at airports we monitored.

Furthermore it was proven by analysis that the most of delays appear at international airport in Prague, and therefore it would be obviously appropriate move some flights (especially charter flights) to other airports, which are not so fully loaded.

It was also proven by the research that the least delays originate in the evening and at night, so again alternative solution is offered to move especially charter flights to these times. We however have to exclude airport in Brno from the recommendation above mentioned, because in Brno there originate the most of delays at night.

Since the reason of delay in Brno and Ostrava is delayed departure from previous destination, it would be probably appropriate to optimise flights in following way. We recommend strengthening flights following-up in a short time to previous arrival in Prague, where there is adequate number of aircrafts and thus it is possible to optimise flights by replacement of aircrafts. Flights with longer



6: *Correspondence analysis: Dependence of length of the delay on aircraft type*
Source: own calculation

time slots between arrival and departure should be organized from other airports.

Subsequently we should consider whether it would be more appropriate to borrow Boeing 737-800 instead of Airbus in summer months. Monitored airline borrow approximately 20% aircrafts in summer months and has more experience with this type of aircrafts, because its fleet consist mostly of this type of aircrafts. That's why the airline disposes of spare parts for this type of aircrafts. At the same time there are more passenger seats in Boeing 737-800 than in Airbus. On the other hand it is necessary to consider also the economic aspect, because borrowing of Boeing seems to be more expensive. But if the airline disposes of only one type of aircraft, the costs of servicing would decrease in total. It is not only question of spare parts; it is also matter of special processes and training of mechanics for each type of aircrafts. Therefore it seems to be cheaper to use aircraft B737 also in different versions (-700, -800) and passenger capacity for various distances and utilisation than to use different aircraftsman type. It would be definitely necessary to carry out more detailed cost analysis. Nevertheless the idea of unified fleet is worth considering.

As cost effective operation as possible is naturally a target of each airline. One of the reasons, why to decrease delays, is also an obligation to pay out compensation to passengers. Financial compensations are a big cost item for airlines indeed. Nowadays there exist specialised companies which enforce these compensations from airlines. They even address passengers by themselves, because these compensations are also their income, they charge around 27% of enforced amount. Compensation per one passenger can range from 250 to 600 EUR (that means up to 15,500 CZK) according to flight length. That is the reason why the selected airline needs to eliminate long delays for the reason of obligation to pay out financial compensations.

Regarding financial compensations we recommend considering possibility of alternative aircraft (without flight plan), which would be available if necessary. For example only in the busiest months (June, July and August). Of course it has to be considered and calculated which solution is more economic in case of long delays – alternative aircraft or financial compensation for passengers.

We would also recommend the airline we monitored employing more staff with unlimited contract. These employees are more experienced after some time and this brings decrease of delays caused by human error. It is again necessary to assess economic aspect – cheap summer job workers versus inexperience and in expertise of this staff.

Since the delays are very often caused by technical issues or defects, we are convinced that it would be very appropriate to invest in maintenance of aircraft to keep the aircraft in perfect technical condition. At least in case of defects that could be prevented by maintenance. Accidental failures can't be naturally influenced in advance. I view of high compensations connected with long delays it would be certainly good investment.

CONCLUSION

Factors influencing delays of flights at three most important airports in Czech Republic were examined in this article. These factors were identified not only by analysis of contingency tables, which were created from gained primary data, but also by using airline database, which includes various reasons for delay sorted according to international codes.

Based on the carried out analysis it was proven, that the most of delayed flights are at Václav Havel Airport Prague. It is also apparent from the research that length of the delays at selected airports in Czech Republic doesn't differ significantly.

Evaluation of data then showed that short delays up to one hour prevail in August. It can be also stated, that the least delays originate at night in the monitored period (June–September). Statistical dependence of length of the delay on aircraft type (Airbus, Boeing 737-700, and Boeing 737-800) was not proven. Statistical dependence of delay of arrival at destination aerodrome on time of day results from correspondence analysis.

It results from the analysis of contingency tables that delays caused by technical issues and aircraft maintenance are most frequent in Prague same as delays caused by operational control and crew duty norms and limitation caused by high concentration of air traffic. Furthermore it was proven that problems caused by delayed departure from previous destination are significantly more frequent in Brno and Ostrava which is probably caused by low number of alternative available aircraft at these airports.

It results from the carried out correspondence analysis that delays caused by suppliers (handling, catering,…) are mostly only short because of the risk of potential penalty. The research also indicates that delays caused by technical defect or necessary maintenance take mostly longer time before the aircraft is ready for departure. It was proven that this reason is slightly more frequent at aircraft of Boeing 737 type.

It is evident from the correspondence analysis that central operation tries to minimise length of delays and thus seeks to ensure fluent and cost effective traffic. It was also proven that there is higher occurrence of delays of Airbus aircraft caused by rental and control of this aircraft by other companies, which causes communication and planning difficulties.

As cost effective operation as possible is one of the targets of an airline, therefore an elimination of longer delays is necessary, because pay out of financial compensations to passengers is very expensive for airlines. Specialised companies search nowadays passengers of delayed flights and enforce by legal way these compensations that are incomes for them. For elimination of these long delays we recommend considering possibility of alternative aircraft (without flight plan), which would be available if necessary. At the same time we recommend investing in maintenance of aircraft to prevent defects that can be detected by maintenance, because these defects are frequent reason of long delays. Subsequently we would suggest considering to borrow Boeing 737-800 instead of Airbus in summer months and consider an unified fleet in general. We would also recommend employing more staff with unlimited contract, because more experienced employees make mistakes less often.

Conclusion was consulted with an expert working in an airline.

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