Doprava a spoje –elektronický časopis Fakulty prevádzky a ekonomiky dopravy a spojov Žilinskej univerzity v Žiline, ISSN 1336-7676

THE IMPACT OF DOOR NUMBER ON DURATION OF BOARDING PROCEDURE

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Introduction

One of the current trends in the air transport industry is reducing the time aircraft spent on the apron between particular flights. Mutualism of airports and airlines is not always helpful for both stakeholders. But this is the case when it is. First off, as the airports struggle with lack of capacity they can benefit from such a reduction by increase of their capacity. It is clear that the same number of stands can accommodate more aircraft a day when the turnaround is shorten. On the other hand, an airline can utilise better its fleet since the reduction of ground time can result in more flights with the same number of aircraft at the end of the day.

The most basic rule the airline managers are applying in practice is well known fact that the aircraft is able to generate revenues in the air only. And this is exactly what low cost carries do in the first place. Their effort to use the fleet as extensively as possible cause they cut the turnaround time down to 25 minutes. This value can be reached even with the narrow body jets like Boeing 737 or Airbus A320 family in its full load. There may be the case that this turnaround time is guaranteed within ground handling contract (so called SLA – Service Level Agreement, signed between the airline and the ground handling company). If the ground handler is not able to manage such a short turnaround, the penalty will apply.

The role of ground time in the industry

What role a ground time has in the airline environment seems to be indubitable. As I mentioned earlier, optimizing schedule in order to reduce turnaround is essential for every airline's scheduling department. More frequencies means more revenues, more revenues means more competitiveness. And this is of crucial importance in today's tough getting-out-of-crisis environment. This is what ground time means for airline itself. As far as airport as the other member of ground operations market, the debate should be as loud as in the airline case.

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Generally speaking, most of the busiest European airports cope with the lack of capacity on a daily basis. Increase in capacity by building a new infrastructure is demanding not only from the economic point of view, but in terms of time as well. In most of these cases the airports has already reached their final limits when talking about land use planning. Therefor is inevitable to look for another way how to increase the capacity not only in peak hours. It is believed that the operational approach is the way.

Alongside slot coordination or implementing various capacity enhancements, one of the possibilities is cutting the turnaround time down. There are few ways how this can be reached. Nowadays two approaches are used most commonly.

The first one is reducing the total turnaround time. In this case we assess the turnaround process as a whole, the macro approach is applied. In macro point of view we are talking about decision making enhancement concepts or concepts of better information sharing and distribution. As an example can be mentioned CDM (Collaborative Decision Making) which is not primarily designed for shortening the turnaround time, but one of the positive side effects is reducing of ramp time. Another example can be various software tools which provide stakeholders with information about the progress of turnaround processes in real time. Hence the coordination of the whole process is much easier.

The second one approaches partially the single turnaround activities. This is so called micro approach. In this case the whole turnaround process is considered as a bunch of activities. At this point, optimization of each activity takes place without interference with the other. However, not every process can be enhanced using this way. In some cases we cannot overcome technology limits (aircraft refuelling) or human resources limits (cabin cleaning). On the contrary, many processes can be speed up employing progressive or unconventional methods (passenger boarding, baggage loading). Low cost model is minimizing the handling activities by ignoring cargo transportation which means lower revenues but it makes the turnaround process more flexible and less time consuming.

Cutting down the boarding time

In the following lines, the above mentioned passenger boarding will be examined. First, the question *why* the passenger boarding must be explained. Let us concentrate on low cost carriers (LCCs) and some of the specification of their operation. LCCs were selected because of their natural effort to cut down the ground time. Legacy carriers, on the other hand, do not act this way in each and every case.

Right now, let us consider the turnaround process as a set of activities such as passenger de-boarding, baggage handling, catering, refuelling, cleaning, passenger boarding and pushback operation. Regarding LCCs, some of the processes are optional and need not be performed at every stop such as refuelling and catering service. Next, process like cabin cleaning is very small in the low cost segment as there is less food on the board and no special staff to clean is required. Some of the processes may be considered as a redundant (especially pushback operation) according some definitions of turnaround because they are conducted after the chocks has been removed from under the aircraft wheels. Hence the most critical processes are passenger and baggage handling. Baggage loading and unloading will not be described in this paper. Passenger disembarking seems to be very fluent as all the passengers are trying to get off the aircraft as fast as possible. However, there is room for improvement in the boarding process. Both of these procedures depend on how many aircraft doors are used.

We can simplify duration of turnaround process:

$$T = O + n.P$$

Where:

T is duration of the whole turnaround process,

O is duration of other activities (except boarding/de-boarding),

n is number of passengers,

P is time required by one passenger to board/de-board.

As one can see from above stated equation, the speed of boarding/de-boarding process depends on how quick one passenger can enter/leave an aircraft. The aim is to minimize k.

If we provide more than one passenger at the same time with the opportunity to enter/leave an aircraft, the boarding/de-boarding time will decrease. That means utilize more than one door at the same time. Average values of k for different number of doors can be found in the *Table 1*.

Table 1 *– Average values of* k

	One door	*Two doors*	*Three doors*
***k* (sec) when boarding**	*13*	*9*	*7*
***k* (sec) when de-boarding**	*8*	*5,3*	*4*

From the table above we can calculate the time saving between various numbers of doors scenarios. For standard narrow body 180 seater (B737, A320) the values are as follows. When using two doors over one door, the time saving is as much as 20 minutes (both boarding and de-boarding). When using three doors over two, the time saving is around 10 minutes (both boarding and de-boarding). Those are significant numbers. For bigger aircraft, the values will be higher accordingly. It is fair to notice that using three doors is not implemented in the narrow body segment at all, in some cases the double-deckers (A380, B747) are boarded by three air bridges (Figure 1). There is one air bridge used for upper decker and two for lower decker.

***Figure 1** – Three doors boarding [1]*

When handling a narrow body jet, either a single air bridge or pair of mobile stairs (or a combination of built-in stairs and mobile stairs) are used. The first case happens at the stand equipped with the air bridge, the second one at the open stand or at an airport that is not equipped with an air bridge. But what if an airline decided to employ the mobile stairs to the rear doors right next to the air bridge up in the front one? In this case, various operational aspects must be taken into account and the safety study must be conducted prior starting such a procedure in order to eliminate any risks. The example of study like that is described below.

Case study

This case study brings an overview how wide the implementation of new procedure may be at an airport. This is not a theoretical case but the real one which happened at the Prague airport at the beginning of 2012. Hence it is a practical approach how to cut down the turnaround time in a real operation.

Current state

Before the case study took place, the passenger boarding was conducted in two ways at Prague airport. Mobile stairs or aircraft built-in stairs are utilized at the open stands (for both turboprop aircraft and the low cost carriers). Passengers are transported by buses from open stands to the terminal building. In most cases, the air bridge in combination with the front door is used.

Requirement for combined boarding

At the beginning of 2012, a low cost carrier easyJet as a customer of Prague airport set a requirement of combined boarding for aircraft of code letter C at chosen stands. The combined boarding means the boarding will perform by air bridge (front door) and by mobile stairs (rear door). The aim of this procedure was to cut the turnaround time down by shortening the boarding/de-boarding process.

Since easyJet is number two carrier (right after the Czech Airlines) at the Prague airport, the airport operator decided to meet the airline requirement. So far, the boarding at the pier stands had never been executed like this, the particular department of airport operator (Department of Quality, Safety and Processes) had to perform a safety and suitability analysis in order to ensure all safety standards to be maintained.

Analysis

This kind of boarding should be performed at the stands 6, 7, 9 and 11 (*Figure 2*). Those are stands which easyJet uses for the ground handling of its flights. All the stands are nose-in stands. They are designed for handling of aircraft of code letter C (wingspan up to 36 meters – A320 family, Boeing 737 and Embraer 170/190). The stands are equipped with visual docking system. Refuelling of A320 aircraft can be done from both left or right side, B737 and Embraer 170/190 are refuelled from the right side only. The stand 11 is able to be used in operation only if the stands 10 and 12 are not occupied. The geometrical characteristics of particular stands can be found in the *Table 2.*

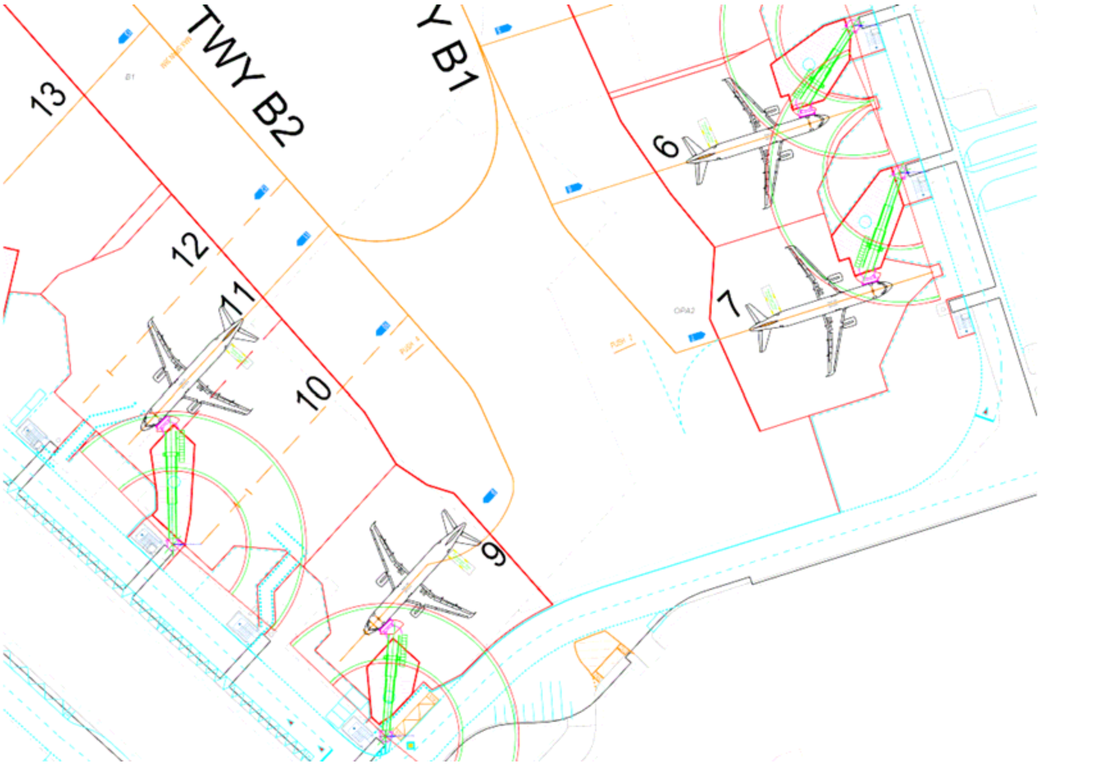

Figure 2 *– Situation at the stands 6, 7, 9 and 11 at Prague airport [3]*

Table 2 *– Geometrical characteristics of stands 6, 7, 9 and 11 [3]*

	Stand 6	Stand 7	Stand 9	Stand 11
Width	43,5 m	45 m	45 m	87 m
Axis placement	Eccentrically	In the middle	In the middle	Eccentrically
Clearance between left/right wing tip and stand limit line	3 m / 4,5 m	4,5 m / 4,5 m	4,5 m / 4,5 m	27,5 m / 23,5 m

It is important to note that the passengers are walking under the construction of an air bridge when walking from the gate to the mobile stairs during the required boarding procedure.

According to the safety audit executed right on the apron, the following generic hazards were identified:

1. Passenger movement on the apron
2. Passenger movement along the aircraft
3. Aircraft ground handling
4. Aircraft refuelling

Assessment of identified generic hazards

1. Passenger movement on the apron

This is the new factor in the Prague airport operation. When meeting the easyJet requirement, half of passengers on particular flights will be moving on the apron in the vicinity of aircraft when boarding and de-boarding. These passengers will walk under the movable part of an air bridge where air conditioning units and other staff are installed. The passengers will have to overcome a distance of as many as 60 meters on the apron (i.e. the distance between gate stairs and mobile stairs leading into the rear part of aircraft cabin) at any meteorological conditions. The conditions on the apron need not always meet the requirements of safe walking (Figure 3). The passenger may cause himself an injury at the iced or contaminated surface.

***Figure 3** – Improper apron condition between the gate stairs (left) and the aircraft at Prague airport (photo: author)*

Hinged air conditioning units underneath the jet ways reduce the height for walkers under air-bridge. The passengers may suffer an injury.

There is risk of FOD (Foreign Object Damage) contamination as the passengers are walking through the apron. FOD can be spread by meteorological conditions (wind) over the airport's movement areas.

The airline proposal suggested the beltway in order to tape out the walkway for passengers. This should exclude the contact between passengers and aircraft. However, at the stands both 6 and 7, the passengers are walking right next to the neighbouring stand (*Figure 1*) where an aircraft may be docking or handling. Moreover, the passengers are walking along the service road at the stand 9. There is a serious injury danger in the above mentioned cases as the passengers are not aware (unlike the airport employees) how to move in a right way on the airport movement areas.

2. Passenger movement along the aircraft

The passengers will be moving in the immediate vicinity of an aircraft when boarding and de-boarding. Since they are not familiar with rules of moving on the airport movement areas, there is a danger of unintended damage of an aircraft or their own injury.

3. Aircraft ground handling

The particular airport directive stipulates the clearance of 3 meters between aircraft outline and the GSE (Ground Support Equipment) in order to prevent the damage of an aircraft. As there is no clearance higher than 4.5 meters (except stand 11) and this zone is used for passenger corridor, there is no possibility to drive with GSE around the left side of an aircraft (unless using the near-by stand). However, this is not allowed by particular airport directive with respect to possibility of influencing the ground handling process on the neighbouring stand. When driving around the passenger corridor, there is a danger of hitting the passenger or and aircraft.

In respect of reducing the space on the aircraft left side by setting the passenger corridor, there is no possibility for GSE to drive around the left wing at stands both 6 and 7. Drivers could override this corridor using the near-by stand but there is a danger of hitting another GSE of staff working on this stand.

4. Aircraft refuelling

Once the passenger corridor is set the movement of GSE around the aircraft is reduced. As the most problematic seems to be a stand 6 where is no room for GSE remaining. The tank truck cannot use the left side of an aircraft (which normally use for a driving into its position on the right wing side) without breaking the airport safety rules.

Once the corridor for passengers is set (left wing side) and the tank truck is already placed at the right wing side (*Figure 4*), there is no room for driving with GSE to the aircraft rear part at the stand 6. On contrary, the stand 11 offers enough clearance from the near-by stand 9.

Figure 3 *– Situation at the aircraft right wing side [1]*

Measures to be undertaken to risk mitigation

From the analysis above it is clear that without suitable changes being made the new procedure cannot be adopted into practice. The measures are as follows:

- Ground handling company must be obliged to perform a check of apron surface condition suitability within the scope of FOD check by ramp agent. The ramp agent has a right to stop the combined boarding procedure when he finds out the surface does not meet the requirements of safe walking.

- The ground handling company must ensure that the passenger corridor do not interfere with the air conditioning unit underneath the air bridge by taping out the walkway out of the air bridge outline.

- The passenger corridor must be taped out two parallel beltways.

- The ground handling company must ensure at least two persons in order to supervise the combined boarding process. The one person should supervise the font part of an aircraft (passengers getting out of gate) and the second one at the rear part beyond the wing.

- When handling the aircraft at the stand 6, both stands 5 and 7 must be closed in order to use this area for driving the GSE and tank truck for handling the aircraft at the stand 6.
- The ban of driving GSE around the left wing when boarding or de-boarding.
- The ban of air bridge movement when passengers on the apron.

Once the above mentioned measures are implemented in operation, the identified generic hazards are mitigated. In consideration of severity of hazards and operational constrains at the stand 6, this stand should not be used for combined boarding.

Discussion

According to the results of above cited study, the boarding in such a way is possible at given airport. However, measures that need to be taken bring some weak sides. Some of them are just restricting the work of ground handling staff (limitation of GSE movement when boarding/de-boarding). Another may cause more serious operational disruptions such as closure of near-by stands which can negatively affect the apron capacity as a crucial airport asset. Therefore it is necessary to judge not only safety and operational aspects but the economical ones as well. When closing the neighbouring stand, the financial losses could not balance the gains (meeting requirements of significant partner). After taking these factors into account, the decision not to use the stand 6 to combined boarding was adopted.

Another drawback is requirement of two persons from ground handling company to supervise the passengers when moving along the aircraft. This is a significant increase in staff required to turn the aircraft around. According to best practices, the modern ground handling companies can turn the aircraft of code letter C around using two or three persons. The solution may be the modification of duties of present staff in order to ensure passenger supervision. Another possibility is to use cabin crew members.

When considering passenger point of view, this kind of improvement could not be taken as an attractive. Half of the passengers will comfortably use an air bridge to board the aircraft, but the second half will use the stairs twice – in the construction of air bridge to get from the gate on the apron and then the mobile stairs to get from the apron into the aircraft. Passengers will be exposed to noise and the weather conditions (snow, rain, wind) because there is an intention to implement this procedure year-wide. And even if the low cost carrier offers one product level, there will be two levels in fact.

Conclusion

At this point it is necessary to note that movement of passengers on the apron is nothing special at other airports (most of airports in the UK). What is special is the combination of air bride and mobile stairs. Another particularity of cited case study is a design of airport stands. They were designed according to placement of air bridges. They meet the requirements of handling the aircraft of code letter C, but they do not meet the requirements for simultaneous movement of GSE and passengers during turnaround (because the original design did not plan to utilize the stand in such a way).

This is a good example how important is to think more than a few (tens of) years ahead when designing the airport.

References:

[1] Photo Blog: *An Inside Look at Lufthansa's Airbus A380*. Available at: http://www.airlinereporter.com/wp-content/uploads/2012/05/LHf.jpg

[2] Soumyajyouti Basu: *Discussion on Cost Reduction Strategies through Ground Handling*. Available at: http://www.slideshare.net/FrostandSullivan/discussion-on-cost-reduction-strategies-through-ground-handling

[3] Letiště Praha a.s., Safety posudek Kombinovaný výstup resp. nástup cestujících na stáních 6, 7, 9, 11**.**

[4] Kazda, Antonín - Caves, Robert E. *Airport design and operation*. - Amsterdam ; New York : Pergamon, 2000. ISBN 0-08-042813-4.

[5] Wu, Cheng-Lung, *Airline operations and delay management: insights from airline economics, networks and strategic schedule planning*. - Farnham, Surrey, England : Ashgate, 2010. - 241 s. - ISBN 978-0-7546-7293-7.

[6] Global geography of airport ground handlers [Globálna geografia poskytovateľov služieb pozemnej obsluhy na letiskách] / Anna Tomová. In: New trends in civil aviation 2011 : [proceedings of the conference] : Prague, 26-27 September 2011. - V Praze: ČVUT, 2011. - ISBN 978-80-01-04893-1 (ČVUT). - S. 135-137.

[7] Thorne A., Price A., Zitkova M.: *The Impact of ID Technologies on Aircraft Turnaround Processes*. Auto-ID Lab, University of Cambridge, UK. 2007.

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Enter to publishing: **28th October 2012**