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Public Transport to the Airport and Its Influence on Handling Process

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Abstract
The paper focuses on several possibilities of the mass public transport to the airport, including analyses of the expected impact on the various airport processes. Within the article, three main transportation system types will be described and compared. Firstly, the problem regarding current bus transfer system to the Václav Havel airport Prague will be analyzed. According to the analysis results the focus now turns to the description of the potential influence of the introduction of the new transfer systems, including the impact on the airport security and passport control process, and other procedures, which include some kind of a queuing process. This airport was chosen as the biggest airport in the Czech Republic, which in today and future business environment could expect problems related to the public transport of the passengers to and from the airport. Besides the description of the current structure, the paper tries to elaborate issues such as calculation of the queue waiting times and to propose a new system, more suitable for the given conditions. Results of the research include various calculations, such dependence of a modal split and intervals of the waiting times within a check-in process.

Keywords
passenger check-in; public transport; queuing process

1. Introduction

Modern society is strongly dependent on well-performing transportation systems within the large cities or regions. Due to many professional or private reasons, almost everyone have to commute within the given region more than once a day. Various transportation systems and solutions are designed in order to satisfy needs of their users, where capacity is one of the fundamental parameters that need to be fulfilled. Transferring passengers to and from the airport is not an exception. A large number of arriving or departing passengers using the regional hub airport has a form of a continuous flow with the low and high intensity intervals during the day or a season.

An insufficient transportation capacity could escalate into serious problem, which has a strong negative impact on the passenger flows, highway capacity, airport processes fluency, etc. Solutions for such kind of problems are various. The system could enable shorter intervals of the connections, however a demand in certain periods of the day could be extremely high, making such shortening ineffective and costly solution. Increase of the frequency could bring an increase of the system capacity, but a solution for the particular situation should

take into account all operational, technical, economic and environmental aspects.

One of the solutions is to utilize larger vehicles and to try to reach a same number of the transported passengers with the lower number of used resources. It is important to underline that such solutions have their limits, so in such case much larger investments and more complex decisions are required. Exactly this is a case that could occur in the near future at the Václav Havel airport Prague. Current airport development and expansion plans lead to a significant increase of arriving and departing passenger. Such increase could cause existing transportation system to collapse, slowing down that way economic progress in large scales. The paper discusses three possibilities: construction of the tram, train, or subway lines to the airport.

Each solution has different capacity, connection options, possible intervals and maximum number of people arriving at the airport at once. This has an influence on queuing process, which is going to be furtherly described. Using relatively simple calculations, the number of passengers coming to the airport will be defined from the actual airport flight schedule. Due to a fact that processing times of passport and security control are available, waiting times on both terminals could be calculated.

2. Current public transport system

Nowadays, to make a transfer from the Prague city center to the airport, passenger has to use subway to the Nádraží Veleslavín station and then change to bus line 119. From the passengers' standpoint, such solution is commonly seen as inconvenient, mainly due to a time consumption, slowness, various obstacles and barriers, available space in the buses for the luggage, etc.

From the engineering perspective, current solution was chosen as acceptable in the given circumstances and conditions. Such solution enabled integration of the expended subway system into the airport commuting possibilities, shortening previous bus line in half. Initiative for the construction of the rail connection to the city is not a new one. The only difference is airport traffic is now at the history peak, requiring expansion of almost all airport and road infrastructure.

Effective mass transit solution at the airport is a backbone of the modern hub airport, which Prague airport has potential to become. The other thing is, that the most of airports with similar number of passengers, have already upgraded their old transfer system [1].

Existing bus lines are the core system of the passenger transfer to the airport in Prague. Lines are intensively used and follow the airport's flights schedule. The line 119 has the highest frequency and the distribution of the number of passengers is partly shown on the following figure (Fig. 1).

The daily passenger waves are noticeable, and these are followed by the offered capacity of the transportation company. The always problematic issues are peak hours and impact of the large number of passengers that are transferred to the airport at once. This has an intensive influence on the queueing process at the various counters and could show actual operational capacity of the airport. Such information, regarding the number of incoming passengers is fundamental for proper capacity and workforce planning. The important analysis topic in this moment is how severely will be airport impacted by the introduction of the high capacity systems such as trains or subway.

3. Possible solutions - Setting a new type of transport

As previously mentioned, there are three types of transport that could technically be introduced at the Václav Havel airport Prague and potentially satisfy current and future transportation requirements. These are introduction of tram, train and subway system. Each solution will be described in the following text.

3.1 Train

This kind of transportation system has the high capacity of about 640 people in one direction. The possible line would connect airport with Masarykovo nádraží train station, which is situated near the subway B line station Náměstí republiky. It is supposed to have 8 stations, where one of them (Dlouhá míle) is designed with the large park and ride area for cars and buses coming from the northwest.

Projected intervals for train lines is 10 minutes in a peak. Maximum speed of the train is planned to be 90 km/h. The platform of the the train is 550 mm above the track, which allows non-barrier entrance to the passengers with reduced mobility. Travel time from the city to the airport terminal station is projected to 27 minutes [2]. Taking into account capacity, trains are very effective. On the other side, it is important to highlight a fact that maximum number of passengers, arriving at the airport by train at one moment is not in line with the current airport infrastructure.

3.2 Subway

Subway transportation is well known because of its very high capacity, which counts around 1500 people per one train in case of Siemens M1 subway train. Construction of the subway system was topic of different studies, where the last project confirmed expected intervals to be 20 minutes. Four different projects were presented [3]. The number of arriving passengers at once is much higher than by train. The positive fact is that the tunnel to Nemocnice Motol has already been dug and it's not too far from the planned airport subway station. It would take around 25 minutes to get from the airport to the city center.

3.3 Train

The city of Prague took into consideration a possibility for connecting the Prague city center with the airport by tram system. Previous study brought a solution, which had two tracks, each with 3 variants. All of them begin at Nádraží

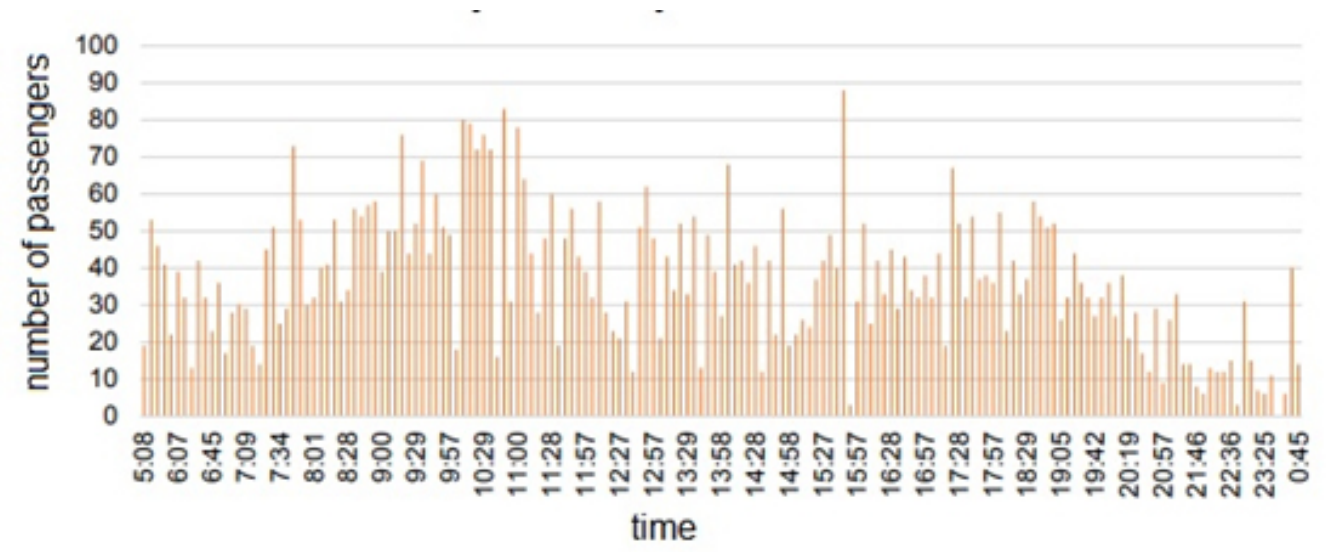

Figure 1. Distribution of passengers for the line 119 (source: ROPID)

Veleslavín station and terminate at Terminal 1 (with ground or underground station). Projected transfer time to the subway station is 13-27 minutes, and 28 minutes to the city center (with the fastest track and 4 minutes to change).

The most suitable tram train selected, depending on the variant, is Škoda 15T with the capacity of 210 people. Due to low capacity, the intervals have to be shorter, around 8 minutes. Even though it is the lowest in the three mentioned rail transport solution, it's two times higher than nowadays bus intervals [4].

4. Impact on the passport and security control

Prague airport has two terminals, with different types of security control. At the first terminal, passenger passes through check-in process (also possible self-check-in, automated check-in and others), than through passport control and the last one is a security control at the gate, which is performed prior to boarding.

According to the available number of counters at all three points the weakest one is passport control. This is also a first point through all passengers have to pass after check-in. There are 13 counter desks and 8 automatic desks enabling entrance to a non-public area. Average time for one person to pass through this type of check is around 30 sec.

Situation at the second terminal is quite different. When arrive at the Terminal 2 the first point is a check-in (if you're not self-checked-in or checked-in through automated kiosks), and it is followed by security control. This is a weak point of the second terminal meaning that the longest queues actually form right here. Number of security desks is 16, with capacity of two passengers per minute. The impact of the large number of passengers arriving at the airport at once is the highest at these points. One of the parameters evaluating this impact is passenger waiting time.

4.1 Number of passenger

The number of arriving passengers to the terminal was approximated from the flight schedule of Václav Havel airport Prague. For each performed or planned flight a type of aircraft as well as average load factor was predicted and used in calculation. The number of these passengers is expected maximum number of arriving passengers, where certain percentage of them (defined by modal split) uses public transport for their airport transfer needs [5, 6]. To make proper calculation, passenger incoming curves are required, which are calculated according to the time of flight.

Problem is that nobody knows when the rail connection is going to be launched. So the possible year, which will be used as referral, is 2022. The passenger number growth is estimated as an average increase from year 2000 to 2017, and it's 6,58 %. To correctly calculate the waiting times, the distribution of travelers between Terminal 1 and Terminal 2 should be known. The Prague airport provided rough information regarding such distribution, which states that from 9 departing passengers 4 leave from the Terminal 1 and 5 from the Terminal 2.

Based on the available data a distribution of the waiting times at the counter in the given time frame is presented on the following figure (Fig. 2).

4.2 Queuing process depending on modal split

For the research needs a modal split of the transportation types was created. It was a starting parameter for following calculations. Figure (Fig. 3) shows a dependence of waiting time on security and passport control based on the modal split for the variant of railway connection. The percentage shows how many people will use train as a commuting system. The rest of passengers are distributed along 5 minutes interval. It's important to say, that the maximum waiting time, set by airport and recommended by international organizations is 10 minutes.

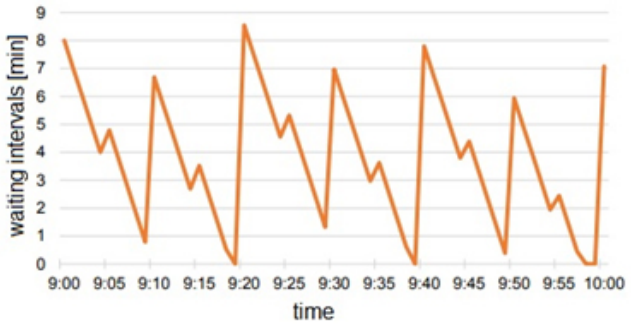

Figure 2. Distribution of the waiting times – security desk

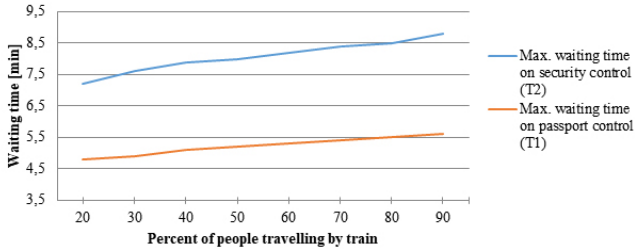

Figure 3. Dependence of waiting time on percent of people travelling by train

As we can see, maximum time spent in a queue is 8,8 minutes for the security control. It could be concluded that there is no specific issue with this type of transport.

The next figure (Fig. 4) represents data for subway variant. It also belongs into the rail transport group, but it has an interval of 20 minutes. This is a crucial issue, because it causes very long queues, as it is noticeable on the Fig. 4. At the terminal 2, waiting time will be always longer than 10 minutes in comparison to the Terminal 1. In case of an extremely high modal split of 90% waiting time is going to be 10,3 minutes.

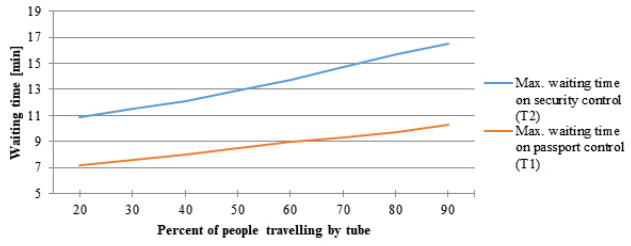

Figure 4. Dependence of waiting time on percent of people travelling by subway

The next figure (Fig. 5) shows a dependence of waiting time on modal split where the focus is placed on tram system. Waiting time never exceeds 10 minutes, neither on security control nor on passport control desks. The longest waiting time is in case of modal split 90 %, 8,6 minutes.

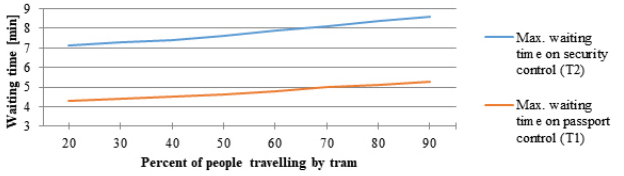

Figure 5. Dependence of waiting time on percent of people travelling by tram

4.3 Queuing process depending on interval

In order to find these dependences a modal split should be known, or how many people will use train, how many people will go by bus, car, taxi, etc. Prague airport has quite high demand for public transport, besides that parking at the airport is expensive, as well as taxi. It could be conceived that if there is a modern type of transport, which is quick, comfortable and reliable, many travelers will use it [7, 8]. That's why following modal split was set to 43% in prosper to train, 9% bus, 25% taxi, 20% car and the rest.

The next figure (Fig. 6) represents dependence of waiting times on interval of the commuter system. Maximum available time spent in queue is 10 minutes, which responds to interval between 14 and 16 minutes for Terminal 2.

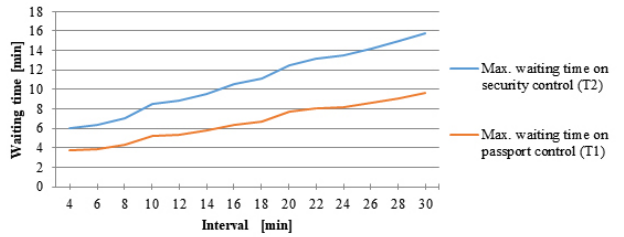

Figure 6. Dependence of waiting time on interval

5. Applied methods and results

The idea was to utilize an airport flight schedule, various types of aircraft and average number of passengers on flights to calculate the approximate number of passengers coming to the airport by different types of transport, e.g. car, taxi, bus. Besides this, other important segments which had to be determined were passenger waiting times. These are based on passenger flows and capacity of the given checkpoint. The operational capacity for the passport control is two people per minute; the same case is for security check. The difference is found in the number of the available counters: 16 for security and 21 for passport check.

Calculation results were presented on the previous figures. They show the possible impact of the concerned transportation type on the current infrastructure. It is important to underline that for more detailed results describing passengers' distribution and queuing, the data from airport daily timetables are required. Also, the modal split should be evaluated and corrected according to the newest data and measurements.

6. Discussion

Compering the results presented in the previous figure, some conclusions could be made. These are not final statements, due to a fact that analysis lacks economic standpoint, which is in final a last trigger for the project acceptance. Subway is the least suitable solution, due to a long 20 minutes interval, with modal split of 43% and maximum waiting time around 12,6 minutes. In comparison to other variants this solution has the worse overall score.

In case of the tram solution, number of passenger is not very high and it is huge disadvantage that tram capacity is relatively low. In one time, exactly at 9:00 (the time of high demand) 163 people will use this type of transport. Maximum capacity is 210, which basically is not a problem. However, until now, only passengers coming to the airport were taken into consideration. Additional passengers travelling to Dlouhá míle station (parking place for cars and buses), employees of the airport and other passengers should also be calculated. As it could be seen, the capacity might not be sufficient. Another problem related to the tram solution is inadequate space for carried luggage. Data from ROPID reveal, that every person travelling to airport has 0,8 luggage, which is not a small number knowing that one luggage take equal amount of space as person. Due to given reason, tram solution is also evaluated as less suitable transport system for such amount of traffic and transport requirements.

This brings us to a conclusion that rail transport system to Václav Havel airport Prague show many characteristics, which define it as the most suitable solution. Its capacity is adequate in comparison to other variants and interval between two trains is 10 minutes in the peek.

How to transfer such big amount of people to and from the airport is not exclusively a problem of Václav Havel airport Prague. For instance, Helsinki Vantaa also had to construct a train connection to the airport, because the situation was unbearable. Many airports are trying to solve similar problems, however the biggest issue is insufficient amount of available construction space.

7. Conclusion

The paper brings overview of the actual transportation system from the city center to the Václav Havel airport Prague. It describes three possible solutions for the improvement of such commuter system, whose development is required, based on airport business and traffic results. Figures representing dependence of waiting time on the specific transport type shows the final calculations, based on the available data. The last figure shows the dependence of waiting time on interval of the available transport service. Comparing all presented results it could be concluded that the best score had a train variant, with maximum waiting time of 5,2 minutes at Terminal 1 and 8,5 minutes at Terminal 2. Its capacity is large enough to transfer all the people coming to the airport and intervals are in the given norm. In order to justify an introduction of a tram connection, it would be necessary to increase number of passengers that will use it, to make interval shorter, or to use much bigger vehicles. Subway is also not suitable solution, due to a long interval and too long waiting times on passport and security checkpoint.

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