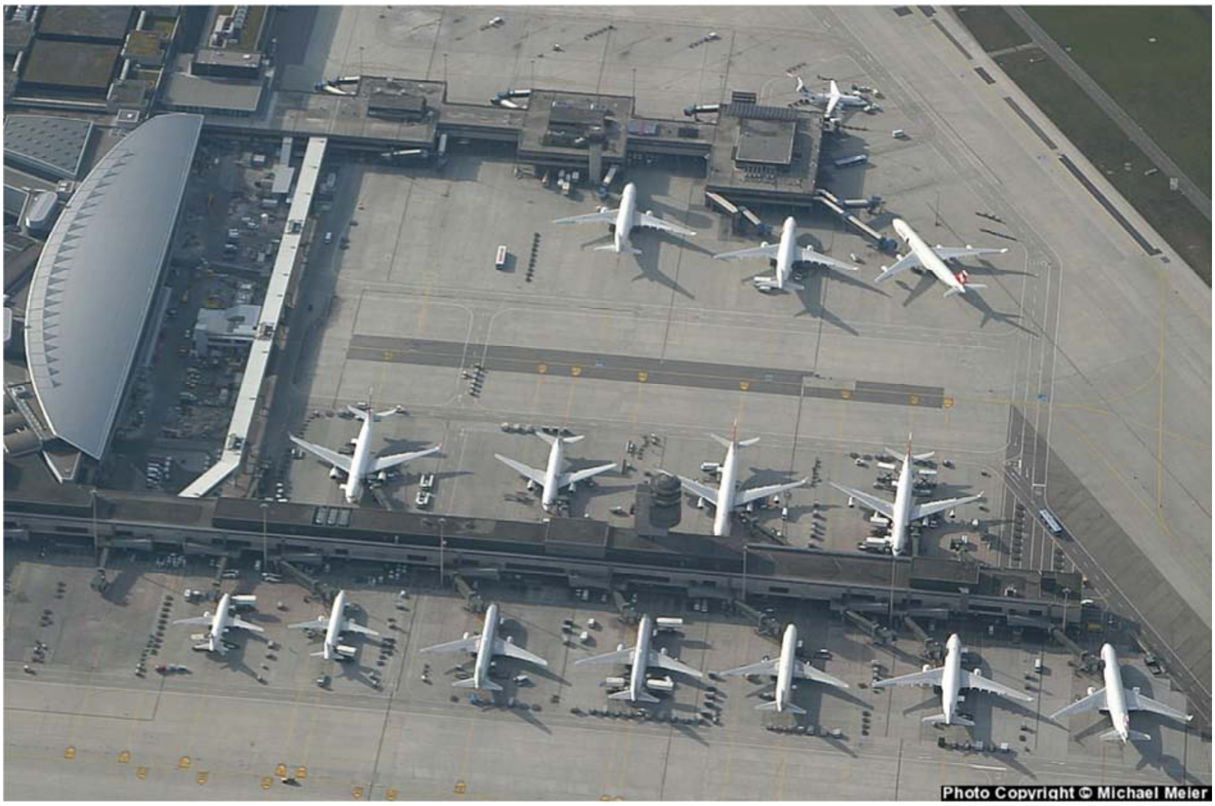

Analysis of Depeaking Effects for Zurich Airport's Ground Handler

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Abstract

Most large airlines today operate using a hub and spoke strategy and have one or several hubs. The hub carrier's flight schedule is highly optimized at its hub airports. This means that flight arrivals and departures are coordinated such that most connections have short transfer times. The result is a high number of flight arrivals and departures during the peak periods but only a few movements in the off-peak periods. This imbalance means that infrastructure and personnel are used inefficiently. De-peaking, which consists of spreading flights more evenly throughout the day to smooth or remove the peaks and valleys in aircraft movements, allows airlines and ground handlers to use their resources more efficiently. It could also help reduce energy consumption by reducing the amount of time aircraft spend running their engines on the ground and circling airports due to congestion on the ground. De-peaking has been successfully applied at major airline hubs. In these cases the motivation for de-peaking was based on capacity constraints.

The goal of this research was to evaluate the cost savings potential of de-peaking for a ground handler. The research evaluated several de-peaking scenarios using data from the Zurich Airport. The paper describes the research study and its results in terms of cost impacts for the main hub carrier. The research shows that de-peaking mainly results in a reduction of extreme workload peaks enabling staff and equipment to be used more efficiently and thereby reducing costs. The results for Zurich Airport show that with a minimal amount of schedule adjustment de-peaking can reduce the ground handler's equipment and personnel costs by about 8 percent. Under the maximum schedule adjustment scenario, de-peaking could reduce costs by up to 20 percent. The research can be extended to include additional peak-oriented costs such as airline company costs and costs of energy as well as revenue impacts of reduced flight connectivity.

Keywords

Airport operations, Airline operations, Scheduling, De-peaking strategies, Hub airports

1. Introduction

The airline industry improved since 2001 but is still in a longer crisis. Rising fuel prices and pricing wars in a very competitive marked force all involved actors to optimize efficiency. Traditional network-carriers suffer under the impact of Low Cost Carriers (LCC), which undermine the hub-and-spoke system. Clearly, new strategies are needed to optimize efficiency and to reduce cost penalties of traditional network carriers.

In the 1980s, network-carriers organized and structured their operation and schedule in a hub-and-spoke structure. In this structure, one or more airports, the so-called hubs, serve as connection points for passengers. The hub-and-spoke system enables these larger network carriers to provide service on many different origin-destination pairs. There are two different scheduling strategies that can be applied in hubs depending on the airport's infrastructure capacity and its efficiency.

In the first strategy, aircraft arrivals and departures are coordinated and grouped. In this strategy airlines try to maximize the number of short connections between popular and high-revenue generating cities. However, this banked-hub strategy reduces the efficiency of aircraft, airport and employees because aircraft must wait on the ground for connections and staff is under-utilized in the off-peak times. Furthermore, hubs with a banked schedule strategy are also more prone to delays.

The second strategy, known as continuous or rolling operations, tries to maximize operational efficiency by scheduling arrivals and departures such that there is a constant flow in the hub throughout the day. In this strategy, aircraft and staff are scheduled such that ground time is minimized and well distributed throughout the day, thus reducing under-utilization in off-peak and congestion during a peak. Ott demonstrated, that in continuous operation, many short connections are lost resulting in longer connection times for passengers. However, it is still possible to optimize connections with maximal revenue potential by careful scheduling to keep them attractive under rolling operations. Furthermore, McDonald believe that many passengers will accept small increases in travel times and their improved reliability that can be achieved through the use of rolling operations. The introduction of rolling operations at a hub is de-peaking.

In 2002, American Airlines decided to de-peak schedules at their two main hub airports Chicago O'Hare (ORD) and Dallas/Fort Worth International Airport (DFW). Applying the new de-peaked schedule, Flint showed, that efficiency was improved and fewer aircraft and gates were used. Also schedule reliability increased and waiting time in queuing and circling decreased. However, as a consequence, average and median transfer time increased by 7-10 minutes. This resulted in less attractive connections, a loss of market share and thus a decrease in revenue. Zhang et al. estimated, that American Airlines lost about 4 percent of their market share at ORD due to de-peaking.

In 2004, Lufthansa introduced a de-peaked schedule for Frankfurt airport (FRA). In this case Lufthansa used iterative stochastic simulation to evaluate different schedules. In the final de-peaked schedule, 35 out of the 50 most profitable connections had a shorter overall travel time in comparison to the original schedule. The new schedule was also more reliable and as a consequence fuel consumption could be reduced by more than 70,000 tons annually (see Franke et al. for more information).

These two examples show that de-peaking can reduce costs both through much higher personnel and asset utilization and also through reduced fuel consumption. On the other hand, this type of rolling operations throughout the day could reduce revenues if market share in profitable connections decreases due to bad connections. However, at mega-hubs as ORD, DFW or FRA, frequent connections on main and profitable routes could be offered to minimize these revenue losses.

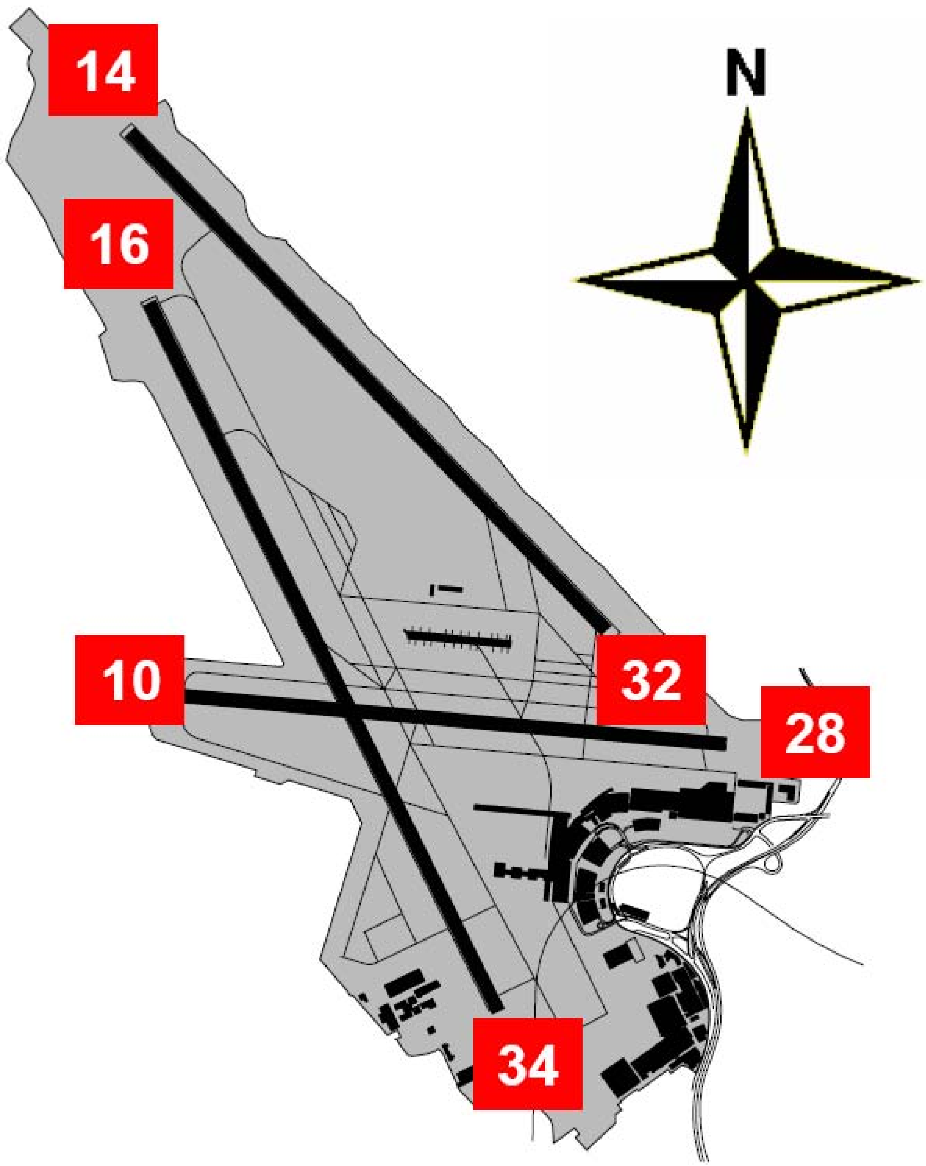
In contrast, at medium sized hubs, it may not be possible to offer frequent connections on all main routes. Therefore, the question is how big are the possible saving benefits by de-peaking and do they outweigh the decreased revenues.

In the next section, the actual situation at Zurich Airport, which is used as example for the study, is described. In section 3, the airport operations and relevant processes are briefly described. In chapter 4, the model to calculate the cost savings due to de-peaking is introduced. The cost savings are then illustrated for several de-peaking scenarios for the Zurich Airport example in chapter 5. And finally, conclusions are presented in chapter 6.

2. Zurich Airport

Zurich Airport (ZRH) is a typical mid-size airport. It serves around 40 different airlines and is the main hub for Swiss International Airlines. The airport has three runways in total (see figure 1), which allows a maximum of 66 movements within one hour. In 2006, 19.2 million passengers used Zurich Airport; 53.3 percent of these were on Swiss International Airlines. A total of 32 percent of all passenger used Zurich for a connection.

Figure 1 Infrastructure at Zurich Airport



Source: Homepage Unique, April 12, 2006, modified by BK

Ground operations in Zurich are mainly executed by Swissport. The airport has three passenger terminals with a total of 65 gates of which 56 are in operation and 25 additional gates for buses, which serve about 100 open stands. Swissport has around 2,200 employees in Zurich.

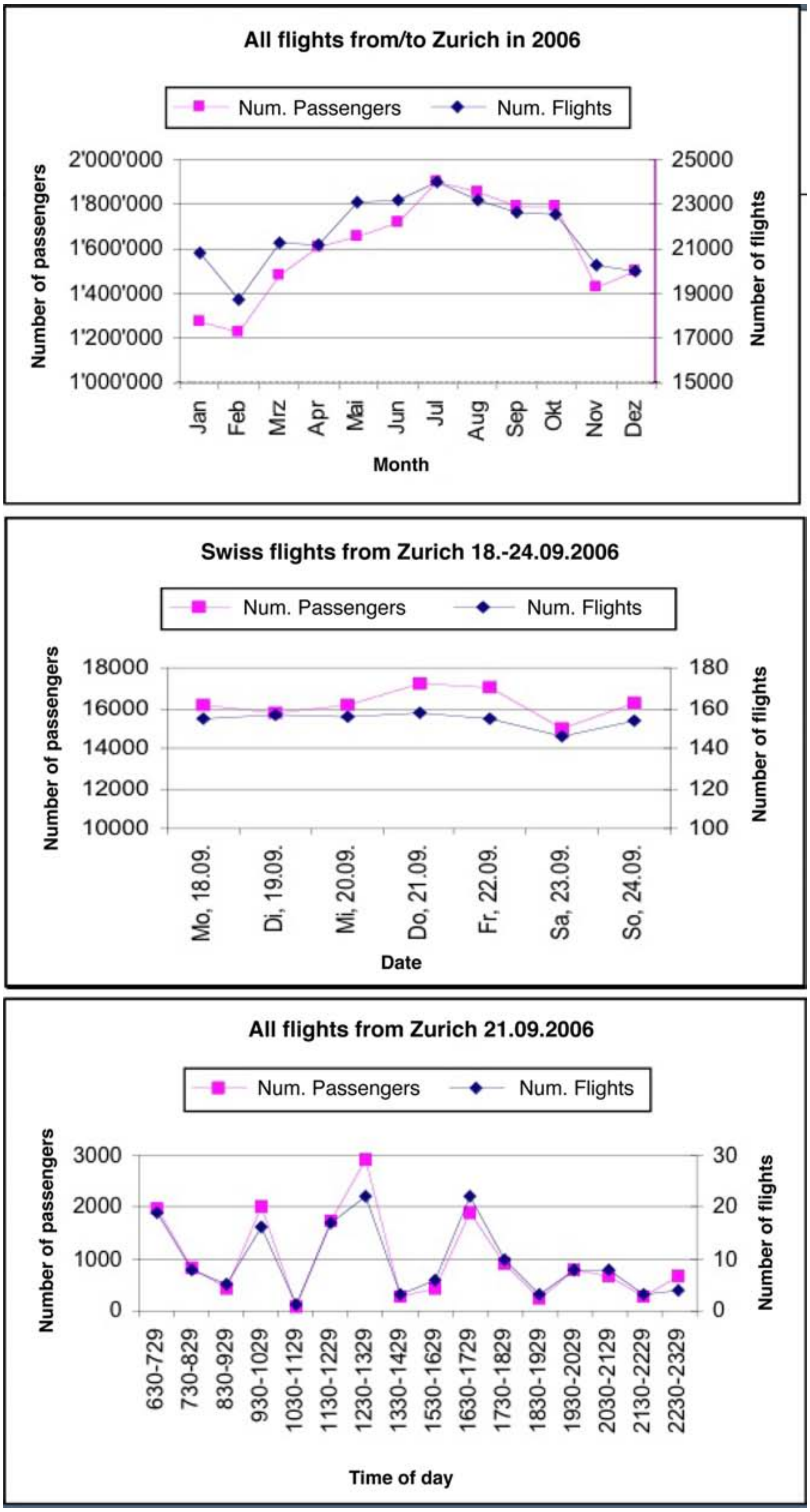
In 2006, Zurich Airport had a total of about 271,000 aircraft movements. During a typical day in the summer 2006 flight schedule, there were 521 landings and departures, of which 315 were by Swiss International Airlines.

On hub airports, different kind of peaks could be identified. First, there is a variation in the demand over the year. Figure 2 clearly illustrates, that in the second half of the year, more traffic is observable. Also during the week, there are variations. On Thursday and Friday, more passengers are using the airport compared to the other weekdays. Finally, the peaks analysed in this study are the variations of movements during a single day. Figure 2 shows that the hub is operated in a typical bank structure. As outlined earlier, this causes inefficient and cost-intensive under-utilization of staff during off-peaks for both the hub airline and the ground operators.

The discussion of de-peaking advantages presented above focuses on the airlines, however, de-peaking also provides similar benefits to the ground operations companies. Today, Swissport's ground operations staff are underutilized in non-peak periods and overloaded in peak periods. While precise scheduling of ground staff can help reduce these problems, if ground operations staff are too precisely scheduled then they will not be able to respond to airline operating delays effectively, thus causing additional delays and unsatisfied customers.

Given the highly competitive nature of the airline business, it is very difficult to obtain airline scheduling and marketing data. Therefore, this research used data from Swissport to evaluate the impact of various de-peaking strategies on ground operations. We recognize that de-peaking would have revenue impacts on airlines, but believe that the analysis of potential cost savings by ground staff is an important contribution to better understanding the benefits of de-peaking.

Figure 2 Different peaks: year (top), week (center), day (bottom)



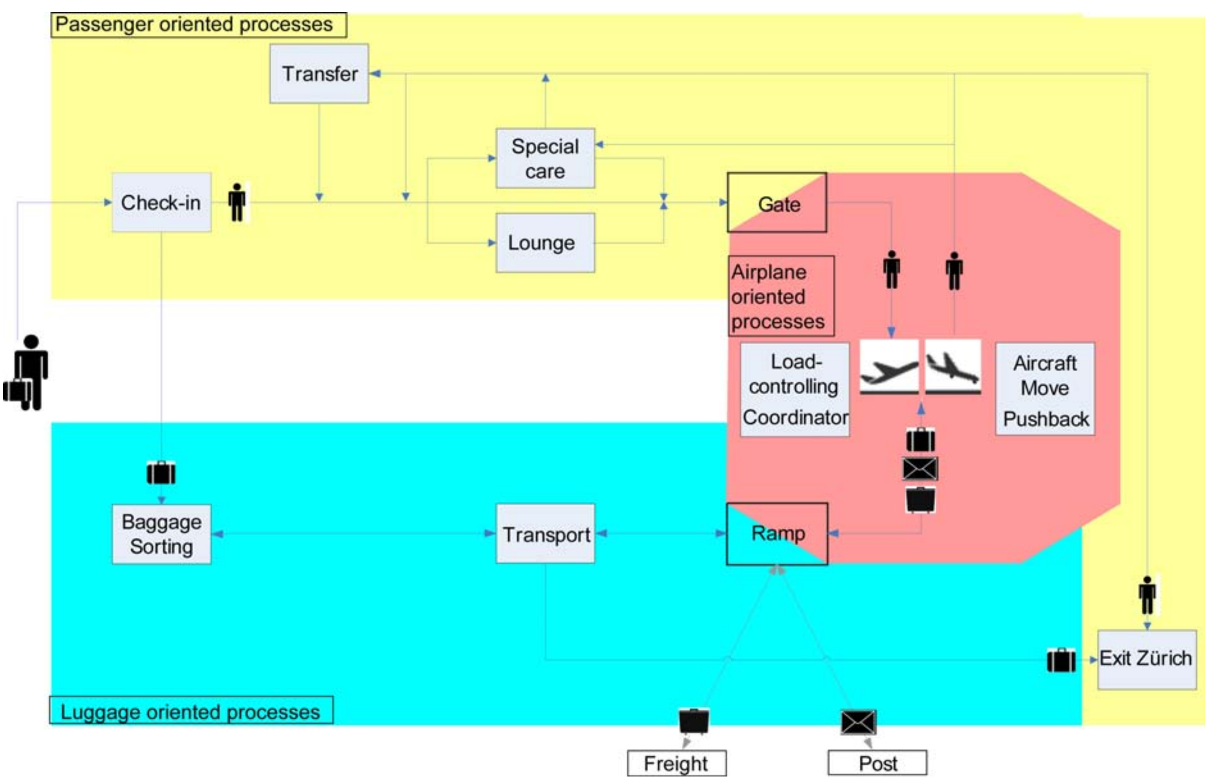
3. Airport ground operation processes

A model was developed to evaluate the impacts of different de-peaking strategies on ground operations processes. The model was based on the resources needed by ground operations to service a specific type of airplane arrival and departure. The activities involved in servicing aircraft can be divided into processes, which consist of specific tasks. This section outlines the ground services processes and tasks, then describes how the model was developed.

3.1 Ground operations processes at hub airports

Ground operations processes can be divided into three main categories: passenger oriented, luggage oriented and airplane oriented. These processes are illustrated in figure 3. As shown in figure 3, two processes are located at the interface between process categories: the gate process is located at the interface between the passenger-oriented and airplane-oriented processes, and the ramp process is located at the interface between luggage-oriented and airplane-oriented processes.

Figure 3 Ground operation processes at hub airports



The passenger-oriented processes begin either with check-in or leaving the aircraft. Zurich airport offers three different check-in areas where Swissport is active. One is designated for Swiss International Air Lines and its partners (check-in 1) another is for other carriers (check-in 2) and one is mainly for charter carriers (check-in 3). Normal check-in procedures are available at all locations. Special check-in such as group check-in or check-in for First class passengers is only available at check-in 1. After check-in passengers and luggage go different ways to the airplane.

A local passenger can go directly to the gate or make use of different services at the airport. Swissport provides special care assistance and lounge services for its customers. Also transfer services are available. Transfer services are only used by passengers arriving without the boarding pass for their connecting flight. Normally transfer services are most important when connections are broken due to delays or flight cancellations. Both departing and connecting passengers make use of the gate services as they board the plane.

The luggage-oriented processes begin when the passenger provides luggage at check-in or the luggage is unloaded from an arriving airplane on the ramp. The luggage goes from check-in through the baggage sorting system and is transported to the plane where ramp will load it into the airplane. The processes are the same for offloading, but baggage with the destination Zurich is brought directly to the belt by transport and will not use the sorting system. Mail and cargo are brought on separate processes to the ramp, but then are loaded by the ground handler. Finally, passengers and luggage meet at Exit Zurich where passengers can take their luggage from the belt and proceed to customs, and onward to the exit.

The airplane-oriented processes include the aircraft move / pushback as well as the load controlling which is done by the “coordinator”. The coordinator plans the load as well as the arrangement of the load in the plane. This function usually doesn’t impact the passenger or the luggage. As the name indicates, coordination of different services is the main issue, whether the service is provided by the ground handler itself or another company (catering for example). Coordinators also are responsible for moving the jet way and therefore are involved in some arrivals as well as departures.

3.2 Production planning and standards

Each ground operations process consists of several specific tasks; each of these tasks requires personnel and equipment. Airlines and ground operations companies work together to develop production plans (or standards) for each task. These plans define the personnel and equipment needed over time for specific operations. Production standards depend on the airline, airplane and whether the airplane is arriving or departing. They are described relative to the time before departure or after arrival. Production standards define exactly how many people of each position and what equipment is needed at any particular time.

In this research three categories of airplanes (widebodies, narrowbodies and commuters), were defined and typical production standards were developed for each of these airplane categories. These production standards were defined in 5-minute intervals for both personnel and equipment requirements. Since the processes for arriving and departing planes and the time needed for these operations differ, a total of six production standards were developed and used in the model, two for each airplane category (a departure and an arrival).

The six production standards are a simplification of real conditions since it is not always easy to put a specific plane into one of the categories. For example, in the model commuter planes are assumed to use remote stands, but in reality they can also use gates with a jet bridge, which changes the specific tasks used to complete the ground operations processes. Nevertheless, the six production standard categories provided a good estimate of resources needed for the de-peaking assessment model.

The model used costs for the required personnel to estimate the cost of each of the six categories of operations.

In addition to personnel, every process uses specific equipment, which also must be considered in the analysis. The following equipment was included in the model and specified in the production standards:

- General Power Unit (remote stands)
- WLAN car (for coordinators on remote stands)
- High loader
- Conveyor
- Container lifting transporter
- Container transporter
- Passenger step
- Pushback-Truck

In order to evaluate the costs for equipment, the model estimated the amount of equipment needed and applied an average annual cost for each piece of equipment.

Finally, it should be noted that consumable material does not need to be taken into account, since the number of flights and passengers has been kept constant, only their distribution over the day varies based on the de-peaking scenario.

3.3 Peaking relevant processes

It is important to recognize that all the activities of ground operations companies are not impacted to the same extent (and some are not impacted at all) by de-peaking. Therefore these activities were left out of the de-peaking scenario evaluation model.

One set of activities not impacted by de-peaking are those already staffed for average passenger demand. These types of activities do not correlate exactly with aircraft arrivals and departures. These activities include:

- Lounge services;
- Special care assistance;
- Transfer services, (workload depends on weather/special events rather than operations); and
- Arrival services (Exit Zurich such as services for damaged or missed luggage).

Another set of activities not included in the model was baggage handling. Baggage handling could not be included since baggage is handled by a different company (Swissport Baggage Systems) and furthermore, the luggage of Swiss and its partner airlines could not be divided from the other baggage.

Finally, the model did not consider check-in services. Although check-in services are traffic constrained and thus should be kept in the analysis, the problem is that other factors such as destination, amount of baggage, land side public transport schedules, airline departure time or the airline itself have a significant amount of influence on the time of check-in for a specific flight. Therefore, the load curve was too inhomogeneous for a general description.

In summary, only the airplane oriented processes were included in the model. Specifically, the gate with gate workers, the load planning with coordinators, the aircraft move with the pushback drivers and the ramp with supervisors and ordinary ramp workers. Nevertheless, the calculated saving potentials could also be applied and transferred to other types of airport activities, which were not modeled in this research.

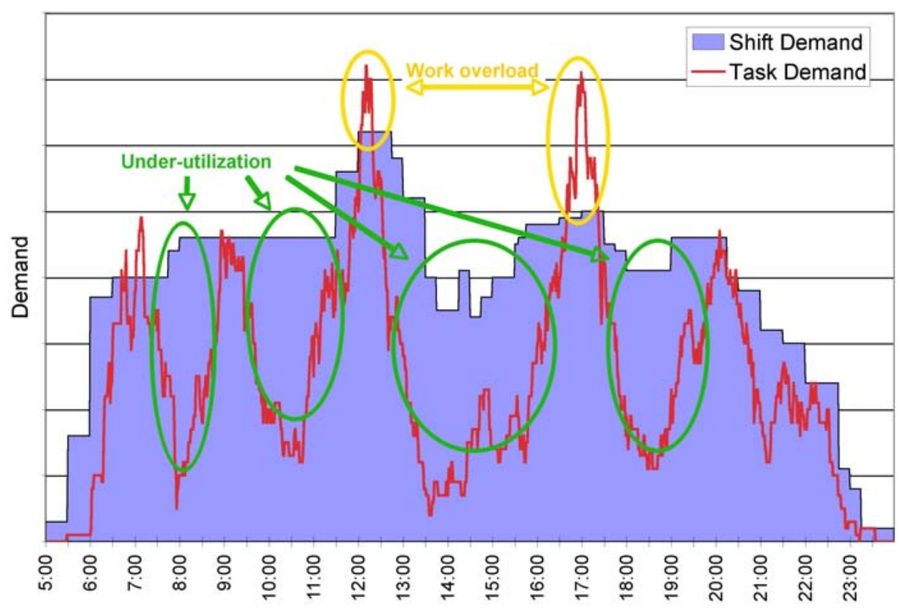
3.4 Swissport scheduling principles

Swissport schedules personnel based on the expected workload, a function of the number of passengers and flights. Scheduling is based on the production standards described in Section 3.2. Swissport estimates the number of personnel needed for each task and develops the "task demand". Figure 4 illustrates the task demand for a typical day. As shown in the figure, the task demand varies enormously during the day and clearly shows the peak and off-peak periods.

Once the task demand is known, Swissport can schedule the specific personnel needed to accomplish the tasks, this is called the "shift demand". The assignment of staff depends on their skills (multi skilled staff can be used more flexibly). The staff shifts vary, but Swissport does not operate with "split shifts", two short shifts with a long break in-between.

As Figure 4 illustrates during peak periods of the day there is greater task demand than staff capacity (work overload), while during non-peak periods staff are underutilized. The goal of the de-peaking exercise is it to rebuild the task demand curve so that it remains under the shift demand. Of course building a perfect schedule (one in which task demand was exactly matched with shift demand) is impossible, given the staff and shift length constraints. However it is possible to improve efficiency to some degree. Similar to the personnel requirements, the demand for equipment also has strong peaks and valleys. Therefore, de-peaking can also reduce the amount of equipment needed at an airport.

Figure 4 Shift demand and task demand for a typical day



4. De-peaking strategies

There are three main strategies for depeaking. Each of these strategies has different consequences on the schedule and on the ground operations workload (which depends on the schedule).

The first de-peaking strategy is to have a completely even workload throughout the day. As the airport opens in the morning until the night curfew the workload is on the same level. The schedule in such a scenario is completely different from today, since there are no peaks. This is en extreme strategy. Under this scenario, the passenger flight connectivity decreases dramatically but it is still possible for the hub airline to maintain some of the important connections.

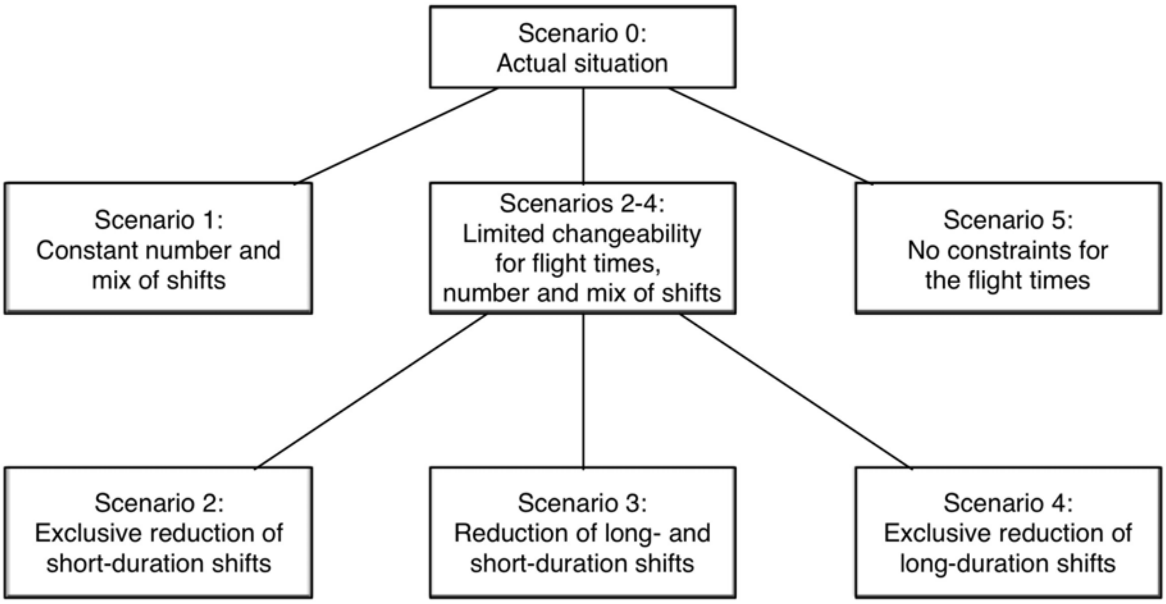
The second de-peaking strategy is to schedule flights so that the peaks are reduced and the maximal workload is the same for all peaks. This strategy does not necessarily create schedule changes at all peaks. Depending on the selected level of maximal accepted workload, scheduled flights during the smaller peaks can remain unchanged. Flights during the higher peaks need to be distributed into off-peak periods. In this case it may be necessary to reschedule flights a relative long time from the original arrival/departure time Therefore, the schedule can be very different from the original or similar to it, depending on the maximum level of workload accepted.

The third strategy requires that flights be rescheduled to a off-peak period directly adjacent to the peak period when it was originally scheduled to arrive/depart. This strategy reduces the amount of schedule change. The percentage reduction of the maximal workload can be the same for all peaks. If the restriction on changing the departure and arrival times is severe, this strategy does not have a big impact on passenger connectivity for the hub airline. The third de-peaking strategy is the only realistic alternative for an airline in today’s market. In this scenario flights are only shifted slightly from their original schedules and more connections are maintained. In this case the main element to be defined is the maximum amount of time that a flight can be shifted from its original schedule. If flights are only allowed to be shifted a maximum of 15 minutes ahead or behind its scheduled departure or arrival time, the main peaks will still be high and the time between almost as unproductive as with the original schedule. On the other hand, allowing flights to be shifted +/- 60 minutes can reduce the peaks, but almost completely changes the original schedule. For the hub airline main connections are important and to completely de-peak its schedule means cutting at least some of these connections. Therefore, although a 100% de-peaked schedule is not likely from a business perspective, it will be considered in the analysis to estimate the maximal possible cost savings possible through de-peaking.

5. Results for the Zurich case study

The ground operations cost model was used to evaluate 5 alternative scenarios, visualized in Figure 5. In the first scenario, the number of shifts is not reduced. Thereby, shifting the arrivals and departures slightly could reduce the strategic overload. The scenarios 2, 3 and 4 were used for different maximal shifts and reduction of different shift types. Finally in scenario 5 a full de-peaking was analyzed. The estimated costs of these scenarios were then compared to the current cost to determine the impact of de-peaking.

Figure 5 Analysed scenarios



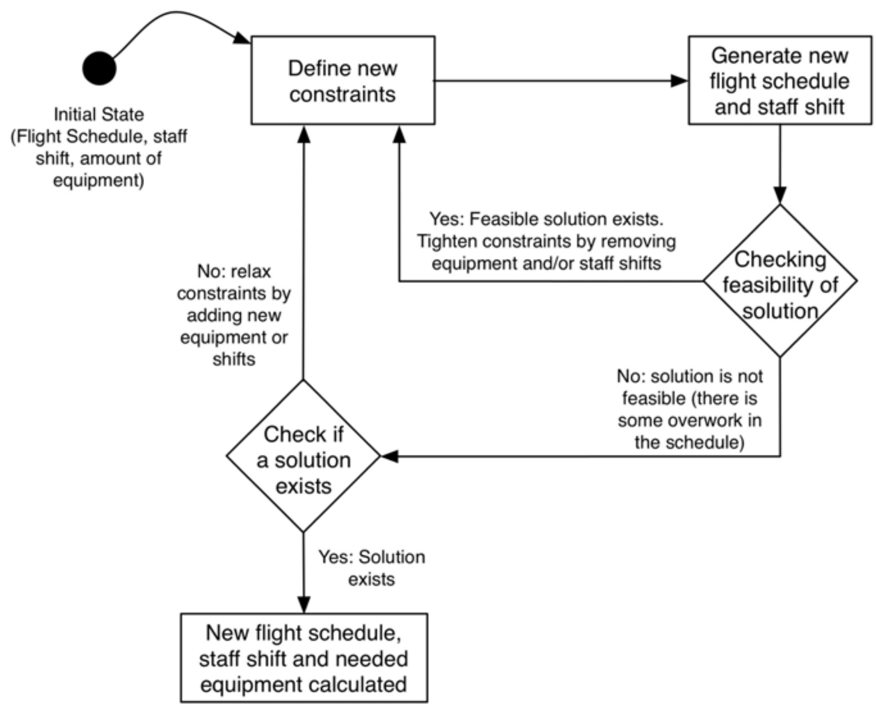
The analysis of each de-peaking scenario started with the original flight plan, equipment requirements and working schedule as initial inputs. Then the maximum time shift for arrivals/departures (15,30, 45 or 60-minutes and no maximum for the full de-peaking scenario) was set as a constraint. The second parameter that could be changed in the optimization was the starting time for each employee in the working schedule. For the analysis, 8 different kind of shifts were defined:

- Gate: short shift: 4.5 h;
- Coordinator: short shift: 4.5 h;
- Ramp: short shift: 4.5 h;
- Gate: long shift: 7.5 h;

- Coordinator: long shift: 7.5 h;
- Pushback: long shift: 7.5 h;
- Ramp: long shift: 7.5 h;
- Supervisor: long shift: 7.5 h;

Using the shift and schedule constraints as input, a new flight and working schedule was generated using genetic algorithms. A schedule was considered not feasible and was eliminated if overwork occurred (i.e. the number of tasks at any point of time was larger than the available staff). The genetic algorithm was used to optimize underutilization during the off-peak period. If a feasible solution was generated, equipment and shifts were reduced based on the scenario type. The procedure used to obtain a valid solution is illustrated in Figure 6.

Figure 6 Procedure to calculate cost reductions

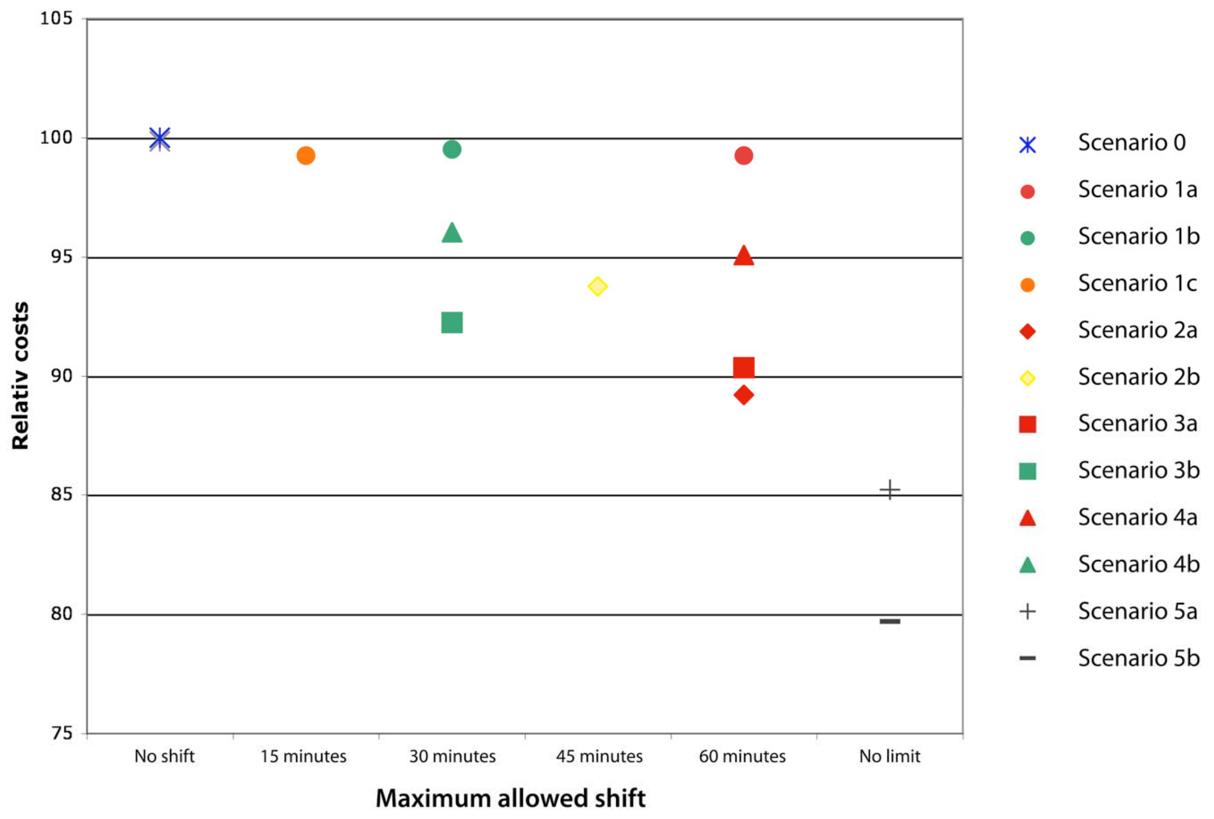


The results for the 5 different scenarios are visualized in Figure 7. It is visible, that for small shift limits (15 minutes), the saving potential is very small. The reason for this is, that Swissport allows temporary overload of work in the schedule as strategic decision to improve efficiency. In our model, overload was not allowed. Nevertheless, the analysis shows, that overload is avoided if the flight schedule is de-peaked by allowing a maximal shift of 15 minutes.

For the 30 minutes shift limit scenario, a maximum of 7.8 percent of the costs could be saved. Allowing one hour does not improve the savings strongly, a maximum of 10.8 percent compared to the original schedule is saved. In the full de-peaking scenario, ground operations costs could be reduced by approximately 20.3 percent. Kisseleff describes a detailed summation of the saving potential for all scenarios.

While it is clear that even a small amount of de-peaking can reduce ground operations costs significantly it is important to recognize several assumptions. First, the model evaluated a typical workday, the level of peaking and the hourly costs are different for weekends and holidays so the impact of de-peaking on costs for these days would be different. Second, only tasks close to production were analysed in the model. Administrative tasks, independent from the schedule, were neglected and offer no saving potentials.

Figure 7 Overview of costs for the different scenarios



Finally, the study only considered costs for the ground handler. However, it can be assumed, that de-peaking can also reduce costs for the airport operator, the hub-carrier and closely related companies. On the other hand, the hub-carrier has to analyze in detail, if such a de-peaked schedule is feasible for its operations and if the potential cost savings outweigh the impact on revenue due to worse connections.

6. Conclusion

This paper has analyzed the potential savings achievable by de-peaking a banked hub for a typical mid-sized airport. A model to estimate the saving benefits and different de-peaking strategies was introduced. The study results show that shifting schedules only slightly can reduce ground operations costs by almost 8 percent and can eliminate overload of work for ground staff. Consequently, even small changes in the schedule offer major benefits through more efficient operations, less under-utilization and higher productivity. A complete de-peaking of operations (constant number of aircraft movements throughout the day) offers the possibility to increase the savings of up to 20 percent, but is unrealistic from a business standpoint.

The research results show that even small changes offer significant saving potential. Higher efficiency through a de-peaked flight schedule strengths the position of both the hub carrier and the airport. This is especially true if the hub airline combines de-peaking with detailed schedule planning to reduce connection times for high revenue origin-destination pairs.

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