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Passenger Management by Prioritisation

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Abstract

Using the check-in area of a generic airport as an example, investigations were carried out as to whether – and if so, how – operational agreements between various process stakeholders have an effect on traffic progress. Individual passenger prioritisations decide whether a person is treated with priority at the common security control point which is a critical element of the infrastructure. In the model, status group division takes place at boarding card control. Instead of membership to a passenger class or frequent-flier bonus programme, traffic aspects are now the defining factor in guaranteeing priorities. The investigations were carried out using a microscopic fast-time simulation. A variety of strategies recommend themselves with regard to maximising the number of passengers who can actually catch their flight, depending on the capacity load.

Keywords: airport ; passenger ; management ; simulation ; prioritisation

Résumé

En utilisant la zone d'enregistrement d'un aéroport générique à titre d'exemple, les enquêtes ont été menées pour savoir si - et si oui, comment - les accords opérationnels entre les deux différents responsables du processus ont un effet sur la progression de la circulation. A cet effet, la hiérarchisation individuelle des passagers entre en ligne de compte pour déterminer si une personne est traitée en priorité au point de contrôle de sécurité commun en tant qu'infrastructure critique. La répartition des groupes de statut s'effectue dans le modèle au contrôle de la carte d'embarquement. À la place de l'appartenance à une classe de réservation ou à un programme de bonus Frequent Flyer, les aspects de la circulation devraient maintenant plutôt être déterminants dans l'octroi de priorités. Les enquêtes ont été réalisées à l'aide d'une simulation en temps rapide microscopique. Selon l'utilisation des capacités, diverses stratégies s'imposent afin de maximiser le nombre de passagers qui peuvent effectivement atteindre leur vol.

Mots-clé: aéroport ; passager ; gestion ; simulation ; priorisation

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1. Introduction

Using a generic airport as an example, passenger simulations were used to investigate whether, and if so how, operative agreements between various process stakeholders in landside airport processes have an effect on traffic progress. The part of the airport modelled here is the departures side. This consists primarily of a check-in desk area, a central boarding card control point, a security control point with flexible staffing and the boarding gates. The object of this paper is to investigate the possibilities of influencing achievable boarding quotas through targeted prioritisation of flight passengers in order to limit the number of flights missed due to long queues at security control. There are two different routes for this between boarding card control and security control. The standard route leads via a queuing system to the control area. The other route, called the bypass, leads to the same point along the shortest possible path. Checked in passengers are routed down one of these two paths to boarding card control depending on passenger prioritisation strategy, system state and the buffer time remaining for each checked in passenger. The first two security control tracks can be used to serve prioritised passengers who reach the control point via the bypass. The security control point is the critical infrastructure of the airport. The prioritisation scenarios investigated here are different from those currently in use which are generally differentiated on economic grounds according to booking class and frequent flyer status groups but are not further differentiated within these divisions so as to have any impact on traffic.

This paper first explains the layout of the generic airport modelled in order to enable transferability of the results. There then follows a description of operational scenarios presenting the traffic load of the model airport and the passenger prioritisation management strategy. In addition, the parameters of the simulation are documented in detail in order better to be able to understand the results of the simulations in the Data Assessment chapter. Finally the information gathered is classified with the intention of helping to transfer the generically acquired data into practical applications.

2. Generic Airport

2.1. Simulation Software

The Traffic Oriented Microscopic Simulator (TOMICS) is a piece of microscopic simulation software for modelling individual movements of persons within an airport terminal. TOMICS was designed to be able to simulate as many traffic and passenger handling processes in an airport as possible. The basis for this is formed by events which are described within a predefined space between two nodes (source and sink). All movements within the space are simulated through time-step related calculations of direction and speed involving a conflict test. The input parameters required for the simulation are entered into the TOMICS database after having been checked for completeness, plausibility and their suitability for fulfilling the task.

2.2. Model Description

The departures side airport model selected was created using this simulation software primarily because the dimensions are freely scalable. So it matters less, for example, how long the routes are than that they remain freely adjustable by scaling. In the simulation used the airlines have three times three departure desks in the entrance area. Here the passengers of the three models airlines can check-in and hand in their baggage. Passengers who have already checked in remotely will only use the desks if they have baggage to hand in. In any other case they can proceed directly through to boarding card control. At boarding card control travellers are divided. Prioritised passengers use the direct route to the security control point and are also given priority there. Non-prioritised passengers are directed to the security control point via the waiting zone. Of the ten security control points modelled, the first two are used primarily for processing prioritised passengers. If these prioritised control tracks are empty then they can also accept non-prioritised passengers in order to prevent loss of capacity caused by overly rigid prioritisations. The remaining control tracks on the other hand always and only serve non-prioritised passengers. In order to guarantee a prioritisation advantage, even at times of high demand, without designating all tracks as prioritised passengers only, access to the prioritised bypass is limited. Rather than giving priority to all passengers entitled to it under the selected strategy, priority is only actually given to as many as can be processed whilst still keeping the average expected waiting time at the prioritised control tracks under the time expected for non-prioritised passengers.

2.3. Model Parameters

The main model parameters for the simulation are concerned with process times at the departure side service facilities of check-in and security control as well as with the speeds of the modelled passengers.

2.3.1. Check-in

The check-in desks serve the customers of a particular airline in groups of three. In order to keep things simple it has been assumed that all departures will be processed at the same time meaning that no further sorting according to flight numbers need take place. The check-in desks serve those passengers who wish to check-in at the airport and those passengers who have already checked in remotely but still have baggage to hand in. Service times at the check-in desks vary within a range of approx. one to two minutes. The waiting time between check-in and security control is limited in this simulation model to the time taken to walk between these two points. Boarding card control takes place along this route as an access control and is not further modelled. However, at this point the boarding card control staff check whether the approaching passenger is authorised to use the priority bypass or whether he must take the conventional path. The prioritisation tool is therefore used on all passengers independent of the mode of check-in.

2.3.2. Security Control

Security control points have an average processing time of one minute per passenger. This time may vary from airport to airport but has been used in the model in order to balance out infrastructure capacities with demand. Since this is a generic model it is possible to transfer the results to real examples using appropriate scaling.

2.3.3. Walking Speed

The passengers in the simulation have individual walking speeds in the range approx. 2.5 to 6.2 km/h. This speed is attributed to the person as he is generated using the Fruin classification. In the 1970s John Fruin transferred the Level of Service concept already familiar from motorised traffic management to pedestrian traffic flows. He assumed that each person has a desired speed which he can achieve depending on the type and number of impediments caused by other people. The average desired speed of able-bodied people is approximately 4 to 5 km/h (Young, 1999).

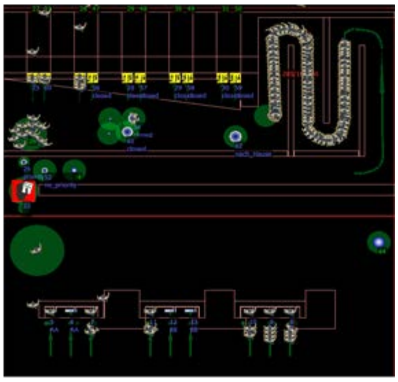

Fig. 1. Detailed view of the generic airport model used.

3. Operational Scenarios and Simulation Runs

3.1. Standard Operational Scenario

In this scenario there are no agreements, instead the results serve as a reference for evaluating the results of the following scenarios. This strategy bears the identifier 1.

3.2. Prioritisation Strategy "Prioritise Early Passengers"

Using the prioritisation strategy "Prioritise Early Passengers" in the simulation leads to the first passengers arriving for any flight being able to enjoy prioritisation. In fact these passengers are given priority so long as sufficient capacity is available at the maximum two prioritised security lanes. In any other case, despite early arrival, no priority is guaranteed since this effectively would no longer lead to faster processing. 90 minutes before departure was chosen as the limit for early arrival. Since passengers are expected to appear in the terminal between 120 and 30 minutes before departure and since the arrival classification lying between these times is not dissimilar to normal classification, only relatively few people receive priority. In the simulation, prioritisation of early arriving passengers is designated as Strategy 1.

3.3. Prioritisation Strategy "Prioritise Late Passengers"

Using the prioritisation strategy "Prioritise Late Passengers" in the simulation leads to the last passengers arriving for any flight being able to enjoy prioritisation. The expected actual time required to reach the departure gate now defines whether a passenger is given priority or not. If a passenger is probably not going to catch his flight due to his relatively late arrival at the airport, a check is carried out at the boarding card control point as to whether the waiting time in the prioritised track will be shorter than on the conventional side. The late passenger is only prioritised if this is the case. This increases the probability of nevertheless catching the flight. In the simulation the prioritisation of late arriving passengers is designated as Strategy 2.

3.4. Operational Scenario Connectivity Intervention

Whilst the first "standard" scenario checked passengers of all three modelled airlines equally against a prioritisation option, it will now be investigated to what extent individual prioritisation could contribute to alleviating operational disruptions. In order to do this the passenger arrival distribution for a selected flight was changed in such a way that now half of the in this case 90 passengers, i.e. 45, all arrive in the terminal at the same time, only and exactly 30 minutes before departure. The flight was selected because of its position in the afternoon peak period at which time the infrastructures experience particularly heavy loads. The difficulty in processing the passengers which now arises due to time constraints for this flight in particular are now to be solved by agreements between the individual process owners. One agreement investigated concerns the prioritised use of resource-critical infrastructure at the competitors' cost. Another agreement leads to processes in the check-in area being delayed in order to reduce throughput and thus reduce the load on the subsequent security control, which is a point of infrastructure experiencing heavy load. This reduction is intended to help direct the late arriving passengers in this scenario to nevertheless catch their flight as a group. Compensation mechanisms would not be relevant, instead of fees it is to be assumed that each airline would make use of these solutions equally. In the simulation this reference scenario without prioritisations is designated as Strategy 3.

3.5. Prioritisation Strategy "Indirect Connected Pax Prioritisation"

Using the prioritisation strategy "Indirect Connected Pax Prioritisation" leads in the simulation to two out of three check-in desks of each airline being temporarily closed. This reduces the throughput and the flow of arrivals at the security control point which in turn leads to shorter average waiting times, in line with expectations. The group of 45 people all arriving late and at the same time for this flight under special consideration thus encounter a security control point which is less busy. The temporary closure of check-in desks for the period of 30 minutes before the arrival of the group to immediately after their arrival contributes to the group being indirectly prioritised. No direct prioritisation via the bypass takes place for any passenger in this strategy. In the simulation the indirect prioritisation of the group is designated as Strategy 4.

3.6. Prioritisation Strategy "Direct Connected Pax Prioritisation"

The use of the prioritisation strategy "Direct Connected Pax Prioritisation" leads in the simulation to only the group of 45 late arriving passengers on the selected flight being treated with priority and being able to pass through security control via the bypass. Other passengers receive no prioritisation. In the simulation the direct prioritisation of the group is designated as Strategy 5.

4. Flight Schedule

The flight schedule used loaded the simulation model with 100 departures within a traffic period from 08:00 to 24:00. The passengers on these flights arrive in the terminal between a maximum of 120 minutes and a minimum of 30 minutes before closure of the boarding gate (see Fig. 2). The flight schedule generator created specifically for this application ensured approximate Weibull distribution passenger numbers of between 30 and 120 seats per flight, a total for the entire day of exactly 5624 passengers. In result, passenger demand is not evenly spread over the day but varies with busier and less busy periods. The passenger frequency for the generic airport is thus in the same order of size as for example Nuremberg airport (NUE) if we take the annual average[†]. 63% of passengers use the check-in desks for checking in and/or handing in baggage, 37% go directly to boarding card control upon arrival at the terminal.

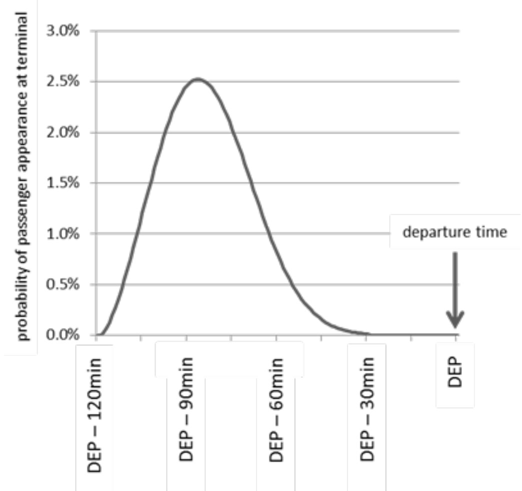

Fig. 2. Probability distribution (density function) for passenger appearance for each flight

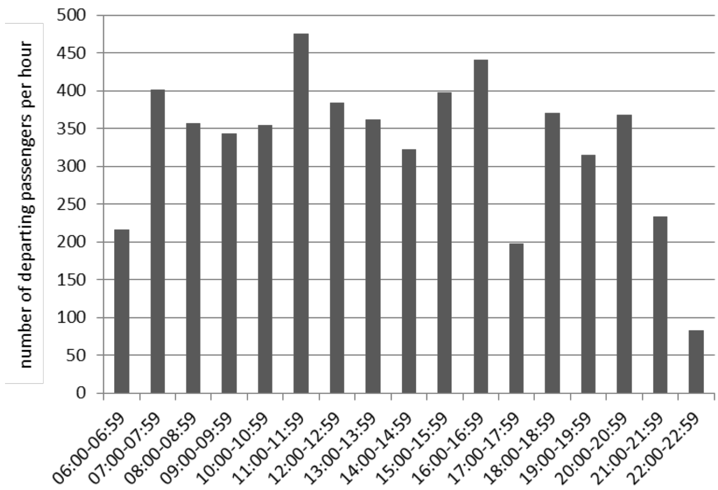

Fig. 3. Departing passenger demand per operating hour

[†] 2012: Passenger volume 3,602,459 (Source: NUE Airport). Calculated average volume:
3,602,459/365 days ≈ 10,000 passengers per day. Assumption: half for departures (approx. 5000 per day)

5. Data Assessment

In the simulations reference case the maximum 5624 departure passengers are generated according to the arrival distribution stored in the system and sent on their route through the terminal. Under these conditions all passengers reach their flight at least just-in-time if six or more security desks are permanently open during the simulated operating day. When desks are closed, with less than six desks open some passengers will not catch their flight whereby an approximately linear progression is in evidence. In the extreme case, with only one open security desk, only 732 out of 5624 passengers catch their flight.

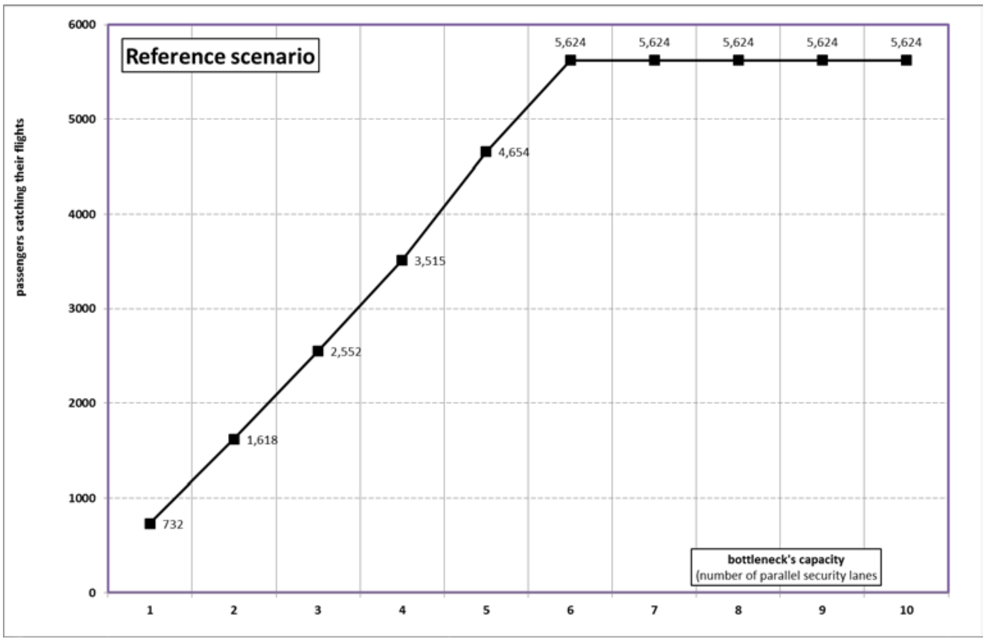

Fig. 4. Passenger numbers of those who catch their flights depending on security capacity

The idea behind Strategy 1 is to prioritise the use of the limited resource for the relatively early arriving passengers in order to enable them to be processed more quickly. Processing somebody particularly quickly, despite the fact that his early arrival means that he is one of those who has the most time available for the processes required seems at first glance to be a reckless approach. In fact the effect of selection proves itself here even when only starkly reduced infrastructure capacity is available. In the simulated extreme case with only one single security control point this strategy increases the quota of passengers catching their flight by a good 20%. The strategy therefore rewards those who (coincidentally) have more free buffer time and who, due to faster processing, are able to catch their flights even when queues are very long. This effect is weakened and is even slightly reversed if capacity at security control is increased. As soon as there are four security lanes or more available, this system is no longer beneficial.

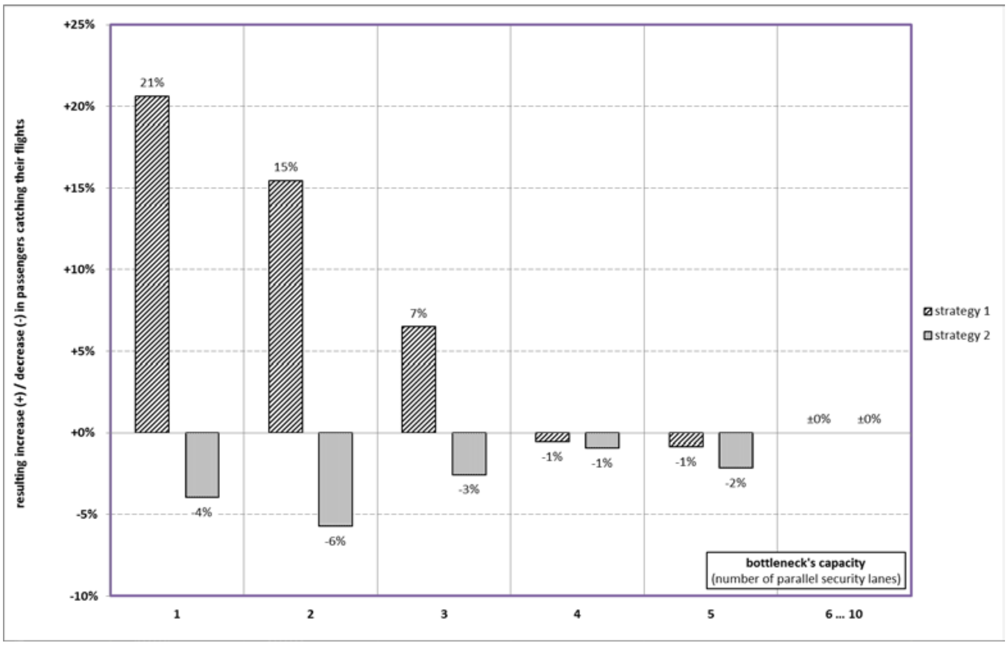

Fig. 5. Prioritisation effects according to strategy

The other version of time-dependent prioritisation is the one in which late arriving passengers are prioritised. This prioritisation model is intuitively the one which might be assumed to be most useful. In the simulation, the prioritisation of later arriving passengers does not however lead to an increase in the total number of those catching their flight. Instead, a slight reduction in numbers is even measured, at least up to the scenario in which the 'do nothing' case also leads to hundred percent target attainment. In cases with more strongly reduced capacities, prioritisation of later arriving passengers led to their faster processing at security. This could, however, not prevent the fact that the majority of these passengers missed their flights since processing times at security were significantly increased due to the unfavourable capacity-demand relationship. In addition, the ineffectual prioritisation of late arriving passengers influenced the processing of the other passengers which meant that more passengers missed their flights. The strategy was not convincing in any of the simulated scenarios.

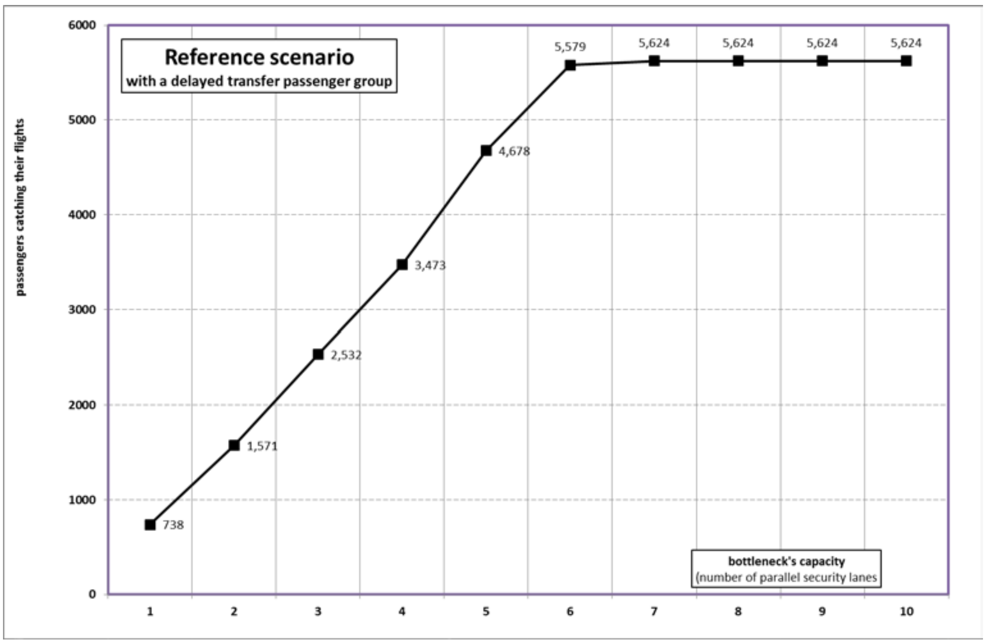

Fig. 6. Passenger numbers of those who catch their flights (now one group of 45 persons being late)

For the investigation of strategies 4 and 5, the simulation process was changed in such a way that a different arrival distribution now applied for a selected flight. Of the 90 expected passengers on this flight, half of the group appeared precisely 30 minutes before departure, i.e. at the very last possible moment. This group could for example be one which had arrived on one bus and whose passengers had already checked in collectively. Compared with the boarding numbers from Fig. 4, minor differences result from this change.

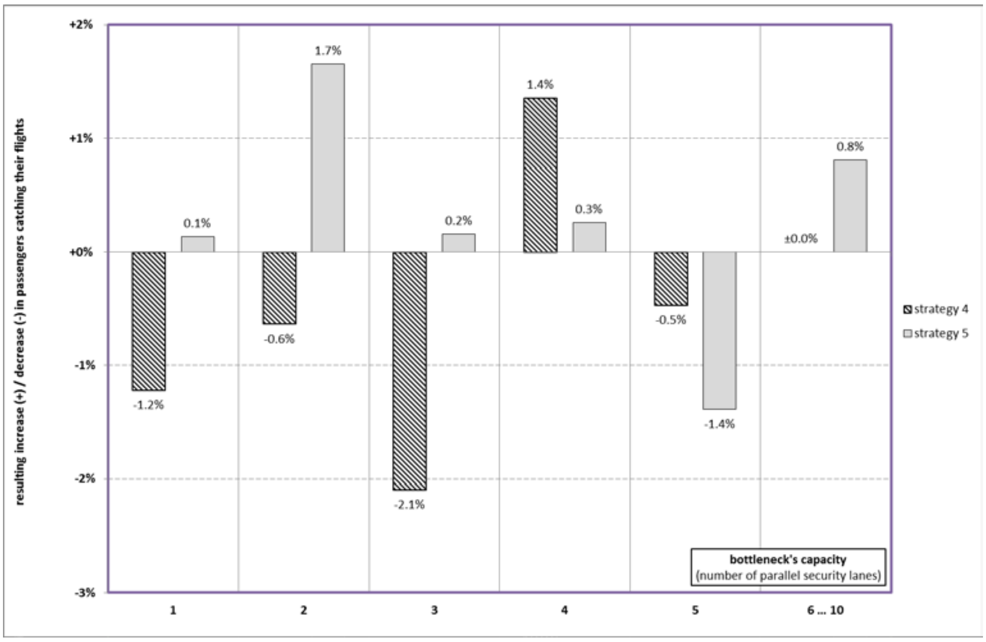

Fig. 7. Prioritisation effects according to strategy

In Strategy 4, two out of three available check-in desks were closed for half an hour before the expected arrival of the bus group. This reduced the load at the security control point, nevertheless at the cost of delaying the demand wave for all other passengers. Strategy 4 also showed a diffuse impact on the total number of passengers able to catch their flight. Whilst the strategy did have a limited positive effect on the group arriving by bus, the needs of other travellers on the same flight and on other flights cannot be taken into account with sufficient differentiation. On the whole the collective disadvantages outweigh the individual advantages. In Strategy 5 the other passengers are not held up at check-in or handled more slowly, it is the 45 late arriving bus passengers who are prioritised and arrive at the security control point via the bypass. This strategy also struggles with the balance between individual advantages whilst taking into account collective disadvantages.

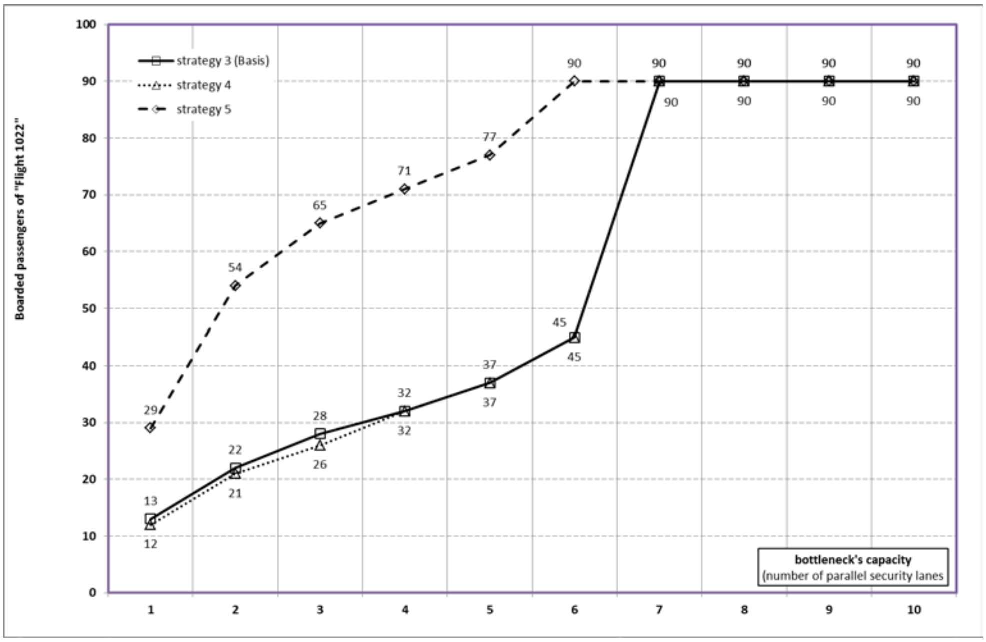

Fig. 8. Prioritisation effect on the ‘Flight 1022’ in question, according to strategy

6. Conclusions

The passenger management strategies investigated here using prioritisation at the common critical infrastructure points have shown varying effects on boarding numbers. Prioritising earlier arriving passengers of a flight leads to those early arrivers having more time to complete the lengthy processes without missing their flights. Where infrastructure capacities are significantly lacking, this strategy shows measurable advantages. However it remains to be investigated whether such a scenario actually arises frequently enough in reality for this type of prioritisation to be considered. In guaranteeing priority only for those passengers arriving early, it must be clearly understood that the system will no longer being able to process all later passenger demands effectively. The variant on this strategy, of only prioritising late arriving passengers, failed in those scenarios with low infrastructure capacity because the advantage achieved through prioritisation was not sufficient to balance the disadvantages which arose. In reality, however, it may be assumed that infrastructure capacity would be allocated at least in line with average demand. Translated to the simulation model this would mean that more than five security control points would be open permanently or flexibly (not investigated). If prioritising late arriving passengers now led to those passengers catching their flights purely due to this intervention, without at the same time meaning that more non-prioritised travellers miss their flights, then this would represent a win-win situation. In the simulations, however, no very late passenger arrivals were modelled (i.e. passengers that arrive less than 30 minutes before flight’s off block time); this will be the object of the simulations in subsequent investigations. The temporary shutdown of upstream processes in order to benefit the group to be prioritised from the simulation example was not a convincing approach. The advantages for the group are overshadowed by increased disadvantages for the general passenger population. The direct prioritisation of such a group on the other hand led directly to an improvement in their boarding quota. What is significant now is whether the other passengers are offered an appropriate prioritisation strategy for this scenario. If this is not the case then the advantages of localised prioritisation cannot be achieved without accepting disadvantages in other areas. In reality, a stochastic mixture of various operational scenarios would form the challenge for the infrastructure service provider. The academic investigation used clearly differentiated scenarios with just one component being changed.

According to the evidence, prioritising early arriving passengers makes sense when capacity is severely reduced and prioritising late arriving passengers makes sense when sufficient infrastructure capacity is available. However, this is no substitute for the discussion about the feasibility of these kinds of prioritisations in the real environment, communication with customers affected, the economic effects of such differentiations and the perceived fairness.

References

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