



# NUDGING PASSENGER FLOW IN CPH AIRPORTS

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## INTRODUCTION

Facing a global trend where cities grow rapidly and gain in importance, commuting also becomes more important. Whether people have to shuttle between different cities or within the city, whether they are commuting to work, shopping or leisure – it tends to be annoying. Even worse, using public transportation consumes an additional amount of time, since one often has to wait in queues to buy tickets, get serviced, check-in and so forth. Flow problems can sometimes be reduced easily by means that are simple but effective. Take the real case of passenger flow at CPH Airports for the illustration of such a situation:

With 26.6 million passengers a year and a plan to be able to handle 40 million passengers a year within the next 25 years, CPH Airports has its eyes set on optimising flow throughout the airport. Improving flow is a key element in making the expansion possible, since congestion and queueing promotes an over-hasty mood and prevents people from enjoying a

coffee, shopping around in the airport's boutiques or reaching their flight on time. Hence, congestion and queueing affects customer satisfaction and is expensive for the airport. Improving flow generally means reducing or eliminating congestion occurring at bottlenecks. One of the potential bottlenecks in CPH Airports is the exit located at the customs area. This is the one location where all arriving passengers need to pass through before they rush to their connecting trains, buses and cabs. Although, this particular bottleneck affects the airport only indirectly, since people were about to exit the area. This made it a perfect playground for us to develop and test an intervention that improves the passenger flow.

## DIAGNOSIS

As a first step we teamed up with CPH Airports to identify the problem, which was rather obvious: as illustrated in Figure 1 the exit consists of two doors. However, most passengers only used one of them. More specifically, approximately 90 percent of the

passengers used the right door.

Having found the problem, we dug a little deeper to find the root of it. We saw three likely explanations. First, entering customs with nothing to declare a majority of the passengers are forced to the right (see Figure 1). Being forced to the right at the entry of custom may lead more to prefer the right exit since it becomes the direct route to the exit. Second, some passengers need to take a cab. The cab drivers are waiting at a parking lot which is placed to the right of the exit (see Figure 1 for location of the parking lot). Third, since most passengers use the right exit some passengers may think that the left exit is closed and that the right exit is the only possible way out. This may lead them to exit through the right exit.

The problem then escalated through social validation: If there is a majority choosing to exit through a certain door, people tend to imitate this behaviour and also choose that door. The bad news of this insight was that the problem was self-enforcing.

The problem in a nutshell clearly was that most people tended to use the right door, and a solution was an intervention that led more people to use the left door.

## INTERVENTION

To counter the problem we wanted to signal to people

that the left door is as good as the right door. This seems obvious when one thinks about it. Though, as so often the point is that people do not think about it. They do not realize that they might avoid a bottleneck if they sway a bit from the straight path.

To solve the problem we designed two lanes (simulating driving lanes) that led people to each of the doors as illustrated in Figure 2.

We expected that people would prefer to stick to a lane once they found themselves on it simply because the duct tape signaled a wanted behavior on behalf of CPH Airports. In addition, both lanes were labelled, prompting people to use the door at the end of their respective lanes. Doing so, we signalled that both doors were equally suitable to leave the area. Finally, we made the left lane wider compared to the right lane. We did this so that more people would enter the left lane by default. To summarise, we changed the architecture by creating two lanes, which were similarly attractive and intuitively recognisable to passengers simply by deploying some duct tape as well as two labels on the floor. On top of that, we were interested in whether the colour of the lanes might make a difference. Having received feedback for the neon green dust bins [1] as well as the neon green footsteps implemented in front of them that helped to reduce littering in downtown Copenhagen, we decided to check the old colour of dustbins in

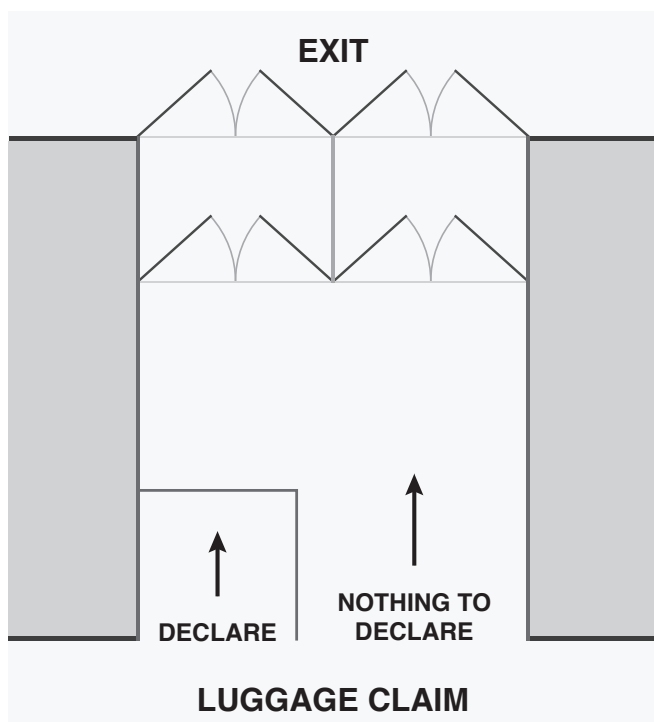


Fig. 1 Exit area at the airport.

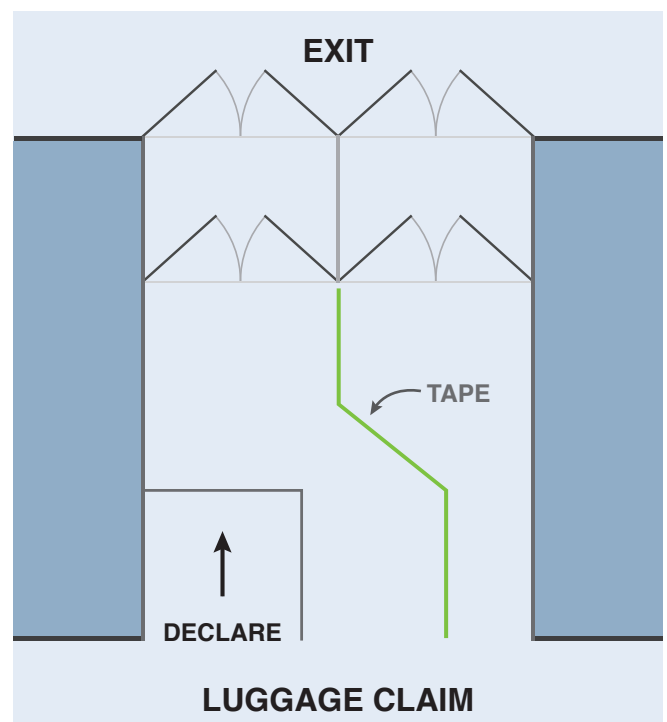


Fig. 2 Exit area at the airport with the intervention.



Fig. 3 The exit area with the two different intervention.

Copenhagen against their new colours relative to salience. Hence, we tested the lanes in two different colours: dark green and neon green. Obviously, we expected the neon green duct tape to be more salient and hence, more effective.

## EXPERIMENTAL DESIGN

To test whether the intervention effects a more balanced passenger flow through both doors, we decided to implement a quasi-experimental pre-post-design [2]. This means that we counted the number of people using each door during three conditions [3] in order to find the distribution of people exiting the left door versus the right door.

In the first condition (control period), no intervention was deployed, in the second condition (dark green period) the intervention with the dark green lanes was deployed and in third condition (neon green period) the intervention with the neon green lanes was deployed. This design enabled us to compare the frequency of each door during each treatment period with the frequency during the control period. Moreover, we could compare both treatment periods with each other.

In other words, we tested whether the share of people using the left door was higher or lower during one of the interventions compared to the control period.

## RESULTS

In total, we counted 10.895 passengers leaving CPH Airports through the exit. Passengers were counted either as 'exiting through left door' or 'exiting through right door' which resulted in a dichotomous variable.

As illustrated in Figure 4 10.75 percent of the passengers used the left door ( $n=2949$ ) during the control period. During the dark green period, 16.55 percent used the left door ( $n=3419$ ) and during the neon green period 24.50 percent of passengers used the left door ( $n=4527$ ). This amounts to an increase of 53.95 percent from the control condition to the dark green condition. We saw an even bigger increase of 127.91 percent from the control condition to the neon green condition. See appendix for a further discussion.

So what does that mean? We wanted to achieve a balanced frequency. That implies that we targeted a frequency of 50 percent for the left door. If we reconsider our findings in the light of this benchmark, an increase from 10.75 percent in the control condition to 24.50 percent in the neon green condition, does not sound that bad – especially if one considers that we achieved this just by putting some duct tape on the floor. Another and more demonstrative way to interpret the results is to assign real-world variables to these percentage points: If we apply the increase of 13.75 percentage points to the control period and

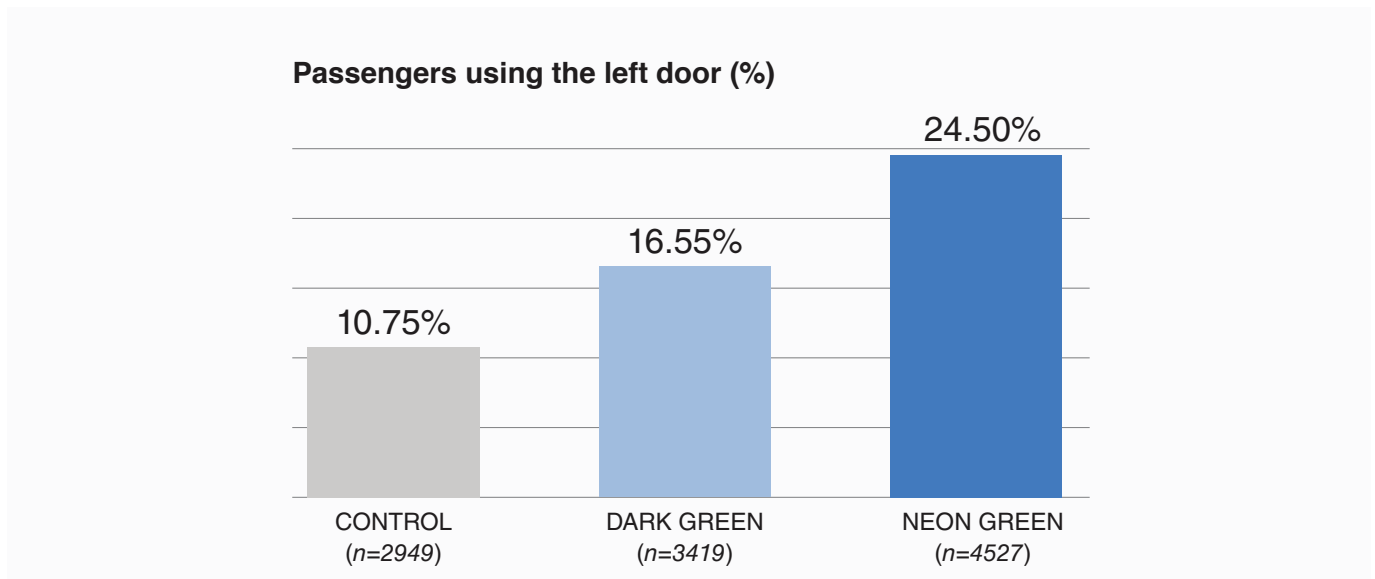


Fig. 4 Percentage of passengers using the left door.

calculate how big this increase is in terms of people, we get an increase of 405 (additional) passengers who would have chosen the left door.

If one takes into account that this increase was accomplished by spending very few resources the intervention looks even better. More broadly, this case study illustrates nicely that one can improve existing approaches if one acknowledges human behaviour. Following this approach, one can observe people's behaviour and develop solutions that are – most of the time – easy (in terms of resources) to implement.

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KH, EH and TKM: data collection.

KH, MM and PGH: editors.

JSJ: data analysis.

1. <http://inudgeyou.com/archives/819>.
2. William R., Shadish, Cook, T. D., & Campbell, D. T. (2002). Experimental and quasi-experimental designs for generalized causal inference. Wadsworth Cengage learning
3. Both interventions were deployed and removed on the same day. In the morning, the neon treatment was implemented. It was removed before the dark treatment was tested in the evening. The control period where we counted how many people walked through either of the two doors without any intervention was a couple of days earlier

## APPENDIX

To investigate whether the interventions were successful, we made predictions that led to a set of hypotheses, which could be tested statistically. More precisely, we expected (or hypothesised) that both interventions would cause a higher share of people who chose the left door. In addition, we expected that the neon green tape was more effective. That means that the share of people leaving through the left door would be higher in the neon green treatment than during the dark treatment. Instead of confirming these hypotheses, one postulates alternative hypothesis, which predict exactly the opposite, and asks whether these alternative hypotheses can be rejected at a certain level of confidence.

Following this procedure, we tested whether the share of people going left or right during one of the intervention periods remained unchanged as compared to the control period. This statistical test was done using a so called Chi-Squared Test, which relies on a contingency table (as illustrated below) that displays the total number of passengers counted during the control period, the number of passengers using the left door during the control period, the number of passengers using the right door during the control period as well as all of these numbers for the respective treatment period. If there was no difference between both periods, one would expect that the share of people leaving through the left door (that is the amount of people leaving through the left door divided by the total amount of

people counted in the respective period) was similar to the share of people leaving through the left door during one of the treatment periods. In general, the Chi-Squared test compares these numbers and measures, how likely it is that the result was due to chance.

However, these inferences are based on assumptions because - as every statistical test - the Chi-Squared test relies on assumptions. One of these assumptions is that the observations are independent from each other. That was the case if every passenger would decide isolated from other passengers whether she chooses the left or the right door. However, as we have already stated above, this is not the case since people tend to imitate the behaviour of others. Unfortunately, we cannot solve this problem by applying another test, because we do not have the necessary data to do so. To put it differently, to the best of our knowledge, there does not exist another test that could solve the problem given the data we have. Second, the periods were distributed over different times of the day and on different weekdays. In addition, the periods in which we counted, varied in their lengths. Consequently, we had to make the assumption that the amount of passengers as well as the kind of passengers (business people, families et cetera) passing through these doors within an hour was comparable during all these periods. The experimenters were aware of this and observed it by the way. Luckily, they could not determine any differences so that we at least can cut this concern back a little.

	Improving passenger flow		
	Right exit	Left exit	
<b>Control</b>	2632 <i>2540.09</i> ( 3.33)	317 <i>408.91</i> ( 20.66)	<b>2949</b>
<b>Dark green</b>	2853 <i>2944.91</i> ( 2.87)	566 <i>474.09</i> ( 17.82)	<b>3419</b>
	<b>5485</b>	<b>883</b>	<b>6368</b>

$\chi^2 = 44.675$ ,  $df = 1$ ,  $\chi^2/df = 44.68$ ,  $P(\chi^2 > 44.675) = 0.0000$

	Improving passenger flow		
	Right exit	Left exit	
<b>Dark green</b>	2835 <i>2682.45</i> ( 8.68)	566 <i>718.55</i> ( 32.39)	<b>3401</b>
<b>Neon green</b>	3418 <i>3570.55</i> ( 6.52)	1109 <i>956.45</i> ( 24.33)	<b>4527</b>
	<b>6253</b>	<b>1675</b>	<b>7928</b>

$\chi^2 = 71.912$ ,  $df = 1$ ,  $\chi^2/df = 71.91$ ,  $P(\chi^2 > 71.912) = 0.0000$

	Improving passenger flow		
	Right exit	Left exit	
<b>Control</b>	2632 <i>2386.50</i> ( 25.26)	317 <i>562.50</i> ( 107.15)	<b>2949</b>
<b>Neon green</b>	3418 <i>3663.50</i> ( 16.45)	1109 <i>863.50</i> ( 69.80)	<b>4527</b>
	<b>6050</b>	<b>1426</b>	<b>7476</b>

$\chi^2 = 218.656$ ,  $df = 1$ ,  $\chi^2/df = 218.66$ ,  $P(\chi^2 > 218.656) = 0.0000$

expected values are displayed in *italics*  
individual  $\chi^2$  values are displayed in (parentheses)