NUDGING PASSENGER BEHAVIOUR

Applying behavioural design interventions for smooth processes and experiences at Schiphol Airport's A-terminal

TU Delft

Master thesis
Jelmer Kok, October 2018

Schiphol

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PREFACE

The thesis at-hand is the result of a graduation project at Schiphol Airport, and the final deliverable for obtaining my Msc degree in Strategic Product Design at Delft University of Technology.

When looking for a graduation opportunity Schiphol immediately grabbed my attention. This is where it all happens, the “organized mess” of different stakeholders, interest, politics, business models and developments that together shape the aviation industry. Crossing the boundaries between service design, behavioural economics and architecture, my project focused on projecting passenger behaviour on the preliminary design of the A-terminal reclaim area in order to predict probable bottlenecks caused by human behaviour.

I would like to seize this opportunity to express my gratitude to a number of people that - in one way or antoher - have contributed to this project.

First and foremost I would like to thank my supervisory team: Arthur, Sicco and Frithjof. Your support and constructive feedback kept me feel positive and confident throughout the project.

Next, I would like to thank all Schiphol employees that have helped me during the past months. Marit and Tiemen, thanks for getting me on-board in this extraordinary company. Thanks Maryan, Marijn and Carla for your continuous involvement and enthousiasm.

Last, but certainly not least:
Thanks Do, for making every day a joy.

Enjoy the read!

Jelmer

EXECUTIVE SUMMARY

To reach the ambition of becoming Europe's Preferred Airport, Schiphol has set targets for the satisfaction rating of various aspects within the passenger journey. However, some of these aspects are scoring below target. One of these aspects that weighs heavy on the overall assessment is the (process of) baggage reclaim.

Aside from the actual waiting time, the most mentioned pain point within this process step is the 'course of events', rereferring to issues with crowding and congestions. Research shows that waiting in a crowded environment will cause discomfort and strengthen negative emotions.

Problems with crowding are in many cases related to human behaviour. Most of our behaviour follows from subconscious decisions and mental shortcuts. As such, pedestrians automatically take the shortest route, the route of least resistance, the most direct route or just follow others. These behaviours can explain multiple bottlenecks and issues with crowding within the current reclaim areas. To prevent or mitigate these issues it is required to achieve a behavioural change on the passengers' side. Behavioural interventions can be used to steer these automatic decisions and nudge the desired behavior.

This project explores if- and how behavioural interventions can mitigate or prevent problems with crowding in order to smoothen the course of events. The insights can be used to enhance the passenger experience for the development of the A-area as well as the existing infrastructure.

The preliminary design of the A-terminal is compared on similarities with the current reclaim areas in order to determine the probable bottlenecks. It resulted in six objectives that - if achieved - either create a better distribution of passengers or prevent crowding around the baggage carousels. A behavioural intervention is proposed for each of these objectives.

By means of a field experiment one of the interventions is tested and validated. An overwhelming majority of passengers in reclaim area 1 tend to use only one out of two exits. It leads to a messy customs process and stagnation in passenger flow. The intervention aimed to redirect passengers to the second exit by making use of floor markings and additional signage, prompting passengers to 'skip the queue' when it started crowding.

The first results suggest that nudges are indeed capable of steering passenger movement and path choice. However, iterations should be made on the design in order to improve its effectivity. If the effect is strongh enough, it might make crowd controllers at this area unneccessary.

Overall, behavioural interventions seems to be a promising area for experiments and innovation within AAS, especially when congestions and process time are mostly dependent on passenger behaviour.

TABLE OF CONTENTS

Section 1 | **INTRODUCTION**

This chapter includes:

1.1 PROJECT INTRODUCTION

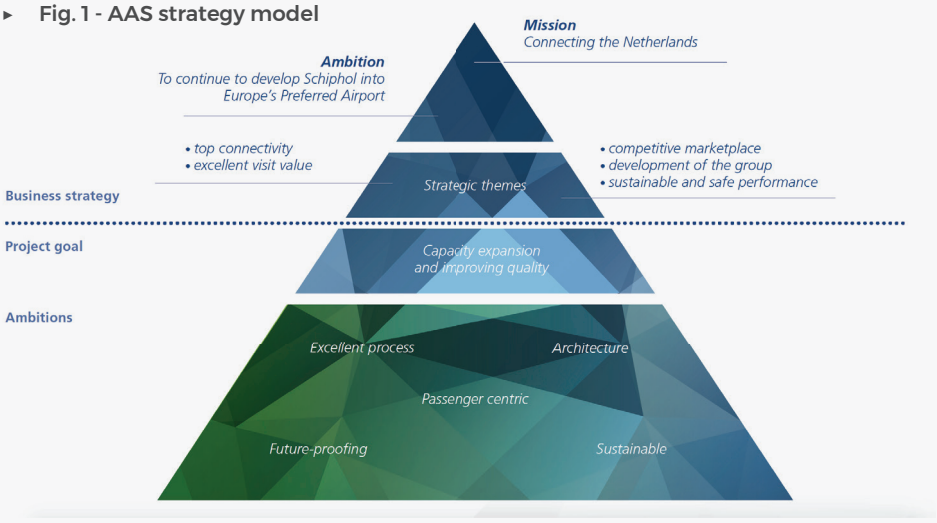
1.1.1 - Amsterdam Airport Schiphol

This graduation thesis is written in the context of Amsterdam Airport Schiphol, from now on referred to as AAS or Schiphol interchangeably. Schiphol is the largest airport in the Netherlands and an important European hub for intercontinental flights. Schiphol's mission is to 'Connect the Netherlands' and its ambition is to become 'Europe's preferred airport' for airlines and passengers alike. This ambition is characterized by five themes: Top Connectivity, Excellent Visit Value, Competitive Market Place, Development of the Group and Sustainable and Safe Performance (fig. 1)

In recent years Schiphol saw a staggering growth of 34% in its passenger numbers: from 51 million passengers in 2012 to over 68.5 million passengers in 2017. This growth puts pressure on Schiphol's capacity, especially during the summer months and holidays. To retain the position of Mainport, Schiphol is required to increase its capacity and quality, keeping the passenger experience in mind as a central element. The development of the A-area is key to achieve this goal. (Schiphol, 2016)

The A-area will consist out of a new pier and terminal, which are expected to be operational in 2020 and 2023 respectively (fig. 2). Derived from the mission and strategy, four ambitions drive the development of the A-area: Passenger centricity, Excellent process, Future proof and Sustainable (fig. 1). Together with complementing architecture, living up to these ambitions should prepare Schiphol for future growth.

▸ **Fig. 1 - AAS strategy model**

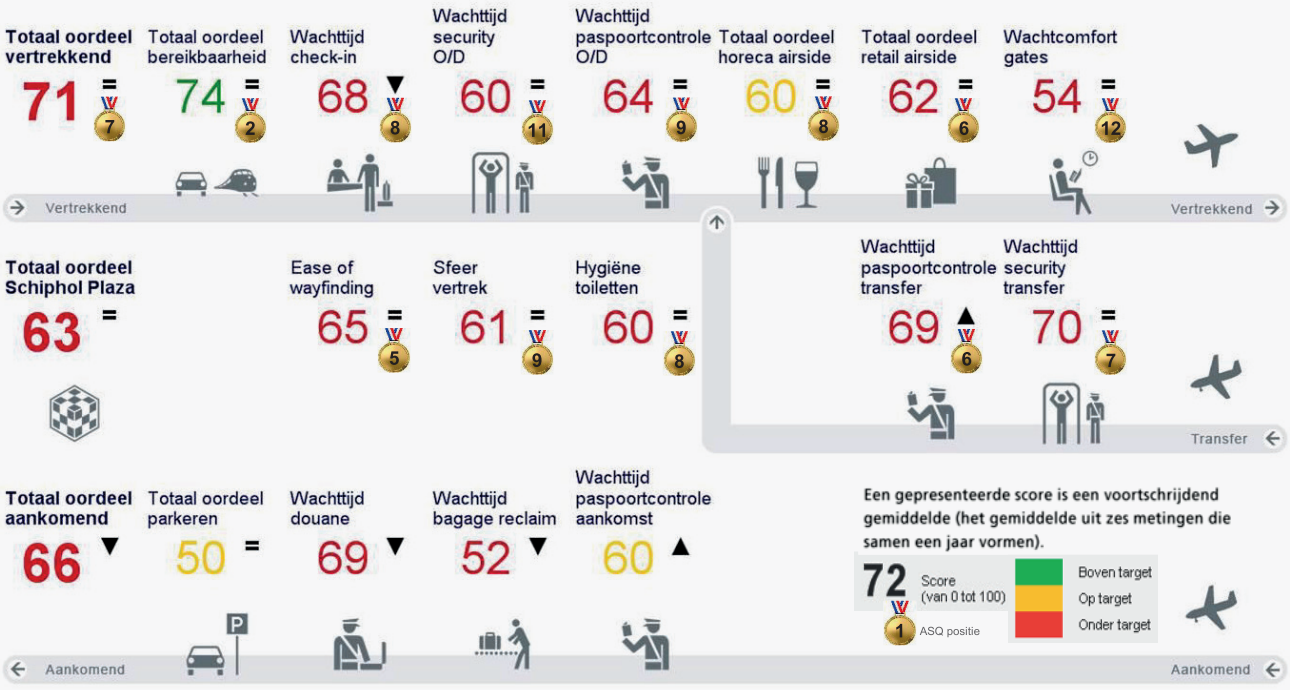


▸ Fig. 2 - The A-area (yellow)

1.1.2 - Becoming Europe's preferred airport

AAS has targets for the satisfaction rating of various aspects within the passenger journey. The target per measured quality aspect is related to the ambition to become and remain Europe's' preferred airport. As of this moment, bimonthly reports from the Customer Insights department (CI) show that certain aspects in the passenger journey are scoring below target. This is problematic, as it is assumed that passenger satisfaction is an important variable to determine AAS' performance and competitiveness. In order to make this ambition a reality, these aspects must improve substantially in the coming years. Of particular importance are the aspects that weigh heavily on the overall assessment of Schiphol.

The yearly CI report shows that the perceived quality of the departure process is more positive than the arrival process (Fig. 3). The (process of) baggage reclaim is one of the most important influential factor for the passenger satisfaction rating for the overall arrival process. When looking at the arrival process as a whole it shows that the baggage reclaim areas have been scoring below target for years (Schiphol, 2018).



▸ Fig. 3 - Yearly report of passenger satisfaction (Schiphol, 2018)

1.1.3 - The baggage reclaim

According to the CI department, passengers evaluate the baggage reclaim areas on two main drivers: the (perceived) waiting time and the experience of the wait itself (Customer Insights, 2015). In prior research, the most mentioned pain point for each driver is the duration of the wait and the 'course of events' respectively.

Though recognizing that eliminating the actual waiting time altogether would be the ideal scenario, its causes are nested within extremely complex organizational and logistical problems (see section 2.4.3). As a starting point this thesis assumes that these developments will not make conventional baggage carousels redundant.

Hence, it was decided that this project will focus on the 'course of events', which is referring to the hassle that passengers encounter within the reclaim areas: (a feeling of) crowdedness, irritations (between passengers) and congestions in passenger flow. As an illustrative example:

" Everytime when I arrive at Schiphol and want to collect my luggage from the carousel, I get annoyed by the chaos around the belt:

All passengers start to crowd to be the first to grab their belongings, while most of the time other bags arrive first.

The ones that actually see their bags and want to collect it, are hardly able to do so without pushing or hitting other people with their suitcases or elbows. "

Excerpt from a customer complaint received on June 6th, translated from Dutch

At this point in time some spatial conditions are more or less fixed. However, objects and (behaviors of) passengers in it are not. As problems with crowding are in many cases related to human behaviour, it becomes interesting to explore how issues originate. Schiphol now has the opportunity to learn from issues caused by human behaviour in the current baggage reclaim areas and incorporate solutions in the design of the A-terminal. This thesis will explore whether behavioural interventions can mitigate or prevent these issues. One promising approach to do so is by making use of 'nudges'. Which leads to the main research question of this project:

If- and how can Schiphol apply nudging to shape a smooth course of events in the A-terminal reclaim area?

1.2 THE ASSIGNMENT

1.2.1 - Scope

The project is scoped from a passenger's point of view on the arrival process at Schiphol. It lays emphasis on issues within the baggage reclaim areas that are caused by the interplay between passengers and the physical environment.

1.2.2 - Project aim

The goal is to advice Schiphol on how to achieve a (more) positive passenger experience in the A-terminal reclaim area. The aim is to carefully align (elements in) the physical environment with passenger behavior in order to shape the optimal conditions for a smooth course of events.

Preferably this would be in the form of small design interventions that are cost-effective and easy to incorporate within the preliminary design of the terminal.

1.2.3 - The Assignment

The assigment has been formulated as:

"Dwesign a nudging strategy that will enable a positive passenger experience in the future A-terminal reclaim area by stimulating a smooth course of events."

The expected value of this thesis will be in the form of a thorough understanding on how passenger behaviour causes the issues in the 'course of events' and how nudging design principles can be applied to prevent or mitigate them. The aim is to validate some of the design principles using prototypes to illustrate how it would work in practice. This will result in a design proposal for (a) physical element(s) in the A-area along with suggestions for future experiments with behavioural design interventions.

1.2.4 - Project Layout

The report is structured in four sections, based on the four phases of the Double Diamond model as described by the British Design Council, see fig. 4 (Stickdorn & Schneider, 2014). Every chapter concludes with a summary and key take-aways from the phase.

The **Discover** phase describes the approach and deep-dives into the context and literature. It includes:

- The approach
- Theoretical background
- External analysis
- Internal analysis
- Passenger analysis

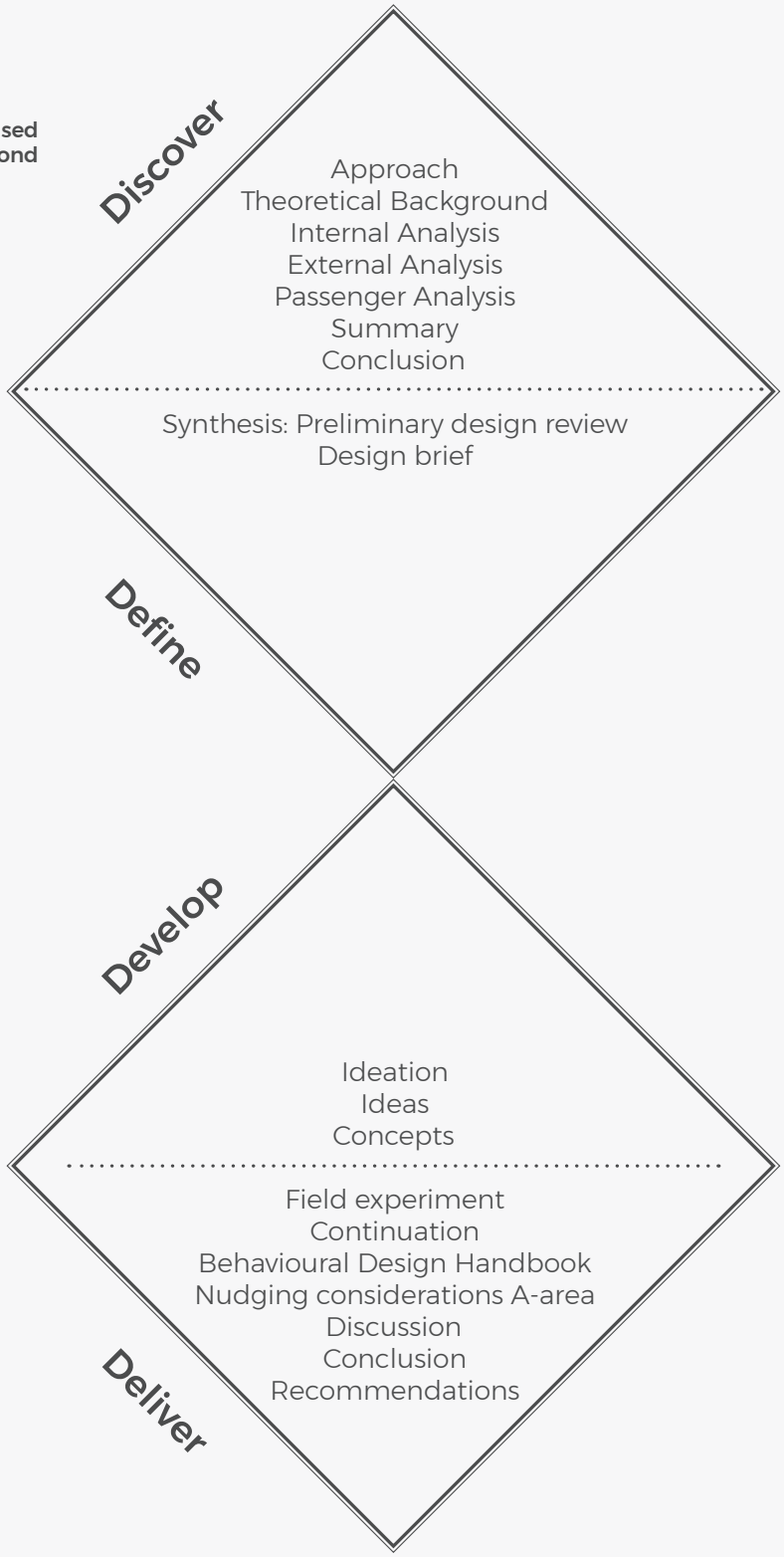
The goal of the **Define** phase is to project this knowledge on the Masterplan Design of the A-terminal and to select the objectives to focus on. This chapter includes:

- Synthesis: Preliminary Design review
- Design brief

The goal of the **Develop** phase is to generate and select behavioural interventions for the objectives as stated in the define phase.

The goal of the **Deliver** phase is to conduct a field experiment to validate and evaluate a behavioural design intervention. Moreover, it adresses the recommendations for the A-terminal and future experiments with behavioural interventions.

The report wraps up in with a discussion on the findings, a conclusion, recommendations for future research and a personal evaluation.



▸ **Fig. 4 - Project layout based on the Double Diamond model**

Section 2 | **DISCOVER**

This chapter includes:

2.1 APPROACH

Designing behavioural interventions to enable a positive passenger experience in a reclaim area that does not even exist yet. Where to even start?

2.2 Theoretical background
Well, as we will learn in section 2.2 - the theoretical background - human behaviour is rather predictable. There are a few key driving mechanisms behind our everyday behaviour that explain the lion's share of our decisions and behaviours. Afterwards, it is explored how the decisions and behaviours can be steered in the right way, *nudged*. Within this section:

- Waiting time
  How do we experience waiting?
- Crowding
  What are the effects of waiting in a crowded environment?
- Behavioural economics
  How do we move through an environment?
- The Dual-System theory and Nudging
  How do we make decisions?
  How can we influence decisions?

2.3 Applications of nudging in the physical environment
Second, we illustrate the literature with some real-world examples of nudges that effectively steer human behaviour.

2.4 Internal Analysis
Third, we take a closer look at the context. What is the current situation in terms of process, lay-out and facilities? What is already known? It includes:

- The process of baggage reclaim
- The stakeholders involved
- The current reclaim areas
- The Passenger Experience Principles

2.5 Passenger Analysis
Next, we need to understand the passenger. Who is s/he, what problems does s/he encounter, what does s/he (dis)like and how does s/he currently operate within the reclaim areas?

Section 2.6 summarizes the issues that are related to passenger behaviour. All of this will act as input for the **Define** phase, where this knowledge is projected onto the preliminary design of the A-terminal reclaim area in order to define the most probable bottlenecks

2.2 THEORETICAL BACKGROUND

2.2.1 - Waiting time

Waiting time is an important factor for passenger satisfaction in the reclaim areas. Research has shown that an increase in waiting time leads to a decrease in satisfaction (Davis and Volmann, 1990; Taylor, 1994). However, it seems that how we evaluate waiting is not solely dependent on the actual waiting time, but also on the perceived waiting time. In fact, this perceived waiting time can even have a stronger effect on satisfaction than the actual waiting time (Davis and Heineke, 1998; McGuire et al. 2010).

Maister (1984) suggests that this perceived waiting time can be influenced by factors such as (un) fairness, (un)certainty and the value that is gained from waiting. According to Maister, occupied time is more pleasant than unoccupied time, and feels as if it passes more quickly. Consider talking with a friend for ten minutes compared to quietly sitting in an empty room for the same amount of time. However, these findings are far for conclusive. According to Norman (2008) people recall occupied time as if it were over a longer time span than unoccupied time. Katz et al. (1991) found that occupied time was evaluated more satisfactory, but the estimated waiting time remained unchanged. Furthermore, McGuire et al. (2010) found no significant differences in perceived wait time between filled- and unfilled time: they suggest it may not be that the wait feels shorter, but that the wait is a more pleasant experience.

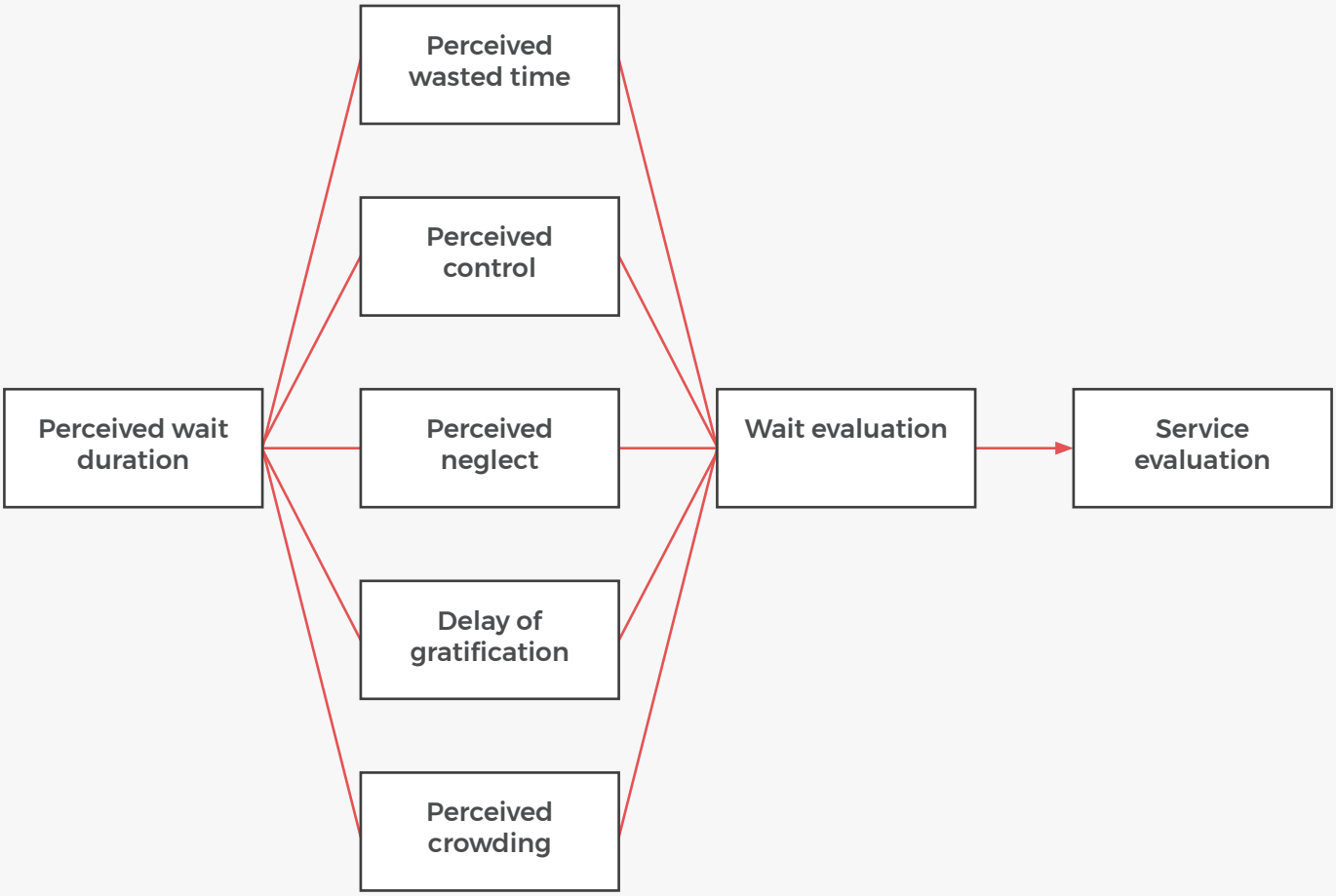
Not knowing how long one has to wait causes anxiety: this makes a wait feel longer and strengthens existing negative emotions (Maister, 1984, Norman, 2008). If the information is available, it does not significantly reduce the perceived waiting time (Hui & Zhou, 1996). However, it does take away uncertainty and gives more feeling of control.

Not meeting the appointment time - in this case the expected bag time – creates uncertainty. Once this indicated time is passed, there is no knowable limit. The expected time is a 'promise' and failing to meet this expectation will cause annoyances and make the wait seem longer. Hence, in the case of baggage reclaim, it is important to show passenger an accurate expected waiting time (Maister, 1984).

Unexplained waits are perceived to last longer than explained waits. If there is no apparent reason or justification for why one has to wait it creates a feeling of powerlessness (Maister, 1984). In the context of baggage reclaim areas, it might be helpful to give insight in the process or give explanations for delays.

Tolerance for waiting is dependent on the value it will bring. People are more willing to wait for something that they perceive as valuable. An arriving passenger will be in the post-process of the service (the flight). Post-process waits feel longer than in-process waits such as the flight itself. Retrieving luggage is a 'have-to' post-process wait with no additional value to be received.

McGuire, Kimes, Lynn, Pullman and Lloyd (2010) developed a framework for evaluating the wait experience (figure 5). They found that the wait experience evaluation is positively related to service encounter evaluations. Next to that, their research suggests that perceived crowdedness and control act as mediators between perceived waiting time and waiting time satisfaction. In other words; perceived crowdedness and a feeling of not being in control will have a negative impact on the evaluation of the wait. Firms can thus benefit from design elements that mitigate crowding or give a sense of control. This is underlined by Mattilla and Hanks (2012), who researched the impact of waiting in crowded and non-crowded environments. Their results suggest that waiting in a crowded environment strengthens negative emotions such as anxiety.



▸ Fig. 5 - Framework for evaluating the wait experience, based on McGuire et al. (2010).

2.2.2 - Waiting in a crowded environment

Within literature the concept of crowdedness is not the same as a crowd. A crowd refers to a nominal number of people within a given physical area and is used in order to describe density. Crowdedness is the subjective experience of a person (Gifford, 2007). As such, crowding describes how an individual perceives the density of people in his/her direct environment (Stokols, 1972).

In general, crowdedness will lead to discomfort and a negative experience. Research suggests that it causes physical stress, a feeling of 'loss of control' and causes us to become more territorial (Epstein, 1981). However, Paulus (1980) argues that high density does not necessarily brings up negative feelings of crowding: It seems dependent on social and contextual factors and whether individuals are competing or share a common goal. As an example, during a festival people do not mind standing shoulder to shoulder, it is even part of the 'experience'. People share the common goal to enjoy their time. When the festival concludes, the partygoers want to go home and will be competing on who can exit first. Now the larger group is hindering the goal of the individual, leading to a negative feeling of 'crowding'.

Problems linked to crowding are in many cases related to human behavior, and thus can be improved by promoting the desired behavior. McGuire et al. (2011) and Mattilla & Hanks (2012) both suggest that (design) elements in the waiting environment can contribute to a more pleasant experience, if they are able to reduce the perception of crowdedness. This is in alignment with Gifford, Steg & Reser (2010), who suggest that – even within a limited space - the negative effects of crowding can be reduced by careful environmental design.

Within this project it is impossible to constantly measure whether or not passengers perceive crowdedness. This thesis assumes that a feeling of crowdedness occurs when a number of unrelated people are gathered closely together, and hinder each other from performing a task. Crowding is referring to unrelated (groups of) people who are gathering closely together at a specific point of interest.

SO WHAT?

The wait experience is related to the overall service encounter evaluation. Since retrieving luggage is a 'have-to', the wait time will never be 'great' time. However, waiting can be made more pleasant.

A feeling of control, certainty, keeping occupied, having ample space and access to information are important ingredients for a pleasant waiting experience.
A crowded environment will cause discomfort and strengthen negative emotions.

NOW WHAT?

Within literature it is suggested that many cases of crowding are linked to human behaviour. It is therefore key to understand the driving mechanisms behind human behaviour.

2.2.3 - Behavioural Economics

Behavioral economics is a discipline that combines psychology and economics to explain how humans make their decisions and what drives their behaviors.

Bitgood (2006) proposed the 'value ratio' as a guiding principle for human behavior. The value ratio suggests that people will choose one alternative over the other, based on the perceived benefits divided by the associated costs (e.g. in terms of money, interests, effort). A different concept with the same underlying principle is the 'law of least effort'. It states that in a situation where there are more options to achieve a goal, people will gravitate to the course of action with the least effort, both mentally as physically (Kahneman, 2011).

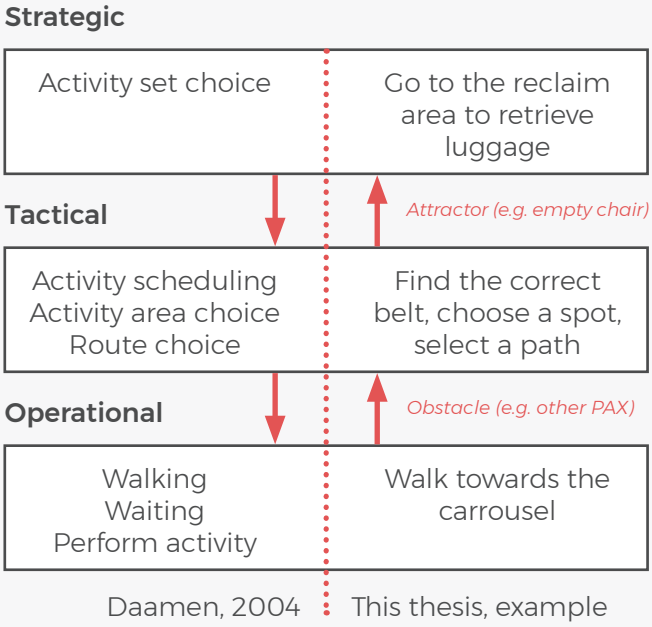
Ajzen (1991) suggests that the behavior of an individual is the result of his or her planned intentions, which motivates individuals to move towards particular targets. These movements are then influenced by (un)conscious decisions and behaviors that are subjected to hierarchy of motion (Hoogendoorn et al, 2002). This model consists out of three tiers: the *strategic* level, the *tactical* level and the *operational* level (fig. 6).

1. Strategic level
On the strategic level, an individual determines the activities s/he wants to undertake. S/he will also globally determine the strategy on how to get there, based on the perceived best way to get there (e.g. on foot vs. bike, most familiar vs. shortest route). In this context, retrieving luggage would be the target, and an example of the strategy would be to follow other travellers.

2. Tactical level
The tactical level is for making short-term decisions. Pedestrians will schedule intermediate activities and select a path to their target. In an analysis on pedestrian route choice strategies, Hill (1982) suggests that path selection is mostly subconscious. Choices for the shortest route, to avoid jams or to switch to a faster route are made automatically (Daamen, 2004). Helbing (1997) suggests that route choice in the tactical level is dynamic, and unexpected attractors may trigger the strategic level to set new targets.

3. Operational level
This tier is subcounscious and is responsible for the actual coordination of our motion. It plans the next step in terms of speed and direction.

► **Fig. 6 - Hierarchy of motion, example within this thesis**



▸ **Fig. 7 - Desire path, example of least costs**

▸ **Fig. 8 - Desire path, example of least resistance**

When a passenger has multiple goals, s/he will plan on a strategic level what the order of these goals will be (Liebig, 2013). In his master thesis, Blesgraaf (2015) states that passengers tend to complete necessary activities before informal activities. This may indicate that passengers will be inclined to walk to the reclaim area before having an interest in informal activities that are not required to complete the process.

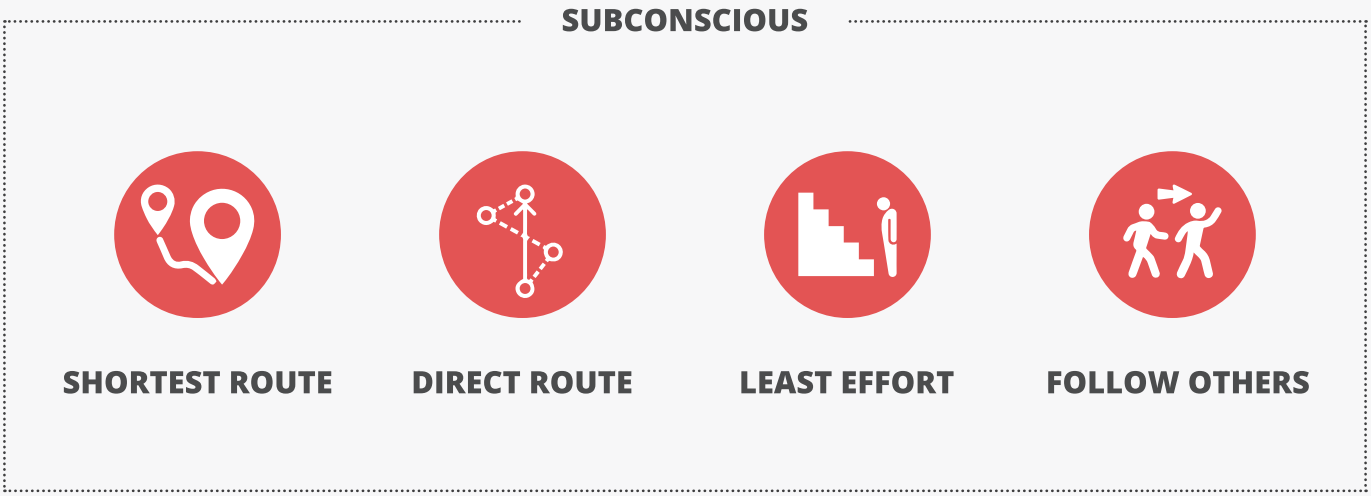
When it comes to pedestrian movements in public spaces, most people will prefer the quickest path or the path of least resistance (Borgers & Timmermans, 1986; Guo & Hang, 2011; Hoogendoorn et al, 2002). Resistance in the form of obstacles and crowds is perceived as additional effort or costs. Typical examples of the two behaviors can be commonly seen in the form of 'desire paths' (Dutch: olifantenpadjes), as shown in figure 7 and 8.

According to Helbing (2005) pedestrians dislike to deviate from their desired walking direction. If there are multiple routes possible with the same length and appeal, a pedestrian will choose the path were s/he can go onwards for as long as possible with a minimum of changes in direction. In earlier research, he found that even if the direct route is becoming congested (around 75% of flow capacity) pedestrians seldomly opt for the longer route (Helbing, 1997).

Within large groups of people the phenomena known as herding - people following each other - is quite common. This tendency becomes stronger in environments that are unfamiliar or unclear (Helbing et al, 2005). Dyer et al. (2008) found that in groups of more than 200 pedestrians, it only takes a small minority of 5% in order to direct the crowd to a different direction.

Figure 9 summarizes the knowledge of this paragraph as 'rules of thumb'.

RULES OF THUMB



▸ Fig. 9 - Icons as used in this thesis to refer to mechanism behind pedestrian movement.

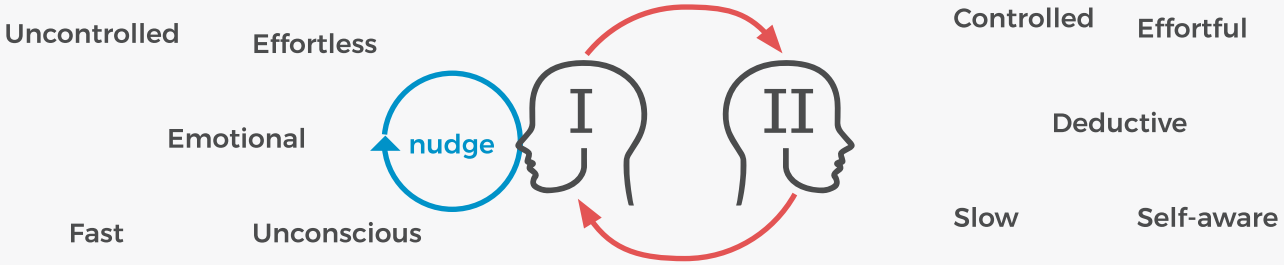
2.2.4 - The Dual-System Theory and Nudging

From a pure economical perspective, people would always make their decisions based on all available knowledge and make the most optimal choice. However, humans constantly make unconscious decisions, some of which are not in their best (long-term) interests. These unconscious (and/or irrational) decisions and behaviors are often explained by the dual-system theory. This theory suggest that the human brain has two mind-states; the subconscious System 1 and the conscious System 2. This thesis uses the definitions of Kahneman (2011):

- 'System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control.'
- 'System 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice and concentration.'

The theory states that people switch between the two different mind states in order to minimize effort and maximize performance. Most of the time people operate on System 1 while System 2 is on stand-by. This can be considered as 'our autopilot' (Hansen & Jespersen, 2013). System 1 is very effective in processing information and coordinating our day-to-day routines effortlessly. For a great deal we rely on our automatic thinking, especially in situations were a quick response is required or when there is a lack of enough information, feedback or experience (Selinger & Whyte, 2011). System 2 comes in to play when attention is required or when we need to make important decisions (fig. 10)

System 1 can make fast decisions with low effort by making use of hard-coded mental shortcuts, also known as heuristics and biases. Heuristics and biases can be deliberately employed to influence the automatic behavior of individuals in a desired direction. This is known as 'nudging'. (Hunnes, 2016).



The automatic System I
Requires little engery
Read a snappy sentence
Routine tasks
Habits and impulses

The reflective System 2
Requires energy and attention
Studying a book
Unfamiliar situations
Important decisions

- **Fig. 10 - Characteristics of System 1 & 2**

Within behavioral economics, the concept of nudging is to deliberately make use of heuristics and biases in order to guide human behavior in a predicted direction (Lehner et al., 2016). Sunstein and Thaler (2009) defined the concept as:

- **"A nudge (...) is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives."**

The core idea behind the concept of nudging is that it is in the best interest of the person being nudged and that it does not eliminate alternative choices. It defines desired behaviors and promotes individuals to act accordingly. There are hundreds of heuristics and biases on which we base everyday decisions. Multiple frameworks exist that aim to categorize them on a high-level.

Sunstein and Thaler (2008) themselves created the NUDGES mnemonic to define six principles that can influence human behavior: iNcentives, Understand mappings, Defaults, Give feedback, Expect error and Structure complex choices.

The British Institute of Government worked together with academics and suggested the 'MINDSPACE' framework (BIT, 2010); Messenger, Incentive, Norms, Default, Salience, Priming, Affect, Commitments and Ego. Later on, the Behavioral Insights Team was created and they readjusted the framework to what is now known as the EAST-method (BIT, 2015): Make it Easy, Attractive, Social and Timely.

They use different mnemonics, but their elements interrelate and overlap as they rely on the same behavioral insights and principles. According to the MINDSPACE framework, social norms, default options and priming are amongst the strongest factors for explaining (and influencing) automatic behavior (BIT, 2010).

This graduation report will use the EAST- method to design and explain the interventions as it considered the most adequate for this project. due to its action-oriented nature (fig. 11)

NUDGE PRINCIPLES

- **Fig. 11 - Icons as used in this thesis to represent the nudging principles based on the EAST-framework. (Based on BIT, 2015)**

As discussed in section 2.2.3, people tend to choose the option of least resistance (both mentally as physically). It implies that if there is a default option given at a choice-point, a large number of people is expected to go with the default option (regardless of it being a 'good' choice for them or not). According to Sunstein and Thaler (2008), this behavioral tendency will be reinforced when there is the suggestion that it represents the normal or recommended course of action.

People are heavily influenced by the actions and behaviors of people around us. Social norms represent values and expectations within a group, which guides our behavior. People tend to 'follow the herd' and conform to others (social proof). Norms can be either explicit (a 'no-smoking' sign) or implicit (being quiet in a library) (BIT, 2010). In contrast, once a social norm has been violated, others are more likely to do so too (the broken window theory) (Sunstein and Thaler, 2009).

Each and every moment our brain is bombarded with information and stimuli. To cope with this overload on information our automatic thinking filters out 'unnecessary information'. Our attention is drawn towards elements that stick out in the environment, and we are more likely to take note of elements that seem novel, relevant, accessible and simple. (BIT, 2015)

The existing literature on nudging is primarily focused on applications within policy making, marketing, healthcare and sustainability (BIT, 2010). In many cases they apply nudging principles in a text-based manner. Interventions in the physical environment are less common, but examples can be found in signage, products and salient objects (section 2.3)

2.2.5 - Nudging: Ethics & Critics

Criticism on the Dual-System theory and nudging is widespread, both on its functionality as ethical considerations. Within literature the nature of the relationship between system 1 and 2 is ill-defined, as is the lack of coherency regarding the distinction between the two (Lin & Osman, 2017). Moreover, it is pointed out that the succesrate of nudges is highly context dependent (Kosters & Van der Heijden, 2015). An intervention that has been proven to work for one group in one context does not guarantee that it is directly applicable to other groups in other contexts.

One important ethical consideration of nudging is that it should always be in the best interest of the individual that is being nudged. This is called 'Libertarian paternalism' (Sunstein & Thaler, 2008). They refer to the *publicity principle*, which states that a nudge should never be applied if the one who nudges is not able or willing to explain the *why* to the people being nudged.

SUMMARY & CONCLUSIONS

Waiting time

How we evaluate waiting is not only dependent on the actual waiting time, but also on the perceived waiting time.

A waiting area that is perceived as 'crowded' will have a negative impact on the experience of the wait and strengthen negative feelings.

Crowding

Crowding is a subjective experience.

Problems linked to crowding are often related to human behaviour.

Problems linked to crowding can be mitigated by careful environmental design, even within a limited space.

Behaviour

Most of our choices and behaviours are made subconsciously.

People take the shortest route, the route of least resistance, the most direct route or just follow others.

Benefits must outweigh costs.

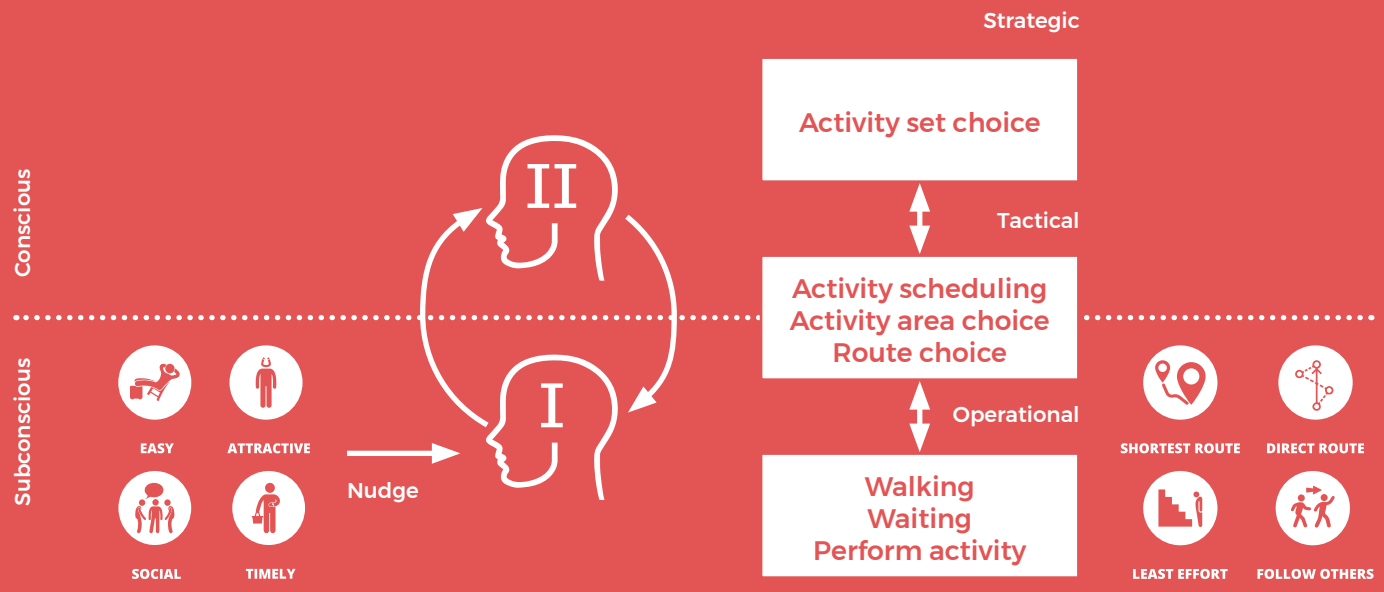
Attractors can set new immediate targets and therefore adjust someone's path.

Nudging

Nudging can be applied to encourage desired behavior, by making use of heuristics.

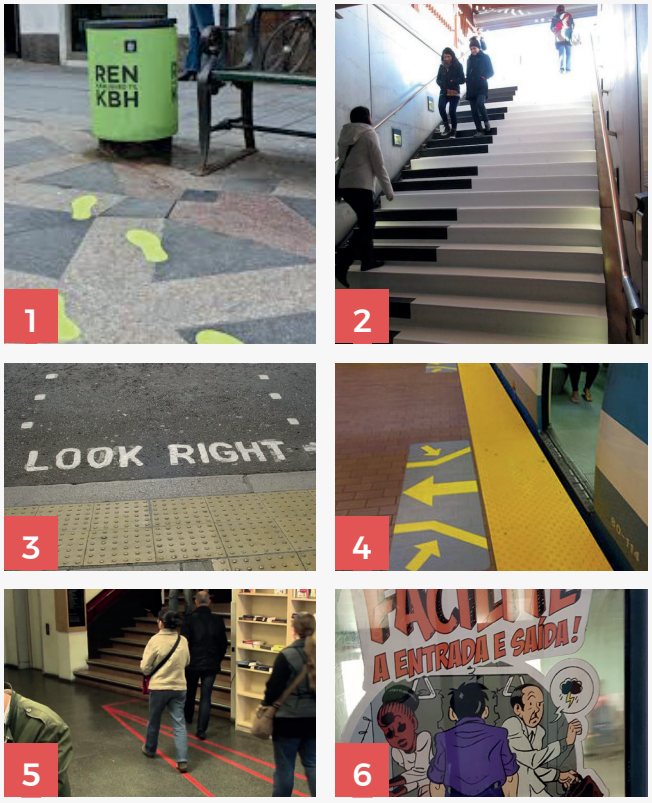
Some of the strongest effects on behavior are social norms, default options and salience.

This thesis adopts the EAST framework: Make it Easy, Attractive, Social and Timely.



2.3 APPLICATIONS OF NUDGING IN THE PHYSICAL ENVIRONMENT

So, what how can we use nudging in the physical environment? This section will look into some practical applications in a spatial setting. First six different examples are briefly discussed, then three applications in situations related to crowd control are presented in more detail.



▸ Fig. 12 - Nudges aimed at human behaviour in a spatial setting.

2.3.1 - Examples

Six different examples of nudging in the physical environment, the numbers refer to figure 12.

1. Attract attention: In Denmark, neon-coloured bins with footsteps reduce littering by making them more salient.
2. Make it attractive: In Stockholm, “piano stairs” were used in order to let more people use the stairs instead of the escalators. There is some debate whether or not this is actually a nudge, because it can also be seen as gamification. Still, it helped to steer human behaviour. (Video: https://www.youtube.com/watch?v=2lXh2n0aPyw)
3. Expect error: To prevent accidents with tourists, the city of London applied nudges of a prompting type at crossings.
4. Make it easy: In the metro of Montreal, floor markings show where passengers should board and suggest people should not wait in front of the doors.
5. Default: The Hivos seduction project tried to save electricty in a public library by guiding people to the stairs with floor markings in stead of the elevators.
6. Make it timely: During holidays I encountered this nudge in the Lisbon subway. It prompts people to step aside from the doors so that othes can exit more easily. It does so by using a snappy sentence and a graphic that explains the problem in an understandable way.

2.3.2 - Wait-here lines

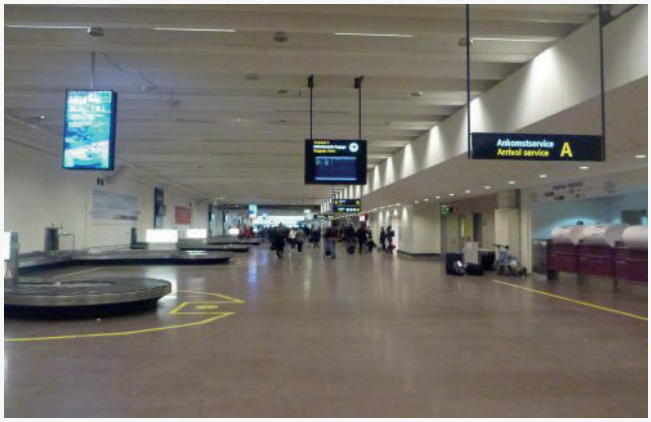
In 2016, as a response to multiple complaints from passengers about the hassle around the carousels, Schiphol experimented with 'wait-here lines'. A pilot test was conducted in reclaim hall 4 at carousel 20/22 (fig. 13). The idea is that the line indicates a default distance to keep, which makes it easier for everyone to collect their belongings. Unfortunately it did not have the desired effect as a large part of the passengers would not conform to it. Moreover, it caused some side-effects that were deemed undesirable, such as that requesting the additional space would force passengers to stand back-to-back (Schiphol, 2016b).

Many airports around the world apply wait-here lines in some form (among others Bangkok, Stockholm Arlanda (fig. 14), Melbourne (fig. 15), Shanghai, Nanita, Incheon). To find out more about its effectiveness at other airports, Richard Bylund - head of unit Project Management at Stockholm Arlanda - was contacted. Quote:

"The main purpose of the yellow line is for security reasons. The idea is to maintain some distance between the passenger and the arrival belt in order to have space for the passengers that are about to collect their bags and make the area closest to the arrival belt less crowded. (...) There are special occasions when the arrival hall is too crowded, but under normal conditions the lines work quite well at Arlanda. So, it must say that it works."

Remarks
Compared to the other airports - that make use broad and colorful floor markings - the question that arises if the wait-here lines that were piloted at AAS' were salient enough to be noticed by the automatic thinking processes.

▸ **Fig 13 - Wait-here lines as applied during the pilot at AAS**



▸ **Fig. 14 - Wait-here lines as applied at Stockholm Arlanda**

▸ **Fig. 15 - Wait-here lines as applied at Melbourne**

▸ **Fig. 16 - Separate routes begin outside the station.**

▸ **Fig. 17 - A photosticker of the stairs on a pillar, to increase the visibility of the exit.**

2.3.3 - Gare du Saint-Denis

Source
BVA guide, 2017 (in French)

What?
In 2017, the SNCF Innovation & Research department experimented with nudging at the Gare du Saint-Denis (France). Facing over 90.000 commuters every day, they had similar issues concerning limited capacity.

Nudges were applied in the environment in order to influence the movements of commuters. They applied colored lines suggesting default paths for different types of passengers (fig. 16).

The goal was to make them use different entrances so that the main tunnel would not congest, and passengers would be better distributed on the platform. Moreover, they saw some exits were not used, supposedly because pillars were blocking the view. They created photo stickers of the exits and wrapped them around the pillars (fig. 17).

The result was that the neglected parts of the station were 'significantly more used and known' to travelers, but no exact numbers are given

Remarks
The colours that are used are very salient in the environment, and the different lines apply to different kinds of passengers. The lines facilitate decision-making, and the new intentions will lead to new behaviour (Ajzen, 1991).

2.3.4 - Copenhagen Airport Kastrup

Source
Liquidminds, 2018

What?
At Copenhagen Airport, new passport rules for the Schengen area would potentially result in long queues and missed flights. In co-operation with the Denmark-based agency Liquidminds they developed floor stickers that where applied in the area in front of the border-control.

Through observational research they concluded that a lot of time could be saved if all passengers would have their passport ready before arriving at the official. They created three zones (fig. 18) with the goal to prepare passengers for the check.

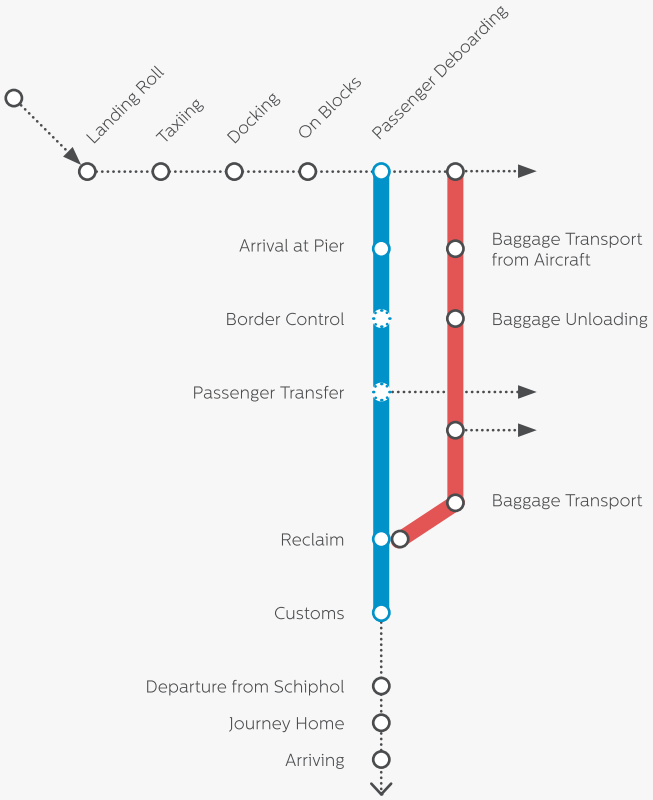
It reached its desired effect and reduced waiting times during peak hours by 18%.

Remarks
The stickers are very salient due to their vibrant colors, clearly indicating different zones. Combining simple icons with short sentences makes it very simple and understandable and prompts passengers to get their passports ready. While it may not win the beauty contest, this is a very interesting example: It shows that nudging can be used to speed up processes that involve human actions.

▸ **Fig. 18 - A photosticker of the stairs on a pillar, to increase the visibility of the exit.**

2.4 INTERNAL ANALYSIS

The internal analysis starts with a global explanation of the baggage reclaim process. Next, the most important stakeholders and their drivers are discussed. The third part addresses causes of (additional) waiting time. The fourth part describes the current facilities within the reclaim areas. The fifth part describes a creative session that was held by the Passenger Experience department on what has been dubbed 'the extended reclaim' journey.



▸ **Fig. 19 - Schematic overview of the arrival process. The red and blue line represent the background processes and passenger processes respectively.**

2.4.1 - The baggage handling process

As soon as an airplane is 'on blocks', baggage handlers can start to unload the airplane. The luggage in the airplane can either be in loading units or simply stacked in the hold of the plane, depending on the plane type. Offloading separate pieces of luggage can be significantly more laborious for the baggage handlers, as they have to crawl into the hold of the plane and push all the BAX out manually (fig. 20).

Once enough dollies or baggage carts are loaded with BAX, the handler drives to the assigned unloading dock in the baggage basement. Because there are limitations of the number of carts a handler may tow, there usually is more than one trip required to unload the entire plane.

Ideally, handlers would first unload the transfer baggage as time can be of the essence. The reality, however, is that transfer baggage gets mixed up with O/D BAX and gets unloaded last. Moreover, some baggage basements do not have access to the baggage handlings system (BHS), meaning the handler must drive to another facility.

While driving to the unloading dock there is a large chance handlers encounter congestions. It can be quite busy on the peripheral roads and other handlers can easily block the path in the narrow baggage basements (fig. 21).

To measure whether or not they meet their SLA KPI's, handlers are obliged to press a 'First Bag' and 'Last Bag' button at the dock. This information is shown on the screens at the carousel, so passengers know what flight is being offloaded.

Ever since IATA-resolution 753 went into effect, handlers are officially obliged to scan all BAX. Currently this is done manually by scanning the label with a handheld scanner before putting it on the conveyor belt. This step will no longer be required once airlines start using RFID labels and AAS installs RFID tunnels. It will provide more detailed information on actual handling time.

Handlers place the BAX are on conveyor belts that transport the baggage to carrousels in the reclaim areas, so it can be collected by the passenger. Occasionally some transfer baggage accidently ends up in the reclaim area. Therefore, reclaim assistants check the labels of baggage that is left behind on the carousels and re-enter it into the Baggage Handling System (BHS) in case of transfer baggage.

2.4.2 - Passengers arrival process

Arriving passengers can be distinguished into two main groups, namely Origin/Destination (OD) and transfer passengers. Further distinction can be made based on the origin of departure: Schengen (S), non-Schengen (nS) and non-Schengen unscreened (nSu). Passengers from a nSu origin have to go through a security check and passport control after deboarding. nS passengers only have to go through passport control. It occurs transfer passengers accidently get stuck at a KMar filter. They have to be escorted back by staff because they may not have access to the Schengen area. Passengers that departed from a Schengen origin can walk to the reclaim area without checks.

Passengers enter the reclaim area at a KMar filter or a one-way filter, meaning once an individual is inside the reclaim area s/he cannot go back. Depending on whether or not a passenger has hold luggage s/he navigates to the correct area and carrousel and waits to collect his baggage. The reclaim areas can only be exited through customs, after which the formal passenger journey is ended.

▸ **Fig. 20 - Swissport baggage handlers unloading a narrowbody airplane onto baggage carts, photo taken during a visit to Zaventem Airport.**

▸ **Fig. 21 - Blockade in the baggage basement. On the left there are dollies with loading units, in front are baggage carts.**

▸ **Fig. 22 - Entering reclaim area 1 with customs in sight.**

2.4.3 - Stakeholders in the arrival process

Many different institutions and departments have a part to play in the arrival process. This section will briefly describe the most important stakeholders, their role and their drivers based on internal documents, interviews and observations. Passengers will be discussed in more detail in section 2.5.

Schiphol

Schiphol mainly acts a facilitator for other parties. There are some conflicting interest between departments within Schiphol when it comes to the arrival process. Passenger Services wants to create fast processes of high quality to optimize the passenger flows. Arriving passengers need to be processed as soon as possible, as the amount of available square meters is limited. From a Consumers point of view, waiting times are financially attractive. A research showed that 53% of the respondents would be inclined to purchase something in the reclaim area when the waiting time is about 10 minutes (Market Research, 2008). This percentage goes up to 69% when the waiting time is 30 minutes. The Passenger Experience (PE) department would like to improve the passenger experience during the arrival process, as it is the 'neglected child' when it comes to ambiance and facilities. However, Schiphol's priority lays with ensuring planes can leave on time, with all passengers and all baggage on board.

Airlines

Airlines want a safe, efficient, reliable and low-cost baggage handling service. Almost half of the passengers that travel from-, to-, or through AAS fly with KLM (32,8 million from a total of 68,4 million in 2017). Hence, their view on the topic was inquired during an interview with Lucille Witmans - customer experience expert on the arrival process at KLM. The baggage reclaim area can be seen as the 'end' of the passengers' travel. Considering the Peak-end rule they think it is important to make sure the journey at Schiphol ends on a positive note.

During the interview she mentioned hassle within the reclaim area is a complaint they often receive. According to her the areas arriving passengers encounter are not welcoming and are lacking a 'fun factor'. She stated: "I recognize the issue with the passenger experience in reclaim areas. (...) What bothers me is that arriving passengers are not treated the same way as departing passengers. Everything is aimed to direct passengers to the exit as quickly as possible, but then they are locked up in the reclaim area."

Royal Military Police (KMar)

The KMar is responsible for passport control of arriving passengers that came from a non-Schengen (nS) country. Schiphol facilitates their workspace and equipment, but they are a state institution. As border protection is their main interest, their priority lays at arriving passengers, in conflict with AAS' priority to get departing passengers to their planes timely. KMar officials have to switch positions regularly throughout the day to relieve their coworkers during peak moments.

Customs

Customs officials are responsible for making sure no illegal goods are imported/smuggled into the Netherlands. Arriving passengers can only exit the airport by passing through customs, located inside the baggage reclaim areas. Customs officials want to have a good view on the baggage belts and want to keep an eye on which passengers came from which flight. They keep an eye on suspicious behaviors and can choose to do routine checks on passengers. Some flights are considered as high-risk and require 100% checks from customs, meaning all BAX will be X-rayed in the baggage basement of Schiphol.

Floor managers
Floor managers are mainly concerned with crowd control and the allocation of resources to ensure the on-airport processes go well. They coordinate floor assistants and inform the Royal Military Police on the expected peak hours for each arrival hall / border filter.

Reclaim assistants
Reclaim assistants are present in the reclaim area to help passengers with their questions and perform small tasks in the operation. The main questions they get from passengers are about where they can find their belt, their follow-up journey or issues with luggage. They check baggage that was left behind to see if it concerned transfer luggage. If so, they have to re-enter it into the baggage handling system (BHS). Moreover, they regulate the items on the odd size belt so that it will not get stuck.

Baggage handlers
Baggage handlers have the task to (off)load airplanes with luggage (BAX). Five different baggage handlers are active at Schiphol (KLM, Swissport, Aviapartner, Menzies Aviation and Dnata). They have service level agreements (SLA's) with airlines for handling luggage within target times set by the airline, based on agreements between AAS and the airlines.

To learn more about their process and concerns a ride-along with handlers from Swissport was arranged. As of this moment, their process time is fundamentally dependent on the availability of sufficient FTE's and tools, the plane size, the amount of baggage and driving times. Handling companies face harsh competition, which forces them to compete on low margins by limiting their expenses. Minimizing their available resources has a negative impact on their ability to deal with irregularities. As an example; when a flights' actual arrival time deviates from its Scheduled Time of Arrival (STA) it disrupts their planning, resulting in a longer turnaround time.

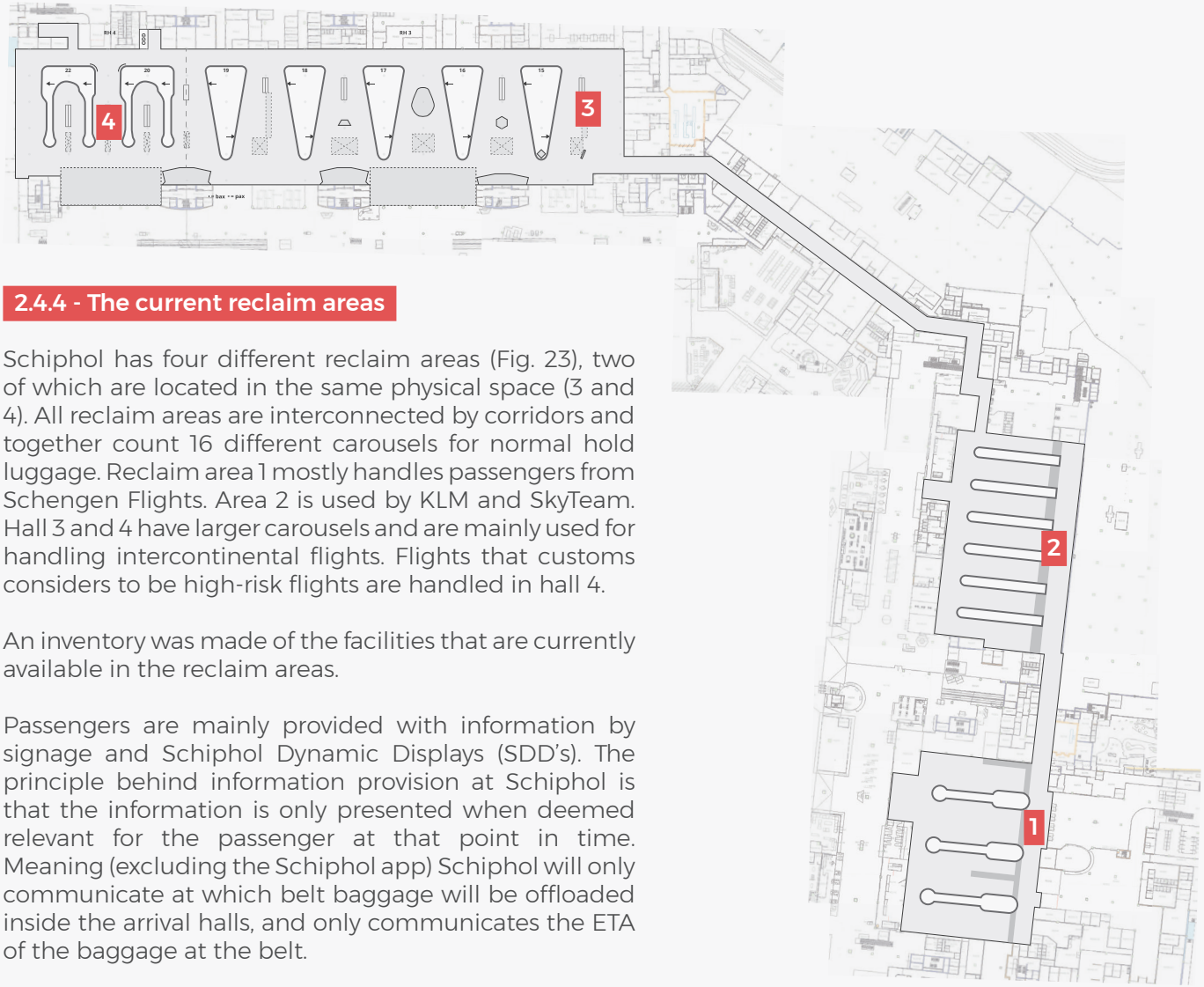
It occurs that handlers press the FiBag/LaBag buttons when they are failing to meet their KPI, even before they started unloading. This is causing confusion among the passengers in the reclaim (section 2.5.5).

All handlers have a helpdesk with representatives in the reclaim areas to help passengers with issues with their baggage. They trace missing baggage and file reports about missing or damaged luggage. The representatives are unaware of the whereabouts or progress of the handlers if they are not informed pro-actively.

Unfortunately, waiting at the reclaim carousel is the rule rather than the exception. This is due to a wide variation of reasons, many of which are outside AAS' direct influence. According to the representative of Swissport:

- The time it takes a passenger to deboard and walk to the reclaim area is simply shorter than the time it takes to offload the baggage under ideal circumstances. *
- A plane deviates from the STA: the handler has insufficient workforce available or it disrupts their schedule for following flights.
- The hold of the plane has been loaded incorrectly by the handler at the airport of departure.
- Traffic congestions on the peripheral roads and in the baggage basements (fig 21).
- During bad weather conditions baggage handlers are obliged to cease their activities.
- When a flight departed from a high-risk origin, all luggage has to be checked by customs.
- Dissatisfied handlers go on strike or perform a 'punctuality action'.

* = It should be noted that this also works the other way around: If passengers arrive later than the handler, the belt saturates causing the offloading process to stagnate.



2.4.4 - The current reclaim areas

Schiphol has four different reclaim areas (Fig. 23), two of which are located in the same physical space (3 and 4). All reclaim areas are interconnected by corridors and together count 16 different carousels for normal hold luggage. Reclaim area 1 mostly handles passengers from Schengen Flights. Area 2 is used by KLM and SkyTeam. Hall 3 and 4 have larger carousels and are mainly used for handling intercontinental flights. Flights that customs considers to be high-risk flights are handled in hall 4.

An inventory was made of the facilities that are currently available in the reclaim areas.

Passengers are mainly provided with information by signage and Schiphol Dynamic Displays (SDD's). The principle behind information provision at Schiphol is that the information is only presented when deemed relevant for the passenger at that point in time. Meaning (excluding the Schiphol app) Schiphol will only communicate at which belt baggage will be offloaded inside the arrival halls, and only communicates the ETA of the baggage at the belt.

SDD's provide information of all kinds: handlers, what items can go through customs, estimated time, FiBag/ LaBag, the follow-up journey etc. SDD's are sometimes easy to miss, especially the ones that explain where handlers can be found. As a form of distraction, SDD's also show the news, wheather and commercials.

Apart from the SDD's there are few distractions or things to do/look at. There is a children play table in reclaim area 3 and passengers are able to see and talk with 'ophalers' through phones near the dividing walls.

▸ **Fig. 23 - Topview of arrivals and the reclaim areas**

Passengers are offered free WiFi throughout Schiphol and toilets and baggage carts are always in close proximity. There is (limited) seating capacity available in the form of metal benches. All reclaim areas have a telephone cell, which also includes a charging point. There are 'information points' in the form of tablets with the Schiphol app installed on it. All reclaim areas have vending machines with drinks and snacks, ATM's and ticket machines for public transport. They have been installed with the idea that passengers can use them to spend their waiting time productively. Ironically enough, during the observations it was noticed that most passengers had already collected their baggage before using them.

Conclusion

The reclaim areas have an utilitarian look & feel and are clearly meant for short-stay. Overall the facilities are simple but organized. Information provision is mainly done through signage, SDD's and staff. However, some SDD's are easily to miss (Beautiful lives, 2016). Facilities are present to help passengers plan their follow-up journey. Sources of distraction are limited. Whether or not passengers have additional needs will be researched in section 2.5.3.

2.4.5 - Creative workshop Passenger Experience

A creative workshop was organized by the Passenger Experience (PX) department (fig 24). The focus was to generate ideas to improve the passenger experience of 'the extended reclaim' journey, covering the passenger journey from deboarding at the pier to arriving at customs. This is a focus area for the PX department in from the 3rd quarter of 2018 until the end of 2019.

PX principles
Within arrivals the PX department has set four drivers for the passenger experience. They all contain three principles. A number within brackets indicate the order of priority.

I am in control

- The travel process is predictable and clear (1)
- It is as efficient and seamless as possible (2)
- Information is understandable and to the point (3)

I feel welcome

- It feels friendly
- It feels familiar (4)
- People go the extra mile for me

I am unworried

- It feels safe (5)
- I experience quality
- People stood up for me

I am inspired

- There is attention for aesthetics and design
- There is an exciting offering at Schiphol
- There is enough room for calmness and rest

The PX departments selects ideas based on the criteria that is should combine IQ, EQ and FQ, it should contribute to the creation of 9+ experiences and (future) scalability.

A brief overview of the outcomes:

Information provision
- A lack of information was identified, common output was '... experts/genius/host" to answer questions.
- Show the baggage process to create understanding and explain the waiting time.
- Personal baggage tracking
- Early information provision
- Show 'time to exit' when deboarding

Reallocating waiting time
- Being able to stop, refresh and take a rest before arriving at the reclaim area while able to see the expected bag time

Distractions
- Fun-facts (on carousels)
- Movies
- 'Wachtverzachter'
- Gamification during the walk to the reclaim

Other
- Borrow mobility facilities (buggy, steps)
- Prevent 'cheating' at the carousel

Conclusion
The PX principles and outcomes have a clear link with what was found in literature. As discussed in section 2.2.1, being in control and being unworried are very imporant in wait situations. As such, these principles will be taking into account during the develop and deliver phase.

▸ Fig. 24 - The Creative Session had attendees of multiple departments, focussing on the the ‘extended reclaim journey’ .

PX PRINCIPLES

▸ Fig. 24 - The PX principles will be taking into account and are referred to with the icons above.

2.5 PASSENGER ANALYSIS

In order to improve the passenger experience for arriving passengers, it is important to understand the current context. This chapter will emphatize with the passengers and explore their pains, needs and drivers. Moreover, this chapter will investigate the relationship between passenger behaviour and issues using the knowledge derived from section 2.2. This results in focus areas for service improvement.

2.5.1 - Objectives of this section

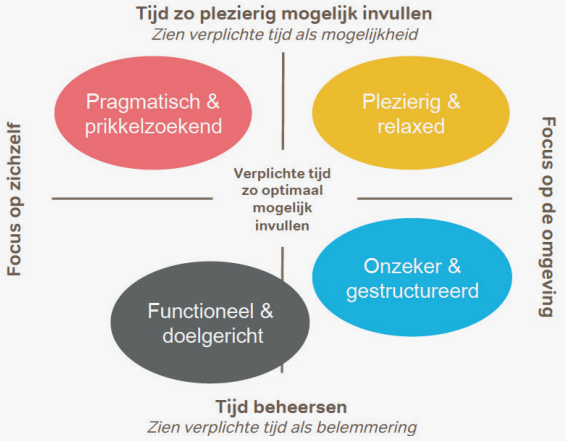
The following questions and objectives were the driving forces behind the user research:

- Who are the passengers?
- What are the current (dis)satisfiers and needs within the current reclaim areas
- What are the passengers pains and gains that can be areas of service improvement or innovation?
- Create an understanding of passenger behavior and drivers in the reclaim area
- Gain insights into bottlenecks in the arriving passenger journey
- Gain insight into passenger movements and positioning in the reclaim areas

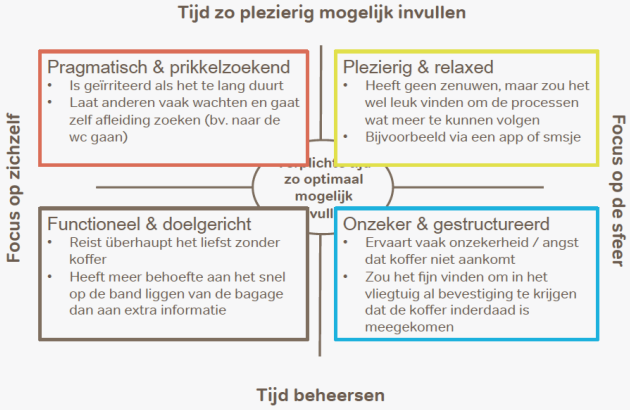
Multiple techniques have been used to gain insights into these topics. They are described in the following paragraphs. Paragraph 2.5.6 shows the Passenger Journey, which combines the results that were derived from the research.

2.5.2 - Prior Research

Schiphol Group (2011) segmented passengers based on different characteristics. They divided passengers into five groups; 'Asians', 'Generation Einstein', 'Business/Premium', 'Elderly' and 'Groups/ Family'. These personas are a generalization of their values and drivers throughout their stay at Schiphol (appendix A). A nice addition to this is the work of Beautiful Lives (2016), who created psychological profiles based on motivational strategies, which segments passengers into four categories:



Moreover, they defined the needs for every profile in every step of the passenger journey. The image adresses their findings within the reclaim area:



(Dis)satisfiers
A dissatisfier is a basic requirement: If it is not met it will lead to dissatiscfation, but if the requirement is met it will not lead to satisfaction. A satisfier is an 'extra', it is something that is not expected per se, and will lead to higher satisfaction (MRI, 2017). Experience, comfort and ease are satisfiers; process (or product) speed, safety and reliability are dissatisfiers.

The research of Beautiful Lives (2016) concludes that arriving passengers want to prevent 'wasted' time and want a swift process. An important dissatisfier during movement are other people who are hindering, for example at the baggage claim and at security. They suggest intuitive crowd control can make the difference.

Waiting time and satisfaction
In prior research at Schiphol a relationship between passenger satisfaction and actual waiting time in the reclaim area was found. Figure 25 shows the results of this research. The sudden drop at >15 minutes is especially noticable. Seemingly there is a certain treshold for passengers to which extent a wait is acceptable.

Stress
Multiple research projects showed that process steps such as security checks, border control and retrieving luggage cause high stress levels among passengers (ACI, 2014; Aerts et al., 2015).

Wachttijd in de Aankomsthal (minuten)	Passagierstevredenheid
0-5	96%
6-10	95%
11-15	87%
16-20	66%
21-25	40%
26-30	32%
31 en meer	29%

▸ **Fig. 25 - Relationship between actual waiting time and passenger satisfaction (Ruig, 2003).**

2.5.3 - Questionnaire and interviews

A questionnaire was conducted with the aim to search for needs and pains and to pinpoint 'anchor points' that influence the positioning of passengers. Moreover, it explored for additional attractors. This paragraph discusses the outtakes, the set-up can be found in appendix B.

The questionnaire was carried out on a street-intercept basis in all reclaim areas. After the passenger had finished the questionnaire, short unstructured interviews were held based on their responses. This was done for several reasons:

Boellaard (2017) found during his research that passengers are more likely to participate if it is a short research which can be stopped at any moment. When the baggage arrives passengers do not want to partake any more. A survey requires little time and passengers can opt to quit at any moment. The unstructured interviews afterwards enabled more in-depth answers, depending on what the passenger found most important..

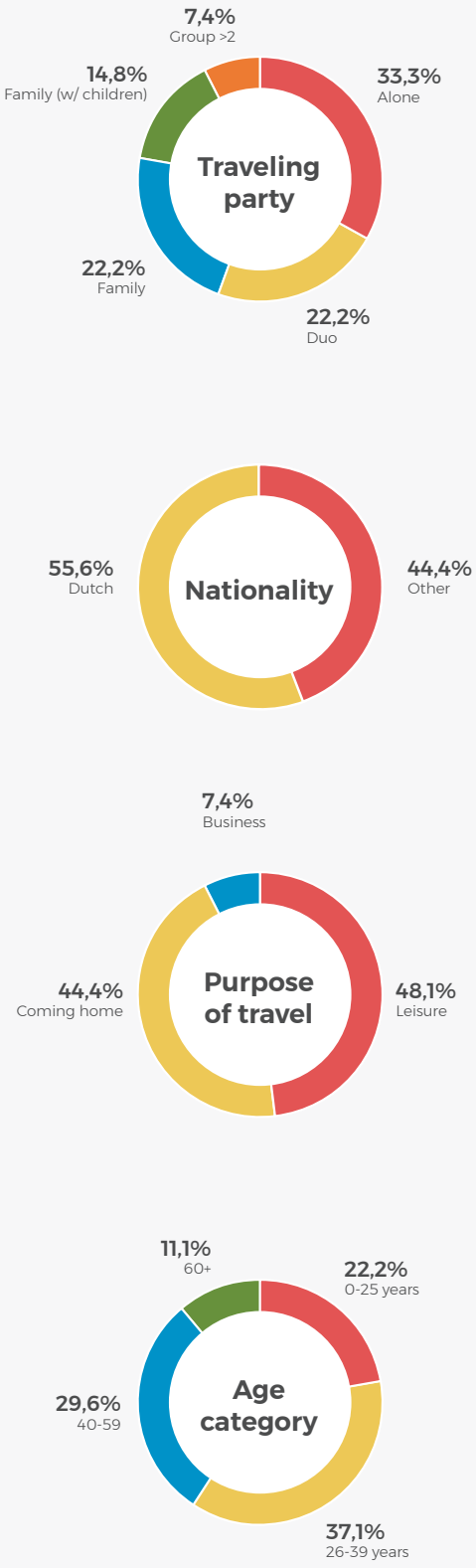
A total of 27 passengers filled in the questionnaire, followed by a short inquiry about their answers for more in-depth answers. Participants were purposefully sampled in order to create a set of passengers with different backgrounds based on Schiphol's passenger segmentation mentioned in section 2.5.2 (Fig. 26).

Note that this questionnaire was used within an explorative research and the answers that were given are heavily reliant on the participants. It does not seek to prove any causal relationships but can be used for a designer to map the global range of the opinions of passengers. The outcomes are used as a starting point for further research.

The following subjects were explored:

- What are the passenger's activities?
- What are the passenger's needs?
- What are the passenger's pains?
- How does s/he select a position?

▸ **Fig. 26 - Participant background**



Outtakes of the research

In line with the research of Ruig (2003), the majority of respondents stated they do not really mind waiting in the reclaim area for a 'reasonable' amount of time. The boundary condition seems to be that the actual bag time does not deviate (too much) from the expected bag time. 13 Out of 27 passengers experienced some sort of inconvenience, most of which was related to delayed baggage and incorrect/insufficient information. It is important for them to be updated about the status of their bags.

A duo of two passengers stated other people were waiting on them to drive them back home, they seemed to be more annoyed by the delay. According to them 'Schiphol is slacking these days', indicating some passengers attribute delays to Schiphol (also see section 2.5.4). A family with children that was spoken to also had more issues with the waiting time, because their children became restless and had to funnel their energy.

Interestingly, when asked what would make their stay more pleasant, some passengers mentioned facilities that are already available (e.g.: vending machines, the news and tickets for public transport). These may be not visible enough in the current areas. Some remarks were made about more seating facilities or objects to lean against. One third of the participants has a need for electrical charging points. Some participants stated they were dependent on their phones for their follow-up journey.

Most participants occupied themselves by interacting with their travel companions, browsing on their mobile devices, contacting friends and families and by 'looking around'. The respondents did not indicate a desire for active entertainment/ distractions in the reclaim area. However, passive distractions such as videos, art or photography would be valued by most.

Some remarks were made about the ambiance/ atmosphere of the current reclaim areas, which they perceived as dull and 'gray'.

Passengers were asked if and on what aspects they selected their position to wait. This question is particularly vulnerable for response bias but could be used as starting points for the observations:

19 out of 27 participants said that they selected their spot to wait because it enabled them to see the information screen. This is mainly to keep an eye on the time and to see if there are any changes.

14 out of 27 said it was they took this position because there was a seat available. This result is most likely directly caused by participant selection, as they were 'easy targets'. However, passengers of all background made use of the seating facilities.

11 out of 27 participants indicated that it is important to be close to the ejection point.

Most respondents made the remark that they find it important to have a view on the carousel. Among some passengers there is a fear that somebody else (accidentally) takes their luggage.

Conclusions

- Probable anchor points to choose a position are the information screen, seating and the ejection point
- Having a view on the carousel is important
- Passengers are not ware of the facilities
- Passengers occupy themselves with their fellow travellers or mobile phones.
- There is no need for active distractions
- Improvements can be made on atmosphere
- There is a need for additional seating facilities and electrical charging points
- Passengers blame Schiphol for delays
- Waiting is more annoying when others are waiting or when travelling with young children.
- Lack of information provision is a pain point

Observations

Spending time within the service environment is in many cases the only way to truly understand the issues passengers encounter. Observations allow to document and research these issues as they occur (Stickdorn & Schneider, 2014). Moreover, observations are useful for identifying instances in which passengers say 'A' but do 'B'. The conclusions from section 2.5.3 acted as input for the next section; the observational study. Section 2.5.4 describes congestions and bottlenecks within the extended reclaim journey. Section 2.5.5 describes the other findings on pains and needs structured as an empathy map.

This section describes the observations that were made during Service Safaris that were performed over the course of four subsequent days. It is supplemented with observations that were made during the shadowing of floor managers and reclaim assistants.

A Service Safari is an Experiential field research to understand how services are experienced from a customer's point of view (Stickdorn & Schneider, 2014). It is a combination of observations and short informal interviews with passengers in order to gain insights about the needs and problems passengers encounter while going through the arrival process. This way, the richness of the data was enhanced (Kumar, 2005). The focus was on the 'extended reclaim journey' as described in section 2.4.5. For practical reasons data was collected by making photographs and notetaking with the use of a mobile phone.

2.5.4 - Observations - Bottlenecks

Bottlenecks at passport control
Because an entire plane arrives at the filter simultaneously, the KMar border filters are either 'on' or 'off'; either very busy or almost desolated. As a KMar official can only process one person at a time, the waiting time goes up rapidly.

Schiphol introduced NoQ. NoQ is an automated self-service passport control, accessible to EU citizens above 16. Not all passengers are aware that they can go through the border check themselves with their EU passport. Floor assistants have to actively inquire who has an EU passport and direct passengers to the NoQ lanes. The process of NoQ self-service goes very swiftly, but the normal border check stagnates, and its waiting times go up very rapidly (fig. 27). This seems especially tiresome for families with young. Mothers can be seen stepping out the queue with their kids to sit down and rejoin their husband when it is their turn.

Due to the stagnation the number of waiting passengers in the area can reach its capacity limit and becomes a safety hazard. Floor assistants may have to deny arriving passengers from going down the escalators, but passengers upstairs do not know why they are being denied access. It causes frustration among passengers, as floor assistants indicate; "Passengers are 'not happy' with us (floor assistants, sic.)".

There are SDD's that show the estimated waiting time for the border check. Information on baggage is presented directly after entering the arrival areas (fig. 28). It was expected that this would cause congestions in passenger flow, but this was not observed. The process goes very 'step-wise'.

Figure 29 shows how hallways can get messy with left-behind luggage that is being processed by handlers. Passengers perceive this as being careless, quote: "Now I know how luggage is dealt with here." (translated from Dutch).

▸ **Fig 27 - Stagnation at passport control: The SDD's show an approximate waiting time of 20-25 minutes while the NoQ lanes on the left are empty.**

▸ **Fig. 28 - Checking SDD after KMar.**

▸ **Fig. 29 - Hallways can get messy with left-behind luggage**

▸ Fig 30 - Groups that wait for eachother can block exits and cause congestions (example from reclaim area 2).

▸ Fig. 31 - People on top-side cause congestions in area 3.

▸ Fig. 32 - Most passengers gather at the top-side. Along with objects it can cause congsestions.

Bottlenecks in the reclaim areas

There are some noticeable patterns when it comes to passenger flow in the reclaim areas.

In general, passengers do not distribute evenly around the belt but accumulate at specific areas. Here it was first noticed that it seems that most passengers are inclined to wait on the side of the reclaim belt from where they have approached it (within this thesis this has been dubbed 'the windward' side. Only a small minority walks around the carousel. Few people move further than 2/3rd of the carousel.

Large groups of people that wait until their group is complete cause congestions at random areas in all three reclaim areas (fig. 30).

In reclaim area 3, when coming from KMar 2, passengers are prone to wait at the top-side of the carousel (fig. 31-32). They are causing congestions in the main flow. Other than one would expect based on the questionnaire, most early arrivers would not go straight to the ejection point. In reclaim area 1 and 2, passengers would stop near the ejection points of the luggage.

When the baggage arrives people can be seen stepping closer to the carousel. Because they all crowd against the belt they have to lean over it to see whether their bag is coming. leading to believe that 'being able to see my baggage' is indeed important to most passengers.

It was noticed that – in duo's or groups - there are 'unproductive' passengers around the carrousels. They do not actually take off luggage from the belt, but are keeping others company. This also includes young children that stand next to their parents. Some travelling parties have (a) 'dedicated bag collecter(s)', with their fellow travelers waiting at a distance.

Bottlenecks at customs

Customs officials profile people and/or do randomized checks for illegal goods. They do visual checks but most passengers can walk straight through.

Although the cycle time for each individual is short, only one person at a time can exit through a door. When the progress stagnates large groups of people can crowd in front of the customs exits. These queues can be considered unpleasant and they add additional waiting time, albeit for a short period of time.

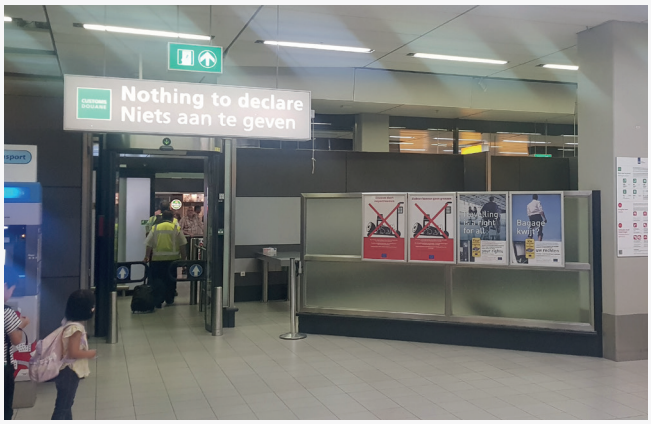
In reclaim hall 3, congestions at customs are worsened by passengers that wait at the top-end of carousel 17 and 18 (fig. 33).

In reclaim area 1, a decisive majority of passengers exits through the right door. Queues form and the process stagnates (fig. 34). Passengers are unsure whether they can exit through the left door (fig. 35) is an exit or not. Some people even deviated from their path to join the queue for the right exit. On particulary busy days (e.g. holidays) Schiphol has to commission crowd controllers to redirect passengers to left exit because it can cause a safety hazard.

Customs officials do not perceive it their task to redirect passengers. Quote: *"Our primary task is to check for (illegal, sic) goods. Crowd control is a task for Schiphol."*

▸ **Fig 33 - Congestions at customs and in the main flow strengthened by waiting passengers at belt 17.**

▸ **Fig. 34 - Passengers standing in row of the customs exit in reclaim area 1, while the other exit is empty.**



▸ **Fig. 35 - The left exit in reclaim area 1 is barely used: it has low visibility and its position is less optimal. Photo taken approximately 30 seconds after fig. 2.5.11 (!)**

2.5.5 - Observations - Empathy Map

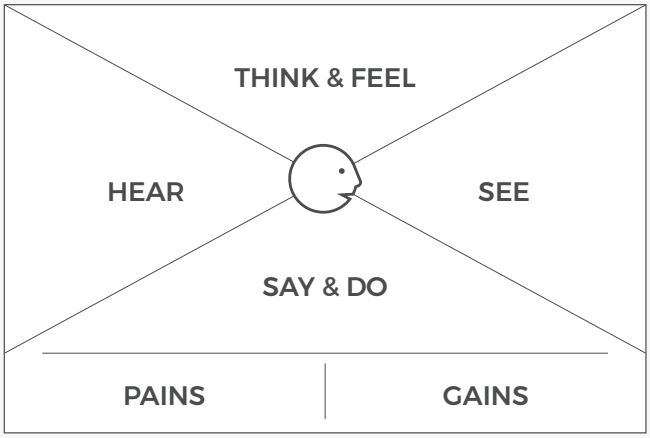
The Empathy Map is used to create an overview of the insights that were gathered through user research in the reclaim area (see figure 36). The Empathy Map is a tool which enables designers to empathize with the user, by looking at the service from their point of view (Conte et al., 2015). The tool consists out of four questions that together give an understanding of the passenger experience:

- **What does s/he see?**
  Input: service safari, interviews, observations
- **What does s/he hear?**
  Input: service safari
- **What does s/he say and do?**
  Input: questionnaire, interviews, service safari, observations
- **What does s/he think and feel?**
  Input: questionnaire, interviews

These impressions can be combined and summarized into pains to be relieved and gains to be created, which can act as opportunities for service innovation or improvement.

All questions will be answered in order with selected findings, followed by a summary of the opportunities found. The complete filled-in Empathy Map can be found in appendix C.

▸ **Fig. 37 - Upon entering RH 1 the left exit is barely visible**



▸ **Fig. 36 - Overview of the Empathy Map**

What does s/he see?
When standing at the carousel it is difficult to see ones own baggage coming because others are blocking the view.

Sometimes one carousel was empty while others were completely full. Passengers see this and do not understand why.

Baggage carts are parked against the carousel and are hindering ones access to the belt.

In some cases the SDD shows incorrect information. For example stating that 'all baggage has been offloaded' while nothing was offloaded yet (also see what does s/he think & feel).

Although there is a lot of signage, passengers still inquire about the whereabouts of certain points of interest (exit/train station/carousel).

In reclaim area 1 it is hard to see the left exit when entering the area (see fig. 37).

What does s/he hear?
There is quite some background noise in the form of beeping and screeching sounds of carousels, public announcements, talking passengers, crying children and the sound of bagge dropping on the carrousel. There is no background music.

Some literature suggests music can enable a better evaluation of waiting time (Hui et al., 1997), so this might be something to look into.

In case baggage deviates from the expected bag time, passengers are not updated pro-actively When they inquire at a handlers office, in many cases the desk agent is not able to answer adequately or to give an explanation:

- 'We asked at the helpdesk, she just laughed and said it happens all the time. She said we will just have to wait for another ten minutes.'

After one passenger has inquired about the status of the baggage, the news will spread around.

What does s/he say and do?
Most passengers occupy themselves with either their travel companions or their mobile phone (aligned with what was found in section 2.5.4). They are planning their follow-up journey, listening to music etc.

Passengers can be seen sitting or leaning against literally anything, even on the carousel. Indicating there is a need for more options to sit or lean on.

Passengers copy eachother, if one passenger sits down on a carousel others will do so too. In reclaim area 1 passengers will join the queue for the right exit without looking for other options.

Some passengers were actively searching for electrical charging points. "My battery is almost out, where can I charge it?"

- ""I might have grabbed a coffee in the lounge if I knew up-front that I would have to wait more than ten minutes in this area."

As soon as the sound of the carousel goes on, people stop with what they are doing and move closer to the belt.

After collecting a baggage cart, passengers tend to choose the closest available spot at the carousel.

What does s/he think and feel?
Information provision is lacking, especially in case of delayed baggage. It is important to realize people blame Schiphol for issues with baggage:

- "Those suitcases have been hurling around for two hours and God knows where. Schiphol is really slacking nowadays."
- "We've been waiting for an hour on our carry-ons. We asked the helpdesk, she just laughed and said it happens all the time. This is not a warm welcome to Amsterdam."
- 'Minste wat je kunt doen is ons laten weten waarom, nu sta ik hier maar te wachten. Daarom pak ik meestal regionale luchthavens, dan heb je dit gedonder niet.'

When handlers press 'LaBag' to reach their KPI's, it causes confusion among passengers:

- 'All baggage offloaded... Nou, waar dan?!'

When a flight is offloaded in two runs, it confuses some passengers. Especially when a different flight is offloaded in-between. In such cases some passengers think it is unfair that others have their bags earlier then they do, while they were there first. Passengers become unpatient or there is anxiety something has happened.

- 'How much time do I still have to wait?'

Some more experienced travellers seem to value the arrival process at Schiphol:

- 'Ik woon in MIlaan en vlieg tweewekelijks, vergeleken met andere luchthavens is Schiphol een paradijs.'

Pains

- There is a feeling of unfairness when a plane that arrived later is offloaded first.
- Passengers feel that they have had to wait multiple times in a row . They do not understand that if they had to wait inside the plane, and border check, they still need to wait at the reclaim area.
- It causes confusion when handlers falsely press the FiBag/LaBag buttons.
- Incorrected estimated waiting times and not being updated about delays cause uncertainty.
- There is no 'priority-reclaim' for business travellers that value rest and ease.
- News on the SDD's as a distraction is in Dutch.

Gains

- Create a better view on the carousel so people can keep an eye on it from a distance (e.g. by making use of screens)
- Make it easier to retrieve luggage
- Just-in-time principle
- Improve the ambiance in the waiting areas
- More comfortable seating or stitting facilities
- Explaining the process of baggage reclaim on SDD's might provide passengers with more tolerance for the wait
- Pro-active information provision by handlers in case of delays
- Real-time baggage tracking
- More charging points for electrical devices
- One idea that also followed from the PX creative workshop was to lead 'unproductive' passengers to different waiting areas. During conversations with passengers some indicated that they would be interested to do so if they knew the wait would be more than ten minutes. An interesting target group may be families with children that can be given a space to get a rest or keep their children occupied.

2.5.6 - Video Analysis

Goals
After the initial observations it became clear it is very difficult to pinpoint how a group of passenger from a flight gather and operate around a carousel. For this reason it was decided to perform a video analysis. If there is a better understanding of the dynamics that are involved, this will help predicting probable bottlenecks in the A-terminal.

Video and audio data are commonly used in qualitative studies, as it enables a researcher to transcribe and replay an event in order to analyze it in-depth. However, video data is very complex to work with and it is an impossible task to reconstruct an entire interaction. Therefore a selection should be made in the topics that are being researched (Silverman, 2010).

The video analysis sought to find out how passengers operate within the reclaim area on the following aspects:

- Choosing a position
- Group forming
- Movements over time
- Standing against the carousel
- Origin of bottlenecks

Time and place
The video observation was performed on the 22th of June, from 8:30-11:30. It took place in reclaim area 3, aimed at belt 15. This specific belt was chosen as it is the most similar compared to the future A-area reclaim. Friday mornings are among the claim area most busiest moments, hence this moment was chosen. During these three hours there were multiple turnarounds at the carrousel. One case study provides sufficient data for qualitative analysis (Silverman, 2010).

Method
A camera (GoPro Hero 3) was placed upon signage in the reclaim area, approximately 4 meters high and 5 meters away from the carousel. This way it was able to capture the carousel in its entirety. The camera had to be placed there by an external company. This type of camera can only record for approximately 1:30-2:00 hours on a single battery. As a compromise between battery life and quality it was set to make a time-lapse video with an interval of two seconds. as the camera had to be placed on the signage by an external company.

After making the time-lapse video it was rewatched several times, transcribed and analyzed (appendix D). As stated before, when transcribing video data a decision has to be made about the level of detail. It was therefore decided to focus only on the aspects listed before. As such, it can be seen as an interpretive process and therefore the first step in analysis. (Bailey, 2008).

Terminology
During the analysis multiple terms were defined to explain certain behaviors and positions around the carousel (see figure 38).

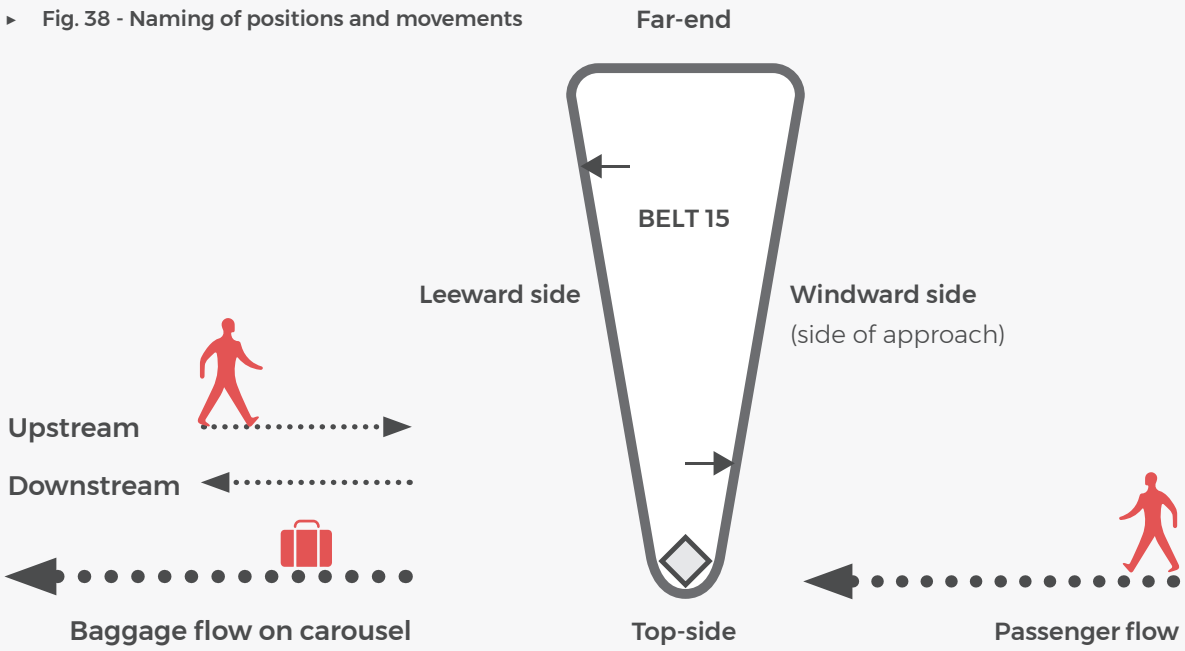
The side on which passengers approach the carousel has been dubbed 'the windward' side. Logically, the opposite side has been called the 'leeward' side. The top-side is the corner side closest to the main flow towards the exit, its opposite side has been dubbed 'the far end'.

Results
Other than expected, there were many people that arrived early at the belt and did not pick a spot at the ejection point. Instead, they were taking a position upstream, between the top-side and the ejection point. This is a very illogical position to choose: The carrousel would have to go all the way round before their luggage arrives at this position. Most passengers can be seen checking the screen before choosing a position to wait. Early arrivers keep a distance of approximately 2-3 tiles from the carousel.

Other passengers that arive choose a position a few meters next to the ones that are already present. Again, the windward side of the carrousel was more crowded than leeward side during all turnarounds. Very early on in the turnaround people are starting to queue in microlines at the 1/3th length of the windward side and top-side. Although there is a lot of free pace available on the far-end and leeward side, people accumulate at these specific spots. Newly arriving passengers start to go to the leeward side after the crowd on the windward side builds up. The far-end has a lesser occupancy rate, people mostly stand at the first 2/3rd length of the carousel. It is believed this because there is no added value/nothing to be gained from walking this way for the majority of passengers. They therefore settle for a more dense position at the beginning.

Passengers are 'sticky': only a fraction is seen moving to a different spot after settling down. Even when the baggage is ejected from the other side, the majority of people stays put. There are a few more pro-active/assertive passengers that actually move to the other side..

▸ **Fig. 38 - Naming of positions and movements**



There are way more baggage carts on the side of approach, as people often grab a baggage cart before entering the reclaim area and then choose the shortest route. There is a type of congestions that can best be described as a 'wall of baggage carts'. Basically there is an excessive amount of baggage carts around the tail of the carrousel, making the pathway very narrow. Combined with a stream of oncoming traffic, it becomes difficult for passengers to take a position further down the carrousel.

Some reasons could be found why people start standing against the belt. They check whether it is their bag, but don't step back. Some passengers park their luggage cart against the belt, and stand next to it. It enables them to easily put their baggage on the cart, but it occupies a lot of scarce space around the carrousel. Some passengers can be seen approaching the belt to read the SDD's, presumably they are a bit difficult to read. Standing against the carrousel works as a domino effect downstream: once the first person does it everyone on his right will copy the behavior. It was observed how a duo 'reclaims' their position after it 'was taken from them'. Some people start sitting on the carrousel, and in some cases, there is just no apparent reason at all.

Conclusion

The 'rules of thumb' for pedestrian movement can explain the lion's share of what can be seen in the reclaim areas. Because passengers themselves do not distribute evenly there is a mismatch between theoretical and actual capacity. Part of the carrousel is not actually used by passengers, and passengers that accumulate at certain areas cause congestions in the flow. Baggage carts near the carrousel are accelerating this process, and they hinder people from collecting their belongings.

Some passengers seem to stand against the carrousel without any apparent reason. It is thought this happens because there is no 'default' distance, thus people do not see a reason to stop walking. One person standing against the belt is enough to cause a domino-effect downstream. People want to keep an eye on their luggage, so if their view on the belt is taken away they too will step in.

Only a fraction of the passengers has the ejection point as a strategic target. For example, when the baggage is offloaded on the other dock most passengers stay put. In general, passengers seem to give little thought about their position at the belt, as illustrated by the accumulation of passengers at the 'illogical' top-side.

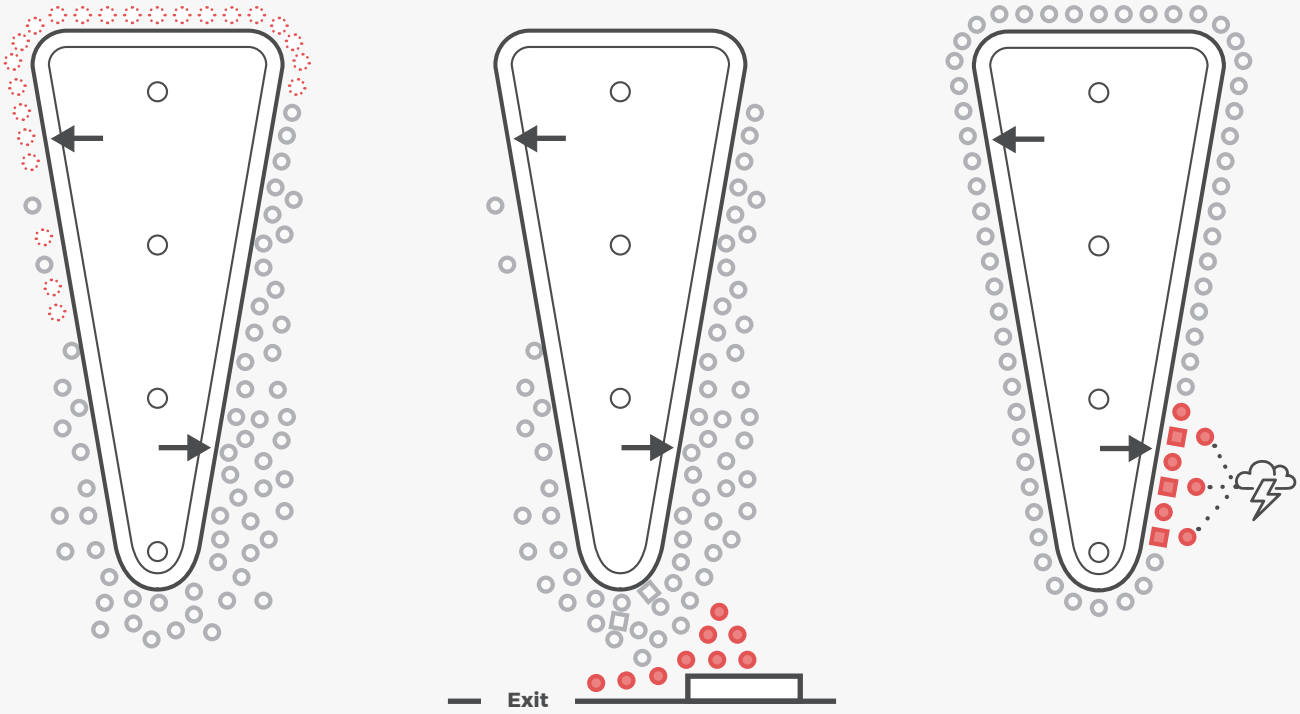
In section 2.6 a summary is given on issues and bottlenecks that are linked with passenger behaviour.

2.6 SUMMARY OF ISSUES CAUSED BY PASSENGER BEHAVIOUR

Positioning around the belt
Passengers are inclined to avoid costs and take a position near the beginning of the carousel. As such, they do not distribute evenly around a carousel but accumulate at specific areas, dependent on the side of approach. The density of the leeward side of the belt is always lower than the density at the windward side. There is a reluctancy to move further down the carrousel than required. If objects are present it can cause congestions on both sides of the belt early on.

Congestions in main flow
As can be seen clearly in reclaim hall 3, belt 16 and 17, passengers that position themselves at the top-side can cause congestions in the main flow,

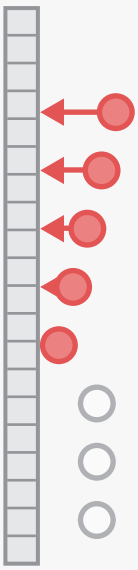
Baggage carts
Baggage carts at the carousels occupy scarce space and can easily cause congestions. As such, they limit accessibilty to the belt. Passengers that make use of baggage carts tend to position themselves in the vicinity of where the cart was retrieved.

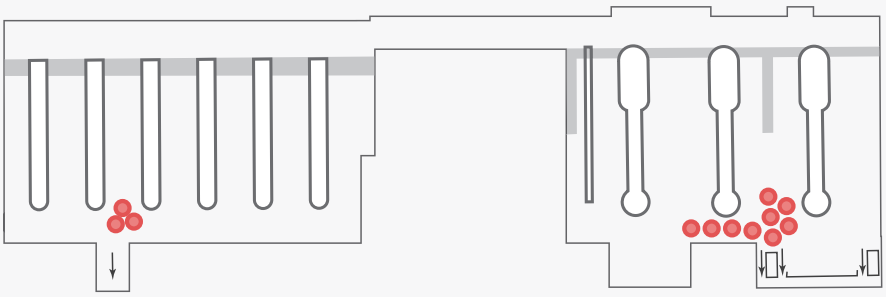


Crowding against the belt
From the questionnaire and interviews it became clear that many passengers find it important to have a view on the belt. Through observations it was noticed that crowding against the carousel is a domino-effect: The first passenger that stands against the belt diminishes the view of the passengers 'downstream', forcing them to take position against the belt as well. Eventually everyone is standing along the edges shoulder-to-shoulder, making it more difficult for everyone to identify and collect their belongings.

Congestions
Large groups of people that wait until their group is complete cause congestions at random areas in all three reclaim areas (fig. 2.5.7).

Exit choice
Passengers in reclaim area 1 tend to use only one out of two exits, causing a messy customs process and stagnation (albeit for a short time cycle). Two things to play a role: 1) They are unaware of the other exit or uncertain that they can use it and 2) people prefer the shortest route with the least amount of turns.





2.7 CONCLUSION

The wait experience is related to the overall service encounter evaluation. Unfortunately, waiting at the reclaim carousel is the rule rather than the exception. Since retrieving luggage is a 'have-to', the wait time will never be 'great' time. However, waiting can be made more pleasant. This is also an objective for the Passenger Experience department for 2018/2019.

One way to enhance the wait experience is by preventing crowding. Crowding has a negative influence on wait evaluation, and lessens the feeling of control.

The subconscious 'rules of thumb' for pedestrian movement can explain the lion's share of what can be seen in the reclaim areas. Multiple bottlenecks and crowding issues were found that are directly related to passenger behaviour. Nudges can be used to influence subconscious decisions and therefore behaviour. This can be done so by making choices Easy, Attractive, Social and Timely.

Section 3 | **DEFINE**

This chapter includes:

3.1 SYNTHESIS: PRELIMINARY DESIGN REVIEW

In section 3 the knowledge gained from the research is combined. This knowledge is then projected onto the preliminary floorplan[1] of the A-terminal to determine probable bottlenecks (page 66). Moreover, it compares the design on similarities with the current reclaim areas. Therafter, the objectives are defined. This leads to a design brief that will act as the starting point for ideation.

As pedestrian behaviour is largely an automated process (section 2.2.4), it is likely that in similar situations, similar behaviours will be seen. Several areas were indicated that show high similarity with the 'problem areas' found during the observations.

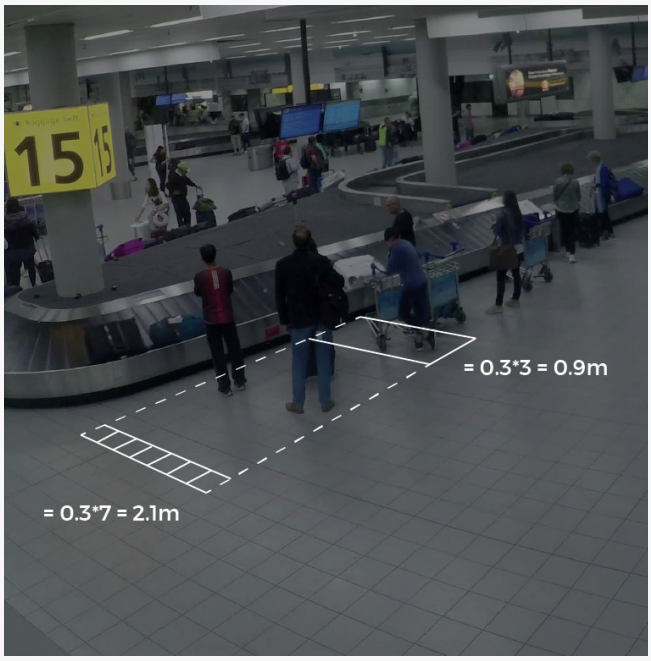
In section 2.2.3 four key principles behind pedestrian behaviour were found:

The first passengers that will enter the reclaim area will be locating their inclined to avoid costs and take a position near the beginning of the carousel. A portion of the passengers will have the ejection point as a target and are willing to make the additional costs (section 2.5.4). Following the insights from the video observation, it is predicted the point of gravity will be at the top-side, 2/3^{rds} of windward side and 1/3rd of the leeward side.

Passengers will remain in the main flow for as long as possible when navigating to the carousel (section 2.2.3; Helbing, 2005).

Passengers that collect a baggage cart will position themselves in the vicinity from where the carts are stored (section 2.2.5).

Passengers that are exiting the reclaim area will choose for the exit that requires the least number of changes in direction and the shortest distance. Only a fraction of the passengers will opt for the bottom green exit.

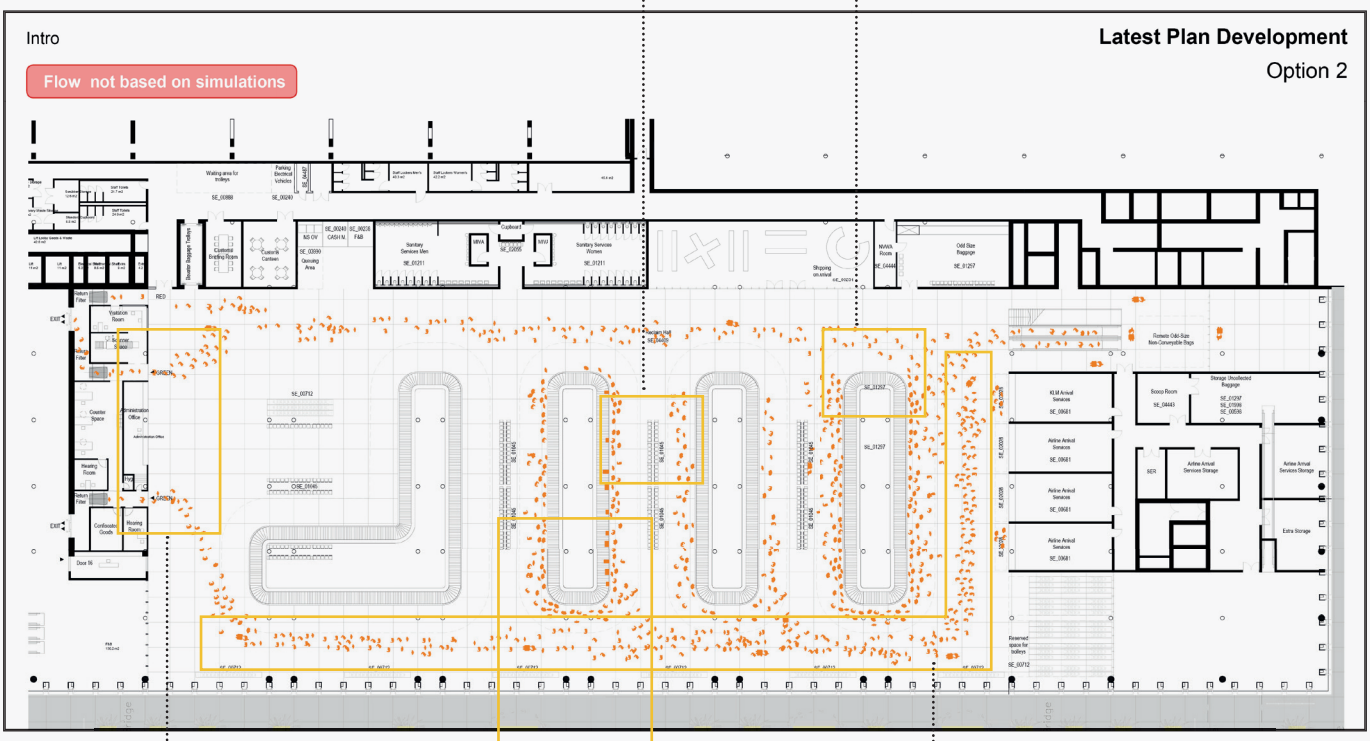


▸ **Fig. 39 - A passenger with a baggage cart occupies 2.1m*0.9m = 1.9m² of space. A passenger without a cart only requires 0,36-0,5m². The flow width for one PAX is approximately 0,9m².**

[1] = Version KLAIR_PD_AR_180828_Mchine_Workshop_Reclaim Hall

There is less than 11 meters between the carrousels. There is a good chance for congestions between the carousels 'early on' if baggage carts or chairs are located here. Passengers with baggage carts tend to minimize the distance, and claim a surface area of 0.9m * 2.1m (1.9m^2) See fig. 39.

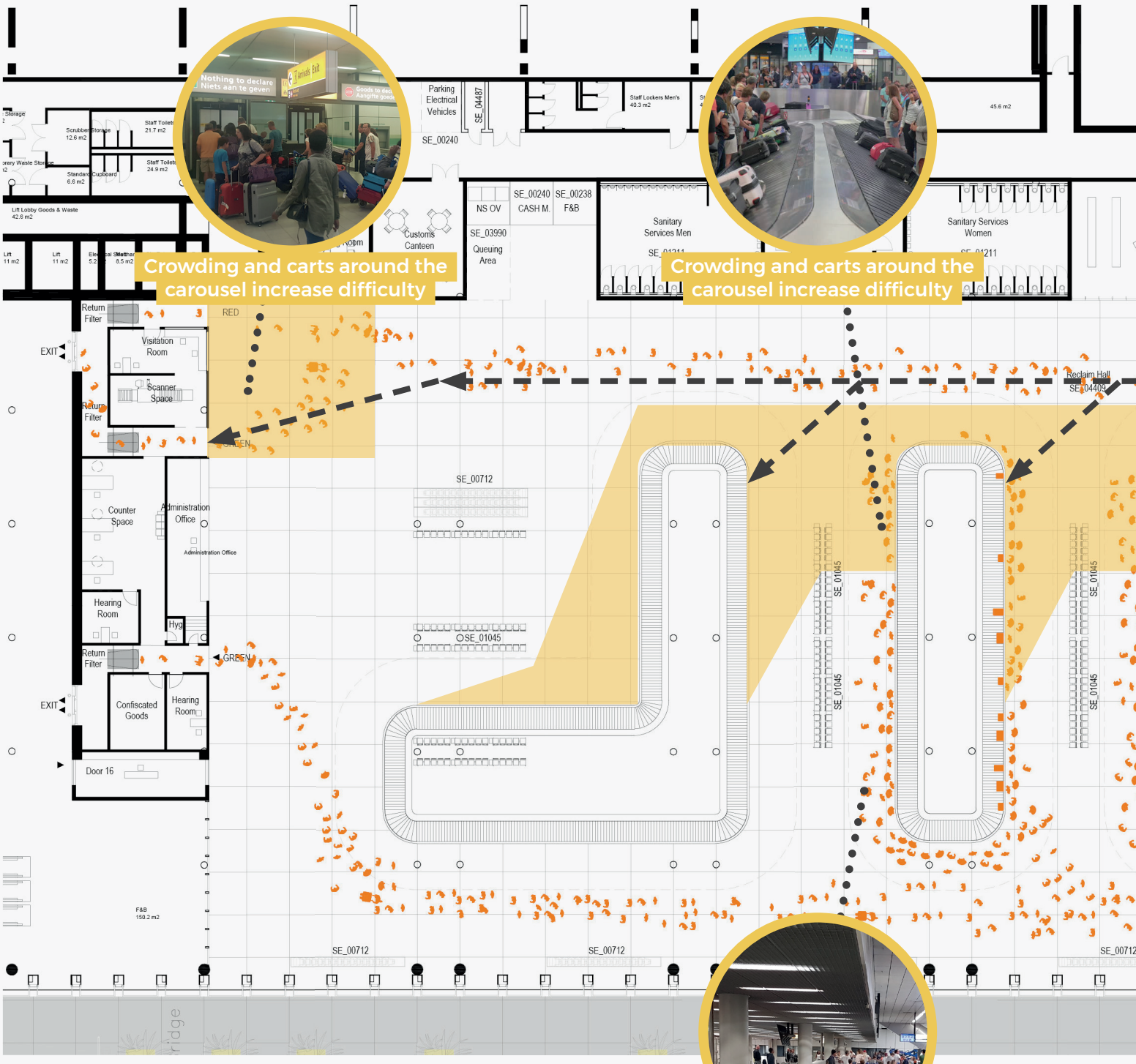
Passengers will accumulate at the top-side of the carousel. It is the shortest route. It may lead to congestions in the main flow



Similar as in reclaim area 1, most passengers will opt for the right door because it is the direct one with lowest costs. Even if it becomes more crowded (More info: section 2.2.3; Helbing, 1997).

This flow is highly unlikely to happen, because 1) people prefer to postpone turning for as long as possible (Helbing, 2005) and 2) people will avoid the costs of additional steps (Bogers & Timmermans, 1986; Guo & Hang, 2011; Hoogendoorn et al, 2002)

Flow not based on simulations



SHORTEST ROUTE

DIRECT ROUTE

LEAST EFFORT

FOLLOW OTHERS

Congestions in main flow

PROBABLE FLOW

Risk of congestions when PAX
limit effort to walk further & obstacles

Odd Size Baggage

SE_01297

SE_00231

Remote Odd-Size Non-Conveyable Bags

KLM Arrival Services

SE_00681

Scoop Room

SE_04443

Storage Uncollected Baggage

SE_01297

SE_01998

SE_00598

Airline Arrival Services

SE_00681

SER

Airline Arrival Services Storage

Extra Storage

SE_02028

SE_01045

Reserved space for trolleys

SE_00712

3.2 DESIGN BRIEF

What is the problem?

The hassle around the baggage carrousels as experienced and caused by the passenger. This includes waiting under crowded conditions at the baggage carrousel and congestions in the passenger flow. It is important to ensure a good distribution of passengers in the area in order to use the available space in a safe an efficient way without a feeling of crowdedness. This requires behavioral change on the passengers' side.

Who will have the problem?

The main problem owners are AAS and passengers with Schiphol as destination.

AAS

- From Schiphol's perspective, it is important that the process goes smooth in order to achieve a positive passenger experience, a quick turnaround, prevent safety hazards and possibly to avoid the necessity of crowd teams.

Passengers

- Passengers can be subdivided into passenger with and without hold luggage. Those without luggage want to swiftly navigate through the baggage reclaim area without being obstructed by other passengers. Passengers with hold luggage want their luggage as soon as possible, want to be able to see and reach for their luggage and want to have a comfortable wait without the feeling of crowdedness.

Ambition

The ambition is to enable a hassle-free reclaim process in the A-terminal baggage reclaim, by nudging passengers to behave in a way that contributes to the process.

In-scope

- Availability, placement and effectuation of furniture, equipment and carousels
- Signage, displays and (floor)markings
- Facilitating discretionary activities
- Both the current reclaim areas and the A-terminal

Objectives – Encouraging desired behaviors

To reach this design goal it is key that the six expected bottlenecks caused by human behavior are prevented or mitigated. The idea is that non-obstructive interventions can shape pedestrian movements into a smooth process, which in turn will lead to an improved experience. The main challenge will be to nudge or motivate passengers to interact with the environment in a way that is in the interest of the group. The objectives and desired behaviors required to reach each objective can be described as follows:

Objective 1
Nudge passengers not to position themselves on the 'top-side' so that congestions are prevented
Desired behavior 1
Passengers will not wait on the 'top-side 'of the carrousel and choose a different position to stand

Objective 2
Nudge passengers to take a position on the 'leeward' side of the carousel to enhance the distribution of passengers
Desired behavior 2
(A portion of the) Passengers will walk around the carrousel and take a position on the leeward side

Objective 3
Nudge passengers to walk further down the carousel to enhance the distribution of passengers and avoid congestions at the top-end
Desired behavior 3
(A portion of the) Passengers will not stop at the first available place around the carrousel but navigate towards a position that is further down the carrousel.

Objective 4
Nudge passengers not to stand against the belt during the wait to enhance the view on the belt and the ease of taking baggage off
Desired behavior 4
Passengers will keep a certain distance of the carrousel, and only step in to grab their luggage.

Objective 5
Nudge (a portion of) the passengers to use the second exit to prevent micro lines and congestions at the exits to smoothen the customs process
Desired behavior 5
Passengers notice and understand that there is a second exit and make use of it when queues are forming.

Objective 6
Nudge passengers not to park their baggage cart against the carrousel so that it is more easily accessible
Desired behavior 6
Passengers will not park their baggage cart against the carrousel and keep their baggage carts at a distance.

Contributing to the Passenger Experience

During the deliver phase the PX Principles are taken into account to connect the behavioural interventions with AAS strategy.

PX PRINCIPLES

CONTROL WELCOME UNWORRIED INSPIRED

Section 4 | **DEVELOP**

In this section, the knowledge from section 2.2 and 2.3 is used to generate ideas for behavioural interventions, targeting the objectives as stated in section 3. It includes:

- 4.1 Ideation
- 4.2 Ideas
- 4.3 Concepts

4.1 IDEATION

4.1.1 - Creative Session with students

On the 18th of July a creative workshop was organised with six MSc students from the faculty of Industrial Design Engineering. They were given a brief explanation on the problem statement. The session focussed on how to distribute passengers in the area and how to improve the passenger experience. The students were free to collectively define their own “how can you’s” as starting point for the ideation. Using brainwriting techniques a lot of initial associations and ideas were grouped into pools. The students were then free to select interesting leads and iterate on them. The resulting ideas then were presented and discussed. The resulting ideas can be seen in appendix E, and can be summarized into the following subjects:

- Making use of (fun) attractors to lure people to certain spots
- Signalling routes
- Making use of lights to attract or deter
- Different types of baggage carrousels
- Different process steps
- Slowing passengers down early on if they will have to wait

4.1.2 - Follow-up ideation

Their ideas were used as inspiration for the creation of seven rough ideas for design interventions aimed at the objectives and desired behaviours. Every idea was accompanied by a proposal for a field experiment at Schiphol. They are described on the following page 74-75. The icons refer to the associated objective, PX- and nudge principles. A recap of the objectives:

1. Nudge passengers not to position themselves on the 'top-side' so that congestions are prevented
2. Encourage passengers to take a position on the 'leeward' side of the carousel to enhance the distribution of passengers
3. Nudge passengers to walk further down the carousel to enhance the distribution of passengers and avoid congestions at the top-end
4. Nudge passengers not to stand against the belt during the wait to enhance the view on the belt and the ease of taking baggage off
5. Nudge (a portion of) the passengers to use the second exit to prevent micro lines and congestions at the exits to smoothen the customs process
6. Nudge passengers not to park their baggage cart against the carrousel so that it is more easily accessible

4.1.3- Idea selection for field experiments

Due to summer holidays in combination with time constraints it was not possible to gather all relevant internal stakeholders to discuss the interventions in a workshop. Hence, the interventions were presented in a document which was e-mailed to Schiphol employees. They were asked to give feedback on each idea and indicate whether they think it is feasible and desirable by filling in a form.

In general, the responses were positive and additional feedback was given on colours, distances and things to keep in mind when dealing with external stakeholders. There were some doubts whether passengers would notice floor markings in crowded conditions.

It was required to downsize the experiments due to time- and budget constraints and some practical issues with regards to get agreements within the given time. Therefore, two different interventions were selected to be developed into more detail.

The programme manager of the Passenger Experience department was interested in the wait-here lines. As a compromise it was agreed to combine intervention 1, 4 and 5 into a single experiment (section 4.3.1)

Intervention 5 was also chosen because it has the potential to show an immediate effect in reclaim area 1. Moreover, it was feasible to test and evaluate within the given time (section 4.3.2).

4.2 IDEAS

This chapter briefly describes the ideas for behavioural interventions. More detailed descriptions can be found in appendix F..

1 - PRM floorsticker

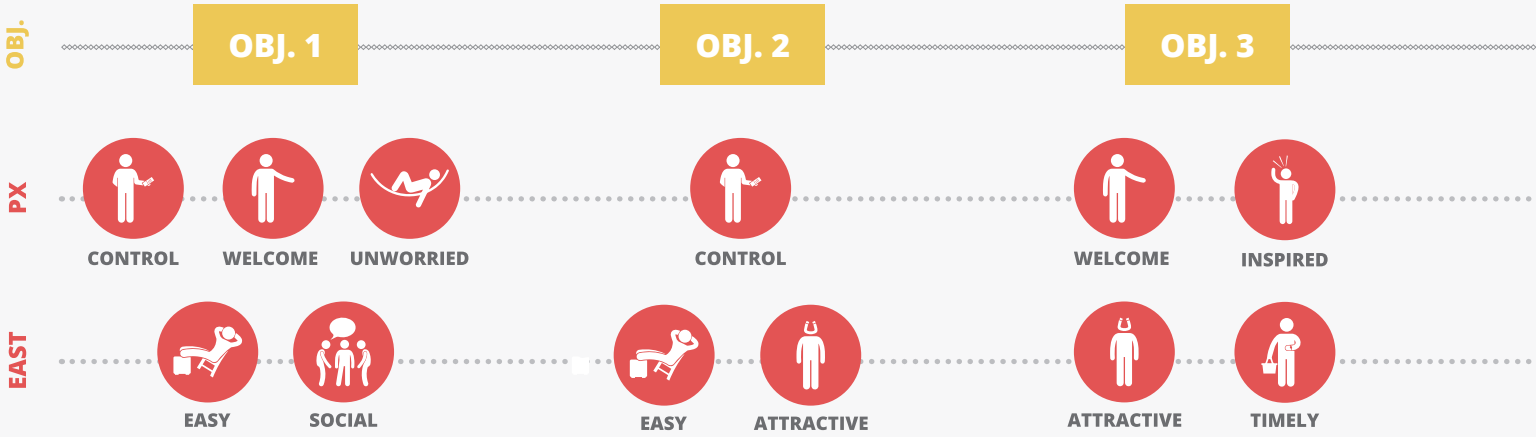
Passengers standing at the 'top-side' of the carrousel cause congestions in the main flow and block exits. Making it a social norm not to stand at here might prompt people to avoid waiting at this spot. Moreover, it becomes easer for PRM to reclaim baggage.

2 - Default path

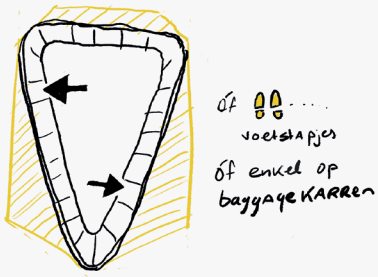
Idea 3.1 is to propose a 'default path' using floormarkings and an 'end goal'. It will lead passengers to the leeward side. Idea 3.2 is to close one ejection point of the carrousel and see if PAX will take the additional effort to walk to the leeward side.

3 - Attractors

The use of attractors to improve distribution. During the research the most commonly heard need was for electrical charging points. A (for this thesis) achievable idea with a fun-factor originated in a creative workshop: A 'selfie wall' with AAS branding.

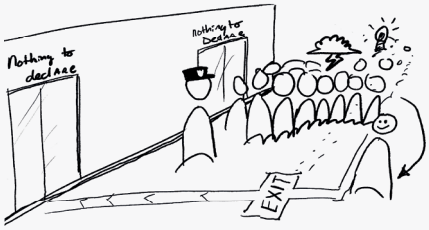


4 - Wait-here lines



Passengers (and baggage carts) crowding at the carrousel limit each other's sight and ability to grab their belongings. A wait-here line can communicate a default distance and social norm. It is proposed to re-try it, using a more salient stroke.

5 - Left exit RH 1



Passengers in reclaim area 1 tend to use only one out of two exits, causing a messy customs process and stagnation. Floormarkings and signage can suggest the route to the left exit and lead passengers to it (skip the queue).

6 - Baggage carts

A very clear and salient poster at the cart 'parking spots' that conveys the issue baggage carts cause and asks to be courteous to fellow passengers. Making the problem understandable and appeal to the moral self-image.

OBJ. 4

CONTROL UNWORRIED

EASY ATTRACTIVE SOCIAL TIMELY

OBJ. 5

CONTROL UNWORRIED

EASY ATTRACTIVE TIMELY

OBJ. 6

CONTROL

EASY SOCIAL TIMELY

4.3 CONCEPTS

4.3.1 - Wait-here lines (combined)

As described in section 4.2.3 it was decided to combine the interventions of idea 1, 4 and 6 into a single experiment. Floor stickers will be made that aim to evoke a behavioural response and will be placed along the lines of the carrousel. It addresses three objectives:

Objective 1
- Nudge passengers not to position themselves on the 'top-side' so that congestions are prevented.

How?
- Creating a 'reserved for PRM' area at the top-side will make it a social norm not to position here. Moreover, it will become easier for PRM and assistants to reclaim the baggage (fig. 40).

Objective 4
- Nudge passengers not to stand against the belt during the wait to enhance the view on the belt and the ease of taking baggage off.

How?
- Very salient floor markings communicate a default distance to keep and options to stand. It also conveys a simple message and communicates why this is socially desirable behaviour.

Objective 6
- Nudge passengers not to park their baggage cart against the carrousel so that it is more easily accessible.

How?
- An additional line that communicates 'no baggage carts beyond this point' in a simplified way by making use of icons.

About the design
The design (fig. 40-41) makes use of Schiphol colours but maximized contrast , which increases salience. Short sentences and icons are automatically picked-up and interpreted by Type 1 'automatic' thinking (Kahneman, 2011). As could be seen in the video observations, a distance of 60cm (two tiles) from the reclaim belt is a natural distance to keep. It drastically improves the view on the belt and creates enough space to take off luggage without 'hitting' other passengers. The default options to stand are at a 60 cm interval. Based on the video observations this is enough space for passengers to stand and wait. The feeling of crowdedness lowers the perception of quality and control (Epstein, 1982). If this behavioral intervention works it will smoothen the process: passengers will have a better view on the belt, have the room to take their luggage of the belt and do not have to worry if they can reach it on time.

Experiment handed-off to PX

Unfortunately it was not possible to conduct this experiment within the given time. It required more resources and alignment between stakeholders.

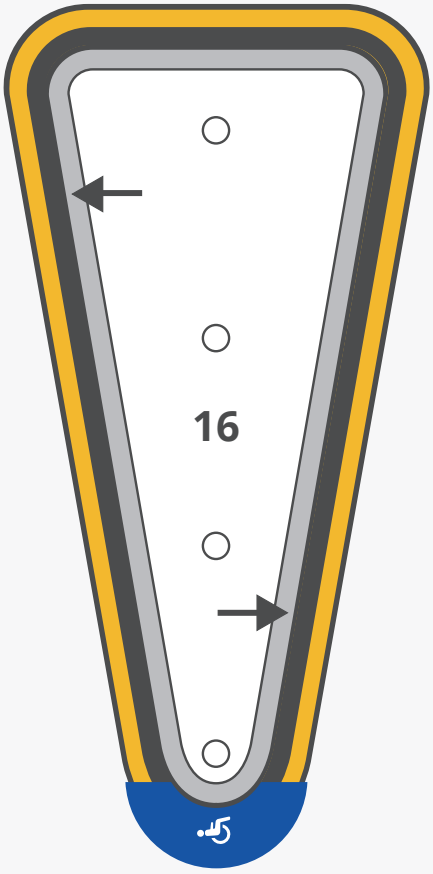
Input for this intervention has been exchanged with the Passenger Experience department (PX) in the form of an 'experiment card' including a test proposal. (appendix G)

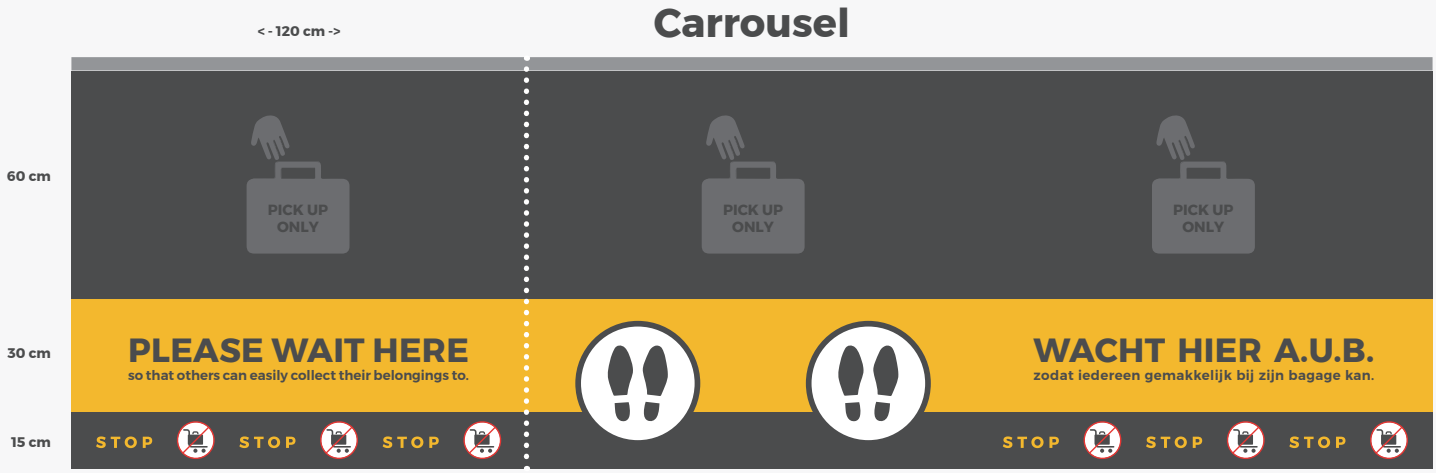
Now what?

At the moment of writing the experiment is still in the pipeline. PX will conduct and evaluate the design intervention at a later moment. After which, PX and OPS should decide if- and in what form it can be used as input for the interior design of the A-terminal.

As stickers wear out, it might be better to work with tiles/vinyl. If proven succesful, the 'PRM spots' are strongly recommended to apply, as it will prevent congestions in the main flow.

▸ Fig. 40- Top view





▸ Fig. 41 - Design proposal for the wait-here lines

4.4.3 - Left exit RH 1: Skip the queue

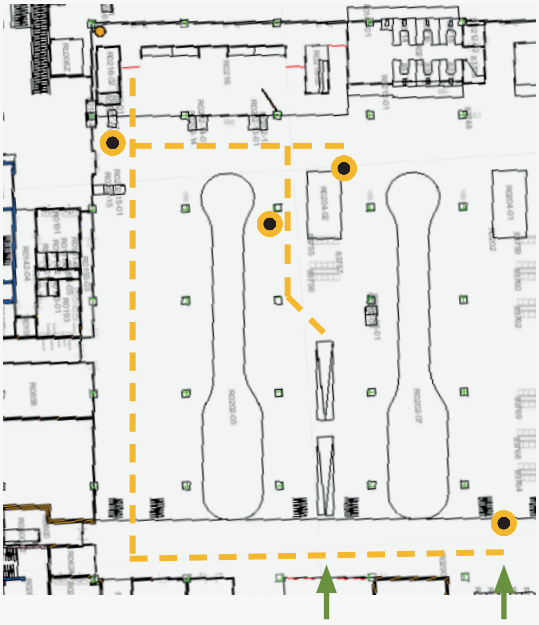
As described in section 2.5.4, an overwhelming majority of passengers in reclaim area 1 tend to use only one out of two exits. It leads to a messy customs process and stagnation.

Objective 5

- Nudge (a portion of) the passengers use the second exit to prevent micro lines and congestions at the exits to smoothen the customs process

How?

- Floor markings suggest a default route (fig. 42) to the left exit. Additional signage will notify passengers there is a second exit (pg. 79). If queues start to form or when it is getting crowded in the reclaim area it should prompt people to skip the queue and follow the path to the left exit.



- **Fig. 42 - Suggestion for the floormarkings to indicate the default path. The circles indicate additional signage. The green arrows represent the passenger entry points.**

About the design

Salient yellow floormarkings are applied, signalling the path to the left exit. At strategic (timely) locations passengers will be notified about the floor markings and the second exit. They communicate the incentive of 'saving time' by skipping the queue (Attractive).

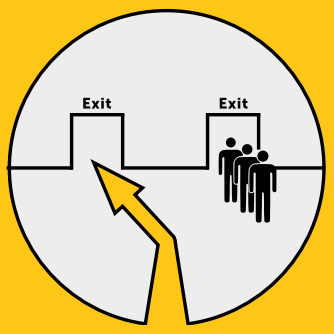
The optimal outcome would be that it able to to render crowd controllers in this area unnecessary, by empowering passengers to make a (better) route choice based on the situation at hand. The literature suggest most people will still opt for the right door. But in crowded conditions, if only a few people respond to the nudge others will follow (section 2.2.3).

Field experiment

This intervention will be tested in a field experiment. Section 5 will describe the method and results.

Quick Exit

Follow the yellow line
Volg de gele lijn



Skip the queue

Follow the yellow line
Volg de gele lijn

Skip the queue

Follow the yellow line
Volg de gele lijn

Exit

Section 5| **DELIVER**

This chapter includes:

5.1 FIELD EXPERIMENT

5.1.1 - Introduction

The design intervention as described in 4.4.3 is selected to be carried out in a field experiment in reclaim area 1. Emperical research on these kind of behavioural design interventions is very scarce. A similar experiment could be found, but it is unknown to what extent it is reliable as it has not been publicated in a scientific journal.

The experiment was performed by the Danish company iNudgeyou that is specialized in applying behavioural research (Hulgaard et al., 2016). Their experiment has many similarities with this situation: using floor markings (tape) they tried to guide more passengers through a second door in a reclaim area in Copenhagen. They performed a chi-square test of indepence to measure the increase in door usage frequency and found a highly significant effect. This experiment is different in the sense that the two options (left door/right door) are not equal; for the majority of passengers it will be rational to exit through the right door because of its central position.

This thesis will wield a similar approach, with the addition of observational research. The intervention is effectuated using yellow floor tape and four posters attached to sign displays (as depicted on page 83. The experiment took place on the 21st of September. It lasted from 9:15 until 18:15.

5.1.2 - Experimental design

Method
The hypotheses will be tested in a quantitative manner using a quasi-experimental pre-post design. To test the effects of the intervention, a chi-square test will compare the frequencies of door usage during the intervention with the 'normal' frequencies. It tests the following hypotheses:

- H0: Applying the intervention in reclaim area 1 *will not lead* to an increased use of the left door and decreased use of the right door.

- H1: Applying the intervention in reclaim area 1 *will lead* to an increased use of the left door and decreased use of the right door.

One of the biggest issues with research designs in a natural settings is the lack of certainty that the different groups are comparable in every aspect except for the treatment (Kumar, 2011). As such, the assumption must be made that the samples consist out of comparable populations.

Measures, data collection and procedure
Both the dependent as independent variable are dichotomous. The independent variable is the condition, and either represents the 'normal circumstances' or the 'intervention'. The dependent variable is door choice, either left or right.

The frequency of passengers that goes through either door is measured by a system called BlipTrack. This system is widely implemented at Schiphol and collects passenger data by using bluetooth and Wi-Fi signals. The data that was used consisted of passenger frequency per 5 minute interval for each door.

Based on the expected peak hours, observations were made from 9:15-11:00, 13:00-15:00 and 17:30-18:15. The observation focused on noticable behaviours that elicit passenger interactions with the intervention.


2


EVACUATION PLAN
Quick Exit
Follow the yellow line
Volg de gele lijn
Exit
Exit
Nothing to declare
Niets aan te geven
Goods to declare
Aangifte goederen


2 2
Arrivals Exit
Customs

The frequencies of door usage are retrieved from the BlipTrack platform. The frequencies per door of three days are compared to each other: Friday the 14th of September, thursday the 20th of September and friday the 21st of September (limited to 9:15-18:15). A manipulation check is performed by comparing the normal conditions to each other (14 vs. 20 September), and comparing the 21st to both.

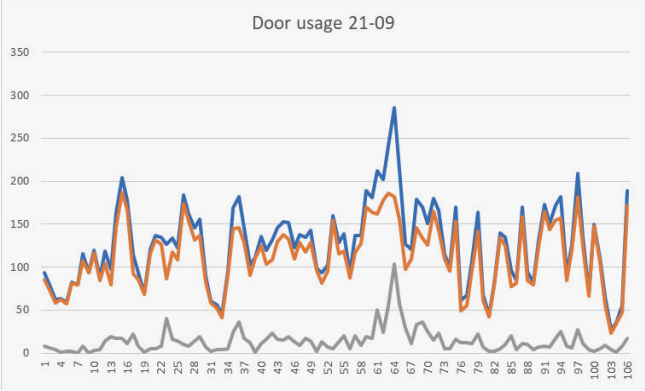
Because both variables are dichotomous, the data is analyzed by applying a Chi-square test in IBM SPSS Statistics. A significant association within a Chi-square test checks whether a difference in frequency was solely due to chance, but nothing about strength or the direction of the association. Moreover, the chi-square test is susceptible to sample size. A reasonably strong association may not come up as significant within small samples, but a weak association might show statistical significance in very large sample sizes (McHugh, 2013). One common way to test the strength of the association is the Cramer's V. Cramer's V is a form of correlation, in which a value < 0.1 is considered to be a weak effect. However, a problem with Cramer's V is that it is difficult to obtain a moderate or high association when a phenomena is not solely dependent on the independent variable. (McHugh, 2013) In case of passengers route choice in the reclaim area there clearly is a preference for the right door; limiting the effect of the intervention by the relatively low rate of passengers that make use of it within the total population. As such, a weak Cramer's V is all that can be expected from this field experiment.

A more useful measure for this effect size is the odds ratio (OR) (Field, 2009). In this case the odds ratio represents the odds that a passengers exits through the left door while the intervention is present, compared to the odds in its absence. Both Cramer's V as the Odds ratio will be determined for each comparison.

Sample

The intervention lasted from 9:15 till 18:15. During this time period, a total of 13.842 passengers exited reclaim area 1 through either one of the doors. The lowest and highest count of passengers per 5 minute time frame were 27 and 286 respectively. The diagram in figure 43 visualizes the data. In it, the blue line represents the total passengers that went through either one of the exits. The red line represents the passengers that exited through the right exit. The grey lines represents the passengers that exited through the left door.

The total sample size on the 14th and 20th of September is 31.872 and 28.517 respectively.



► **Fig. 43 - Passenger door usage frequencies reclaim area 1 on the 21st of September 2018, 9:15-18:15.**

Looking at the graph in figure 43 it becomes evident that usage of the left door increases when the total number of passengers at that specific moment is higher. Therefore is was decided to do an additional comparison between the 14th and 21st by ordering the timeframes based on their sample size:

$$0 =< n_{\text{total PAX within timeframe}} < 100$$
$$100 =< n_{\text{total PAX within timeframe}} < 200$$
$$200 =< n_{\text{total PAX within timeframe}} < 300$$

5.1.2 - Results - Based on day

Manipulation check
The results have been summarized in fig. 44. See appendix H for the original SPSS output of the manipulation check.

14th of September v.s. the 20th of September
There was no significant association between day and door usage x2(1) = 1,29, p > .05. The H0 is therefore accepted, and door usage was not associated with the day.

Control versus intervention:
14th of September v.s. 21st of September
There was a significant association between condition and door usage x2(1) = 14,58, p < .001. The H0 is therefore rejected, and H1 accepted: Door usage is associated with the condition. The Cramer's V has been calculated as 0,018, indicating a weak relation. Based on the ODDs ratio, the significance represents that the odds of passengers opting for the left door was 1,14 times higher than during the intervention condition.

Control versus intervention:
20th of September v.s. 21st of September
There was a significant association between condition and door usage x2(1) = 21,72, p <.001. The H0 is therefore rejected, and H1 accepted: Door usage is associated with the condition. The Cramer's V has been calculated as 0,023, indicating a weak relation. Based on the ODDs ratio, the significance represents that the odds of passengers opting for the left door was 1,17 times higher than during the intervention condition.

Manipulation check				
	Value $x^2(1)$	**Asymp. Sign. (2-sided)**	**Cramer's V**	**ODDs ratio**
14 vs 20	1,292	0,256	0,005	1,023 x
14 vs 21	14,585	0,000	0,018	1,135 x
20 vs 21	21,716	0,000	0,023	1,172 x

▸ **Fig. 44 - Summarized output of the SPSS test.**

5.1.3 - Results - Based on timeframe sample size

Section 5.1.3 showed significant differences between the normal conditions and the design intervention. Over the course of the entire day the odds were slightly higher that a passenger would exit through the left door.

To determine when the effect is the largest, the data was ordered based on the total numbers of passengers, and subdivided into three groups:

$$0 =< n_{\text{total PAX within timeframe}} < 100$$
$$100 =< n_{\text{total PAX within timeframe}} < 200$$
$$200 =< n_{\text{total PAX within timeframe}} < 300$$

Figure 45 represents the data that followed from this analysis. The number represents the frequency, the number in brackets represents the expected frequency. There is a significant difference between all data sets (p<.001).

The strongest effect was found when there are less than 100 passengers within a 5 minute timeframe, with a Cramer's V of 0,059. The odds of a passenger opting for the left door was 1.6 times higher during the intervention than during the control period.

The effect size for the 100-200 and 200-300 data sets are the same, with a Cramer's V of 0,046. The odds of a passenger opting for the left door were 1.4 times higher during the intervention than during the control period.

In the first data set (0-100), the percentage of passengers that exited through the left door during the control condition was 4,9% against 7,8% during the intervention. This 7,30% against 9,80% and 16,30% against 21,30%. within the 100-200 and 200-300 data sets.

0 =< n < 100			
	Left	**Right**	**Total**
Control (14-9)	210 (257,4)	4096 (4048,6)	4306 (4306)
Intervention (21-9)	204 (156,6)	2417 (2464,4)	2621 (2621)
Total	414 (414)	6513 (6513)	
$X^2(1) = 24{,}491$, $p < 0.001$, Cramer's V = 0,059 ODD ratio left door I v.s. C = 1,6 x			

100 =< n < 200			
	Left	**Right**	**Total**
Control (14-9)	1310 (1477,4)	16731 (16563,6)	18041 (18041)
Intervention (21-9)	958 (790,6)	8696 (8863,4)	9654 (9654)
Total	2268 (2268)	25427 (25427)	
$X^2(1) = 59{,}277$, $p < 0.001$, Cramer's V = 0,046 ODD ratio left door I v.s. C = 1,4 x			

200 =< n < 300			
	Left	**Right**	**Total**
Control (14-9)	1553 (1620,4)	7972 (7904,6)	9525 (9525)
Intervention (21-9)	334 (266,6)	1233 (1300,4)	1567 (1567)
Total	1887 (1887)	9205 (9205)	
$X^2(1) = 23{,}925$, $p < 0.001$, Cramer's V = 0,046 ODD ratio left door I v.s. C = 1,4 x			

▸ **Fig. 45 - Results from the Chi² test based on timeframe size**

5.1.4 - Results - Observations

During the observations no passengers were redirected to the left exit by customs officials or airport staff. As expected, passengers heading down the slope would not follow the markings to exit through the left door if there was no queue in front of the right exit.

When small queues started to form, people would still join the queue. A man was overheard stating 'Oh, we could also just exit there... Oh nevermind.' just before exiting the area through the right door.

During the experiment some (groups of) passengers still hesitated about exiting through the left door when:

1. there is no customs official present.
2. it was not used by others while they had it in sight.

On one occasion, a group of four elderly people walked towards the left door. The doors already opened, but his wife called and gestured him back to go the right exit were they joined the queue.

During off-peak hours, it became clear the intervention could cause confusion. On multiple occasions, it was observed that passengers came down from the slope right in front of the right exit would follow the path towards the lext exit. They would stop, walk back and ask the customs officials whether they could exit there.

The signs had to be placed out of the main flow, so they were placed against fixed objects such as columns. During peak hours, it occured that passengers would lean against the objects, thus blocking the view on the signage.

Figure 46 shows how passengers follow each other. A few passengers that break with the pattern soon attract other passengers to follow. A separate flow arises. Once the queue has diminished, it 'rebuilds' and it will take another 'pattern breaker' to split up the group into two flows.

► **Fig. 46 - Passengers copying each other.**

5.1.5 - Discussion on the findings

The purpose of this experiment was to explore the effects of adding a design intervention in the environment would lead to an increased usage of the left customs exit. The findings suggest that the intervention had a significant effect: when the intervention is present, more passenger exit through the left exit. However, the strength of the association is limited.

Measured over an entire day, when the intervention is present passengers are 1,13-1,17 times more likely to exit through the left exit than when it is not. When comparing frequencies based on sample group, passengers are 1.4-1.6 times more likely to exit through the left door compared to normal circumstances. The share of passengers that exitd through the left door was increased by 2,9%, 2,5% and 5% for timeframes where 0-100, 100-200 and 200-300 passengers would exit the area respectively.

Observations were made next to the quantitative analysis in order to research if- and how people interacted with the intervention.

Some observations were made that contradicted prior assumptions. Based upon learnings from the literature, a general rule for pedestrian route choice is 'directness'. That is: unless they are hindered by obstacles, pedestrians will walk in a straight line towards a visible destination (Daamen, 2004; Helbing, 1997). Closely related to this, pedestrians are expected to take the shortest route or path of least resistance (Bogers & Timmermans, 1986; Guo & Hang, 2011; Hoogendoorn et al, 2002). However, in some occasions passengers would deviate from the direct path towards the left door and exit through the right, even if there was a small queue in front of the right door. In contrast, when a passenger would make use of it s/he would immediately attract others to follow. Helbing et al. (2005) found similar results in that people tend to follow others (herding) in situations in which the environment is unclear or unfamiliar.

The research of Lovreglio, Fonzone, dell'Olio and Fonzone (2014) shows similar results in the case of evacuation situations: decision makers are more likely to show herding behavior if the least crowded exit has no people in it. They too suggest this is caused by uncertainty, and people can think the congested exit is the only one that is available. Hence it is argued that social validation plays an important role in route choice. The absence of customs officials at this doorway may also be an important factor for uncertainty.

If the cycle time was short enough, people would still join in the queue. This is aligned with Helbing (1997) who found that people will prefer the direct route above the longer path, until it is around 75% of flow capacity. The cycle time or flow capacity has not been measured, but apparently there is some sort of queue treshold that passengers are willing to accept.

5.1.6 - Limitations of the research

On friday the 21st there was a storm, which cancelled flights as a result. It is impossible to say if- and how this has had any influence on the results.

Within the research it was not possible to determine what exactly is 'the treshold' for people to opt for the alternative route.

The sign displays that were used in the experiment were suboptimal, as they are only 80cm in hight. During peak hours passengers that waited in front of them might have limited the result by blocking the view.

5.1.7 - Conclusion and suggestions for iterations

The first results of the field experiment show that it is indeed possible to use behavioural design interventions to alter passenger flow. However, considering this increase was achieved with just a roll of duct-tape and four posters it shows to be an interesting lead.

Time did not allow to make iterations. The following suggestions are made to improve its effectivity:

- The signage should be placed higher above the ground, so people will not block the view on it.
- The message 'quick exit' caused confusion during off-peak hours. 'Skip the queue' is more appropriate. Ideally it would only be visible when it starts to crowd, e.g. by making use of a combination of sensors and SDD's.
- If there is no customs official present, which is usually the case, many passengers do not seem to be aware (or sure) that they can exit through the left door. It might be an idea to place a sticker of the arrival hall on the sliding doors.
- Passengers are not looking for a place where they "will not declare something", but for an exit point. The exit sign is oriented perpendicular to left door, so it is not visible for passengers that approach it from the front (fig. 47). It might be an idea to rotate the sign 30-45 degrees so it will become visible from both the front as the right.

- **Fig. 47 - Front view of the left exit.**

5.2 CONTINUATION

From the 3rd quarter of 2018 up to and including 2019 the PX department focuses on improving the passenger experience within the 'mini arrivals'. Within this time period the PX department will experiment with the wait-here lines as described in chapter 4.3.1. It would be wise to evaluate the effectivity of the lines and the PRM spot separately, as they have different underlying objectives.

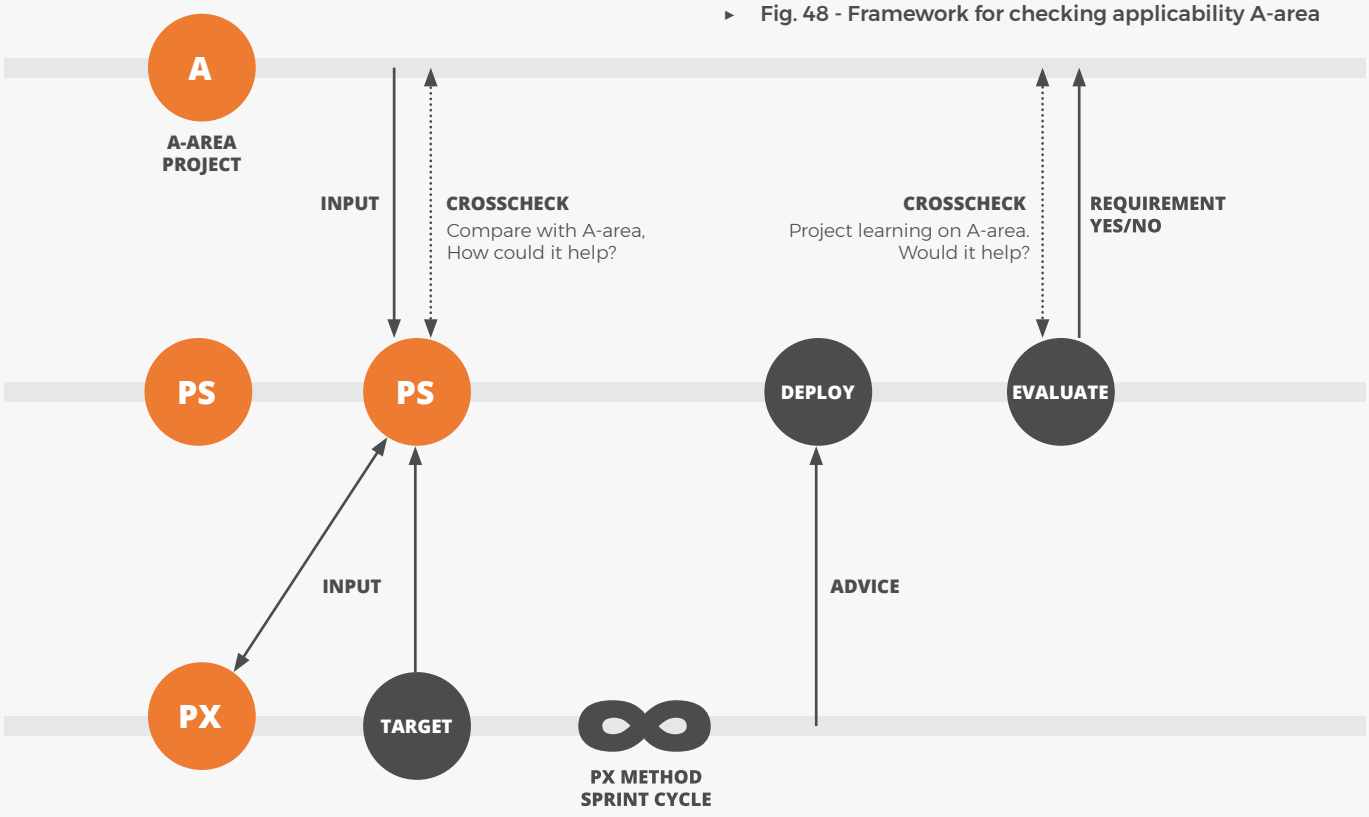
The service and process owners within arrivals are are advised to connect with the PX department, because they are the bridge between the current facilities and the A-terminal. When experimenting with improvements within the reclaim areas, thought should be given to:

1. similarities with the A-terminal.
2. its potential for improving passenger flow and distribution, both in current areas as the A-area.

It is important that there will be a feedback loop from the owners back to the A-terminal project so that, if proven succesful and desirable, it can be included as a requirement for the interior design. Figure 48 proposes a framework for these projects.

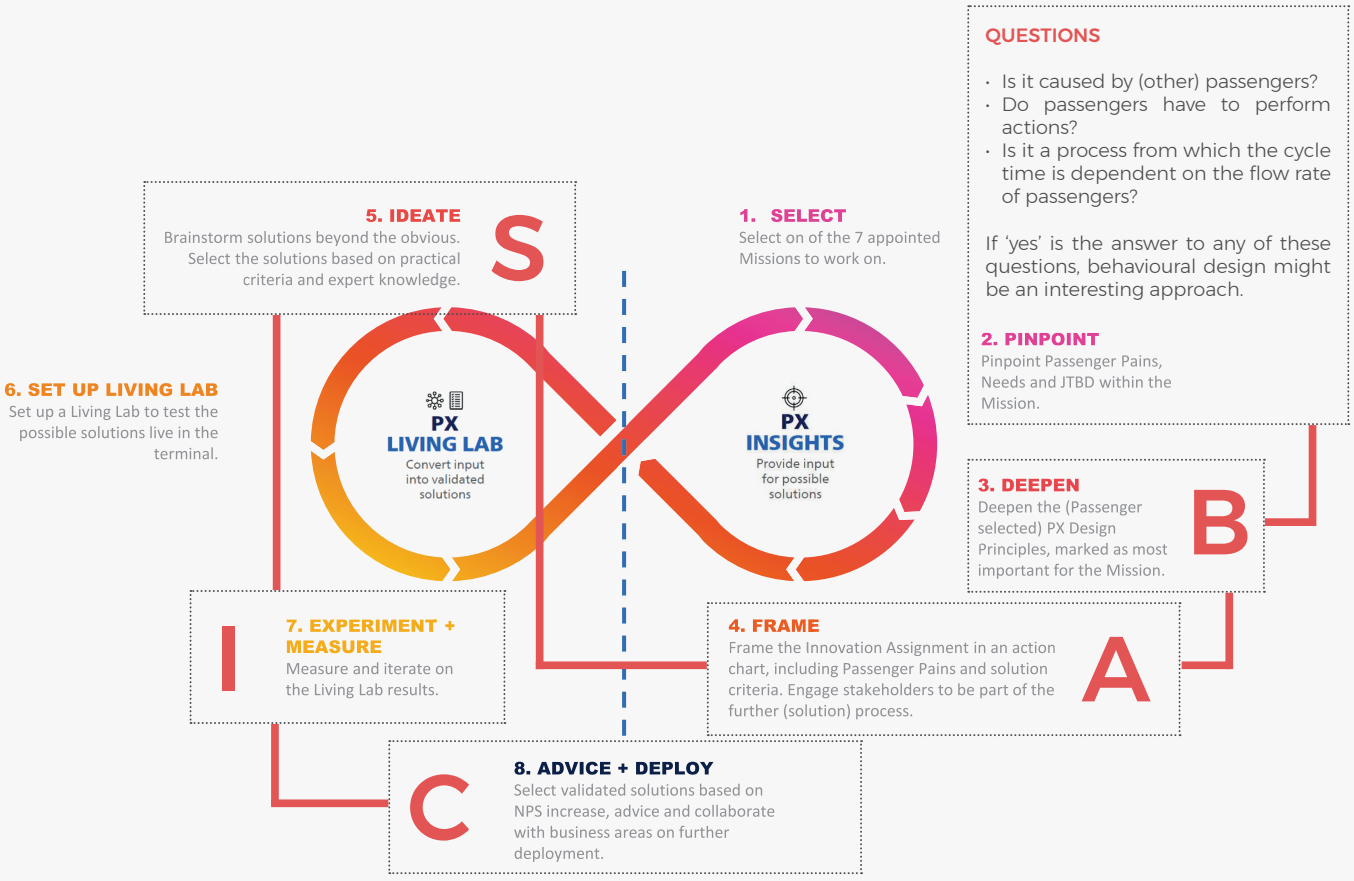
The research in chapter 2.5.3 showed that passengers are not always aware of the facilities that are present. Very salient electrical charging points might be able to function as an attractor. After which, there should be an evaluation on how passengers interact with it and its effect on distribution.

▸ Fig. 48 - Framework for checking applicability A-area

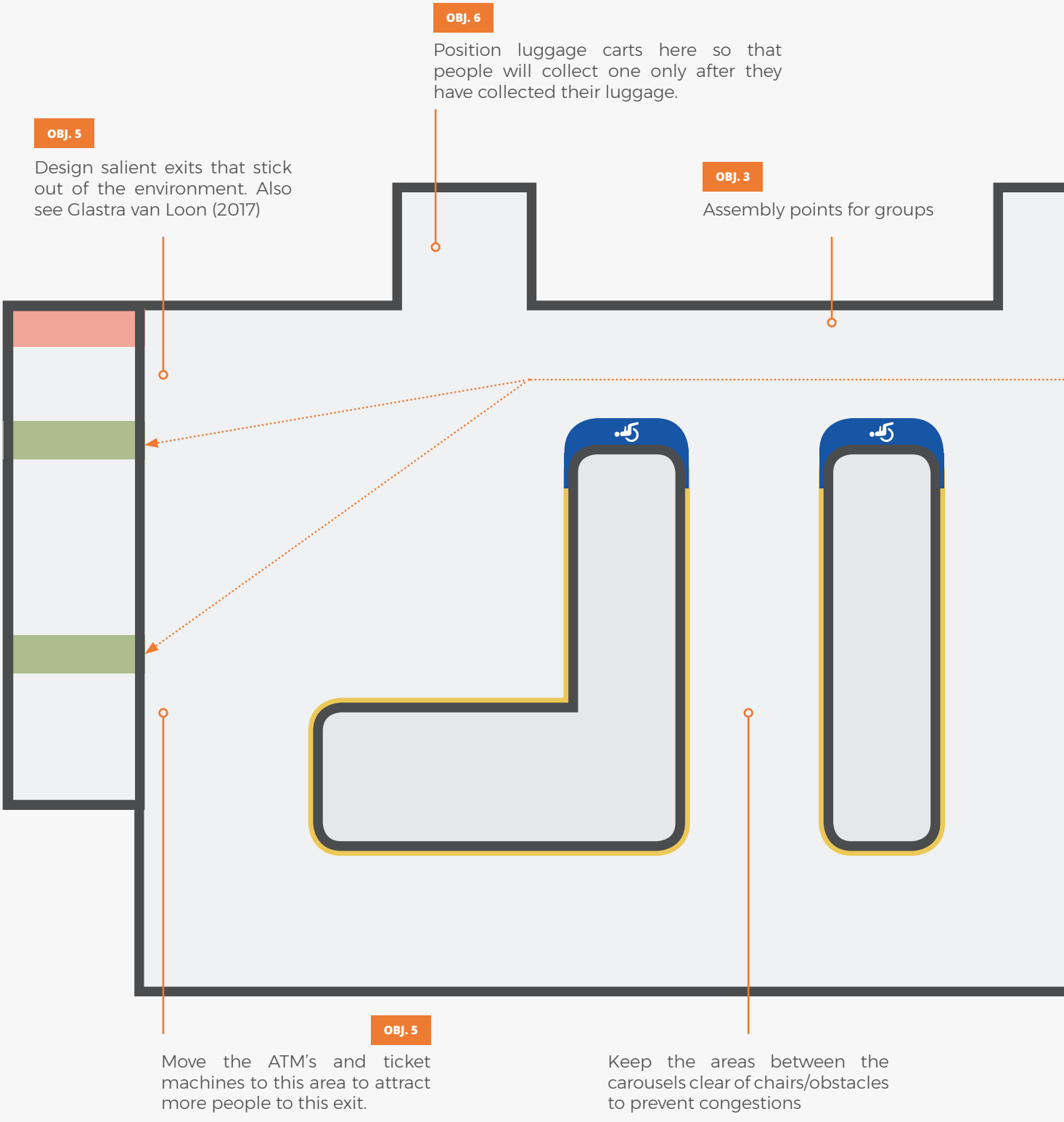


5.3 BEHAVIOURAL DESIGN HANDBOOK

The AAS Behavioural Design Handbook can act as a guide for future experiments with behavioural interventions. It summarizes the most important findings from this thesis and describes how to incorporate the BASIC approach (Hansen, 2018) within the Schiphol PX method. It can be found in appendix I..



5.2 NUDGING CONSIDERATIONS IN THE A-TERMINAL RECLAIM

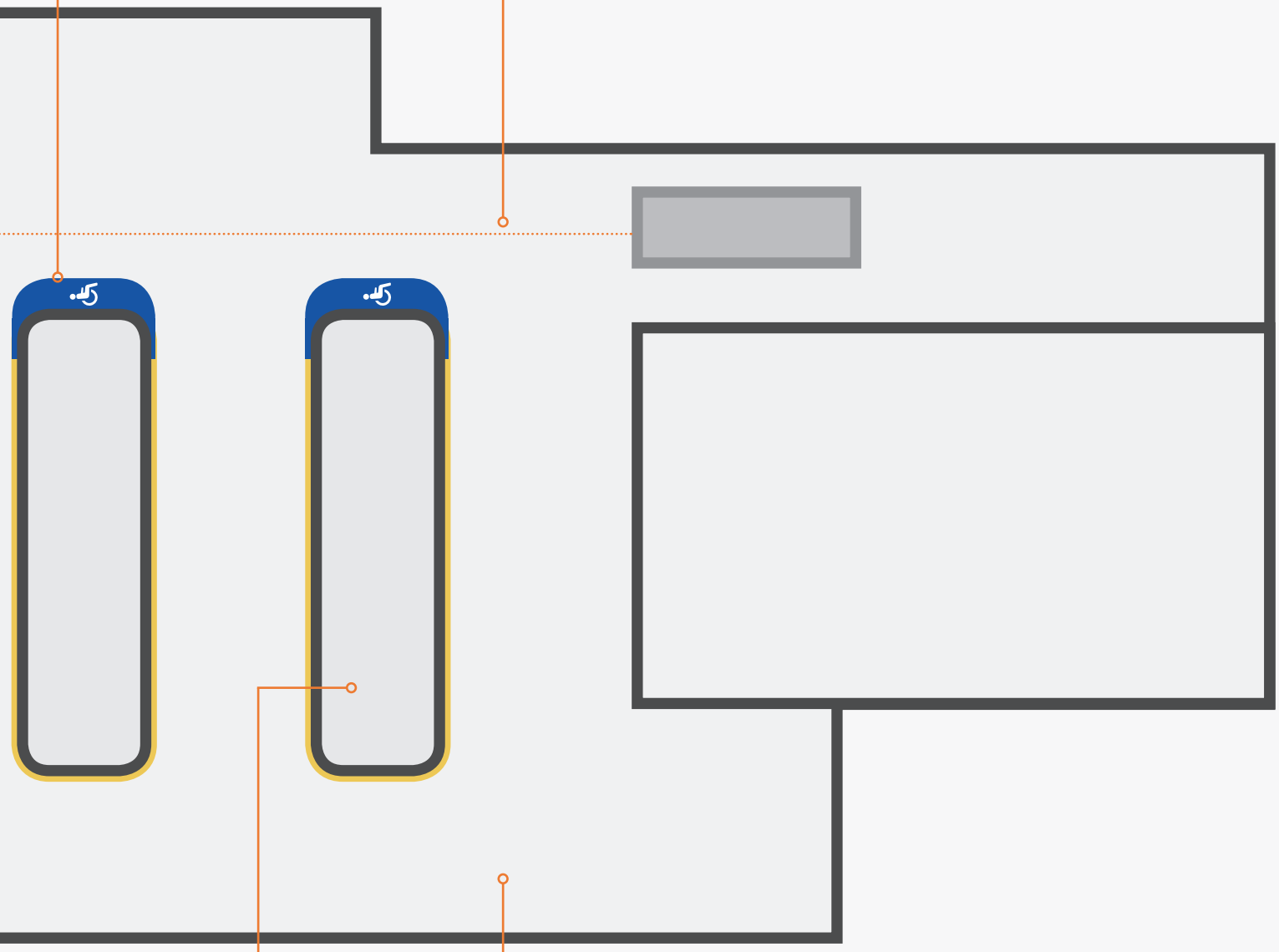


OBJ. 1

Keep the top-end of the carousel clear of accumulating passengers by making it a social norm. It also becomes easier for PRM (assistents)

OBJ. 5

Keep these trajectories free of obstacles to minimize directional change and keep the path length short to both exits



OBJ. 2 OBJ. 3

Use the positioning of the ejection point as attractor. Testing the effects of the location of the ejection point on passenger distribution can be done in reclaim area 3.

OBJ. 3

Place seating facilities and salient electrical charging points at the facade to attract more people to walk down the carousel.

Section 6| **DISCUSSION, CONCLUSION & RECOMMENDATIONS**

This chapter includes:

6.1 DISCUSSION

The purpose of this graduation project was to explore if- and how Amsterdam Airport Schiphol can apply nudging in order to smoothen the course of events in the reclaim area of the A-terminal.

Since the A-terminal is yet to be built, the research started with combining literature studies on pedestrian movement and behaviour with observational studies in the existing infrastructure. The observations that were made concerning the positioning and movement of passengers within the current reclaim areas accurately reflect what could be expected based on the insights from the literature review. Although not specifically (dis)proven in this thesis, it seems that applying these rules of thumb on floor plans is suitable for making predictions about bottlenecks caused by human behaviour.

Most passengers prefer the shortest route towards their goal, and are primarily concerned with their own relative position instead of having a collectivist mindset. Avoidable instances of crowding and congestion were found that were a direct outcome of passenger behavior in the environment. Aligned with the findings of Helbing (2005), it gives to show that most pedestrians do not actively reflect on their behavior. Passengers operate on an automatic level and give little thought about their route choice and/or positioning. This is especially visible in phenomena where groups of waiting passengers congest the main routes. It leads to a suboptimal passenger flow, usage of space and resources. Therefore it is argued that when designing a (public) environment, there will be a mismatch between theoretical and practical capacity when human behavior is not accounted for.

The thesis proceeded by proposing multiple behavioural design interventions that have the potential to mitigate or prevent crowding. By means of a field experiment one of those interventions was tested and validated. The first results suggest that nudges are indeed capable of steering passenger movement and path choice.

It was found that the ability of interventions to alter pedestrian flow is somewhat limited. Route choice is subjected to other strong subconscious mechanisms and contextual factors such as social proof. Aligned with Helbing (1997) it was found that even if the direct route is becoming congested, passengers are relucant to take the detour. Only once enough passengers would accumulate the group would split into two separate passenger flows. This shows a match with the research of Dyer et al. (2008), who found that within large groups of people, it only takes a small minority to redirect the crowd. So although nudges might not be able to prevent this congestion from happening, at the very least it can help to resolve it more quickly.

Aligned with Nikolopoulou et al. (2015), it was found that the intervention had a more noticable effect (odds ratio) when it was not very crowded. Logic dictates that within a more dense environment, the interventions will become less visible. However, the effect size of the intervention did not decrease between the 100-200 and 200-300 samples. It may well be that visibility of the intervention is less important than social proof.

6.2 CONCLUSION & RECOMMENDATIONS

The project started with the question if- and how Schiphol can apply nudges to shape a smooth course of events in the A-terminal reclaim area.

To answer this question, research was done on behavioural economics, nudging and the current problems passengers encounter in the reclaim areas. It resulted in an understanding about how passengers operate within the current facilities.

By projecting this knowledge onto the preliminary design of the A-terminal reclaim, probable passenger-caused bottlenecks were located. As a response to this, six behavioural interventions were proposed. Two of which were developed into more detail. Though there is a scientific foundation for all the proposed behavioural interventions, it was only possible to test and evaluate one intervention.

While it seems promising, iterations have to be made to strengthen its effect. A set of proposals for iterations is given in section 5.1.7. The wait-here intervention will be developed further by the PX department. The results of this experiment must be evaluated in order to determine if it should be a requirement for the interior design of the A-terminal.

Additional research is required to investigate whether the proposed interventions will lead to the desired behaviours and he effects on the passenger experience. It is therefore hoped for that the Behavioural Design Handbook can act as an inspiration and starting point for the continuation of experiments. Furthermore, within this thesis the focus lay on preventing crowding and congestions in the baggage reclaim. But as illustrated by the border control example in 2.3.4, behavioural design can also be useful to speed up processes. Time critical process steps where human behaviour is the key determinant for cycle time seems a very promising area for experiments and innovation for AAS. Top-of-mind applicabilities next to passport control are ‘getting ready for security checks’, boarding and self-service drop off points.

6.3 PERSONAL EVALUATION

I vividly remember the first weeks of my internship at Schiphol, were I came to conclusion that formulating an own assignment is way harder than it sounds. Constantly doubting whether it is the 'right' one, whether it is relevant, etcetera. During the first meeting with the supervisory team my scope was way to broadth and we had to narrow it down. By now I can say this project was officially the opposite of what I had in mind during my first contact with Schiphol - and I believe it was for the better. I am satisfied with the end result and am very delighted knowing that some ideas will actually be tested at Schiphol.

This project has given me the opportunity to acquire a whole lot of new knowledge on human behaviour and nudging. I loved doing the observational research and see the theories happen in practice. I will almost certainly continue exploring the applications of nudging in service design during my professional life.

During the project I learnt about bureaucracy the hard way. Getting permission to do the video observations costed me almost 1,5 months. Therefore I am really grateful for all the help that I got from my colleagues at OPS .

Being a designer I am used to work in project teams. It was frustrating to see how little progress is made when working mostly on your own. Usually I like to be the one that sets out the course and is plotting the broad strokes without paying too much attention to the details in it. As such, writing down my findings was quite a laborious task for me. At moments it was quite hard to keep myself organized. This was especially the case doing the literature review at the start of the project. I would read half a paper and then switch to another, without noting down what was in it or where I got it from. It has cost me a lot of time to retrace some papers. Next to that, I really missed the energy that I get from teamwork.

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APPENDICES

6.5 APPENDICES

A - Persona's Schiphol
B - Questionnaire
C - Video transcript
D - Empathy map
E - Creative session
F - Ideas
G - Experiment card
H - SPSS Output
I - Handbook

A. PERSONA'S SCHIPHOL

Aziaten
2010: 8% van passagiers komt uit Azië en Midden-Oosten, grootste deel uit China; groeipotentie tot 16%

Key insights
- Belangrijk: familiebanden, **groepsgevoel** en eigen cultuur
- Sterke voorkeur voor **high value (luxury) brands**
- Gevoelig voor **gezichtsverlies**
- Onzeker vanwege de **taalbarrière**
- **Zeer beleefd**, willen ook zo behandeld worden

Generatie Einstein
2010: 14% van de passagiers is jonger dan 26 jaar; deze groep wordt in de toekomst een van de grootste groepen

Key insights
- Initieert veranderingen: '**Power to the people**'
- Continue **interactie** via internet, mobile en social media
- Snel en dynamisch: '**latest best practices**' direct bruikbaar
- **Kiest zelf** en heeft hoge mate van **zelfredzaamheid**
- Belangrijk: **functioneel design** en **authenticiteit**

Business / premium
2010: 30% van de passagiers vliegt vaker dan vier keer per jaar met een zakelijk motief; de groepsgrootte zal stabiel blijven

Key insights
- Frequent flyer
- Belangrijk: **snel**, **betrouwbaar** en **compact** proces
- Voorkeur voor **comfort**, exclusiviteit en rust
- Must: een (werk)plek met **internetconnectie** en elektriciteit
- **High demanding** en onafhankelijkheid in opereren

Ouderen
2010: 10% van de passagiers is ouder dan 60 jaar; Deze groep zal verder groeien i.v.m. vergrijzing

Key insights
- Belangrijk: **gemak** en **persoonlijke service** (niet tegen hoofdprijs)
- Wens: **meer zorg, zekerheid** en **begeleiding** (vanwege leeftijd)
- Goed geïnformeerd en zeer **(prijs)kritisch**
- Hebben doorgaans **veel tijd en geld** te besteden

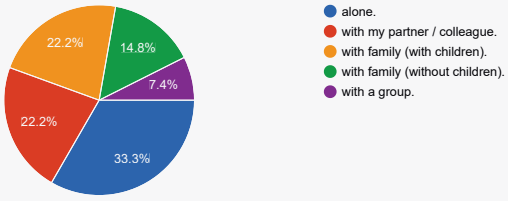
Groepen / familie
2010: 20% van de passagiers reist met 3 personen of meer; de grootte van deze groep zal stabiel blijven

Key insights
- Belangrijk: **voorspelbaar**, **betrouwbaar** en **compact**
- Willen als **groep** bij elkaar blijven, ook tijdens het proces
- Faciliteiten ingericht voor **families** (entertainment, playgrounds)
- Willen zo snel mogelijk **bagage** afgeven

B. QUESTIONAIRRE

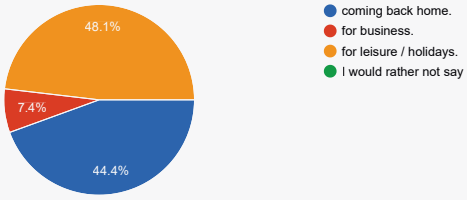
I'm travelling...

27 responses



I flew to Schiphol...

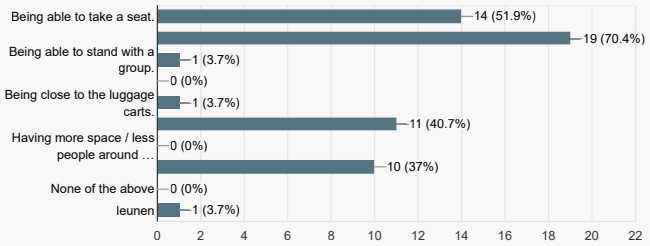
27 responses



Waiting for your luggage

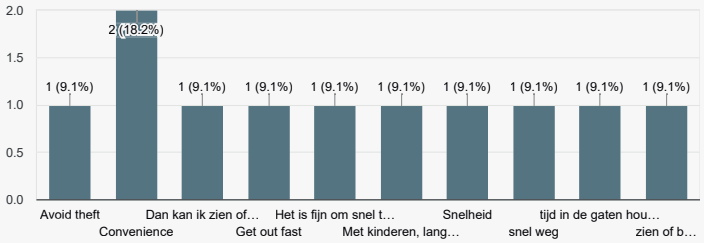
On what aspect(s), if any, did you select your spot to wait in the reclaim area?

27 responses



Can you indicate why these aspects are important to you?

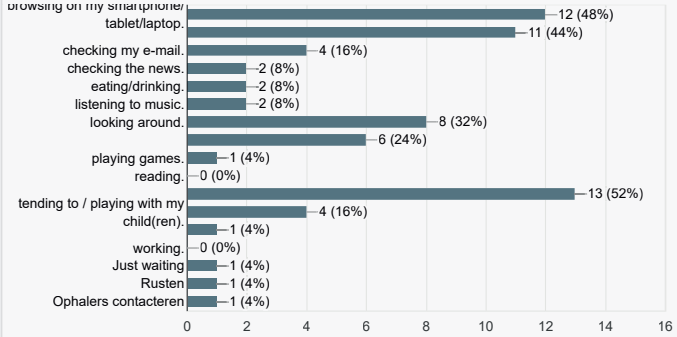
11 responses



Waiting for your luggage

Within the reclaim hall, I spend my time waiting by... (multiple answers possible)

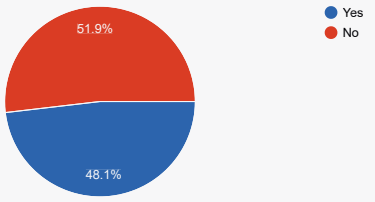
25 responses



Distraction / entertainment

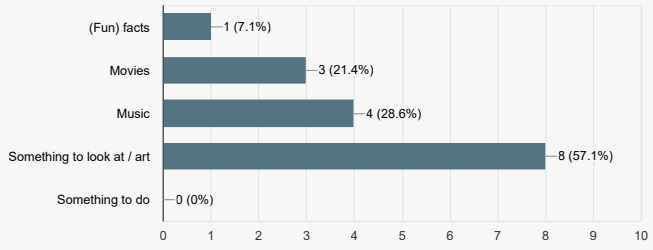
Would you like to have access to distraction / entertainment in the reclaim area?

27 responses



If 'yes', what kind of distraction / entertainment would you like?

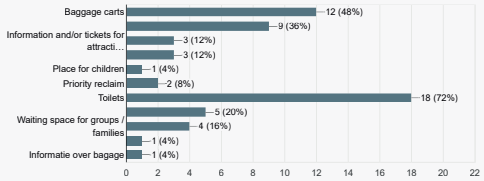
14 responses



Facilities in the reclaim area

To what facilities would you like to have access during your wait?

25 responses



Is there anything else that would make your stay more comfortable?

5 responses

Telling updates about delays and why

a standing table

betere stoelen/bankjes

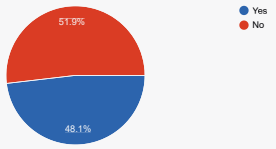
goede uitleg waar bagage blijft

benches not really convenient

Issues and irritations

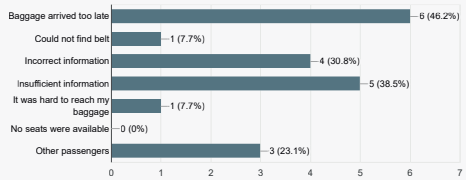
Do/did you experience any issues or irritations in the reclaim area?

27 responses



What kind of issues/irritations did you experience?

13 responses



If so, can you elaborate on what the issue was?

8 responses

Not too late but its taking a lot of tile >15 min, first time waitimg (2)

Bagage kwam niet al stond er dat eerste bagage gelost was

One baggage was missing but arrive late. So there was no a problem at the end

bagage kwam later

waarom staat iedereen altijd tegen de band aan? grote irritatie

staan in de weg, konden niet goed zien of onze koffers kwamen

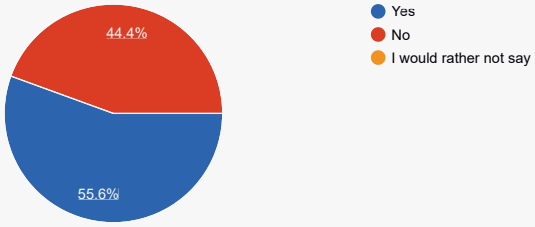
Staan zeker al 30m te wachten zonder uitleg

Wrap-up

Wrap-up

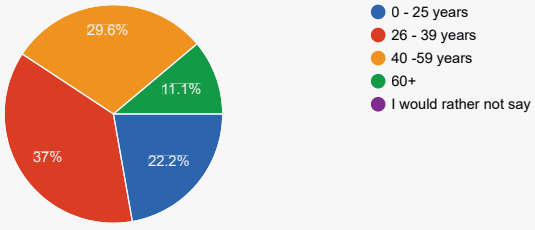
Do you have the Dutch nationality?

27 responses



Which age-category applies to you?

27 responses



Thanks!

C. EMPATHY MAP

Think

- Unfair that others have their bags earlier
- Why is this flight offloaded?
- Tired and annoyed
- Confused / uncertain
- It's 'grey'
- It's alright if it doesn't take too long
- 'Minste wat je kunt doen is ons laten weten waarom, nu sta ik hier maar te wachten. Daarom pak ik meestal

Hear

- Beeping noise of the carousel
- Surrounding sounds
- Hearing baggage drop
- Crying children
- Other pax talking/complaining
- No updates about status, when asking a handler: 'Delay? Ha, it happens all the time.'
- Listening to music

Say

- "Schiphol is really slacking these days"
- "God may know where our luggage has been"
- "This is NOT a warm welcome"
- Sit/lean on everything
- "My battery is almost out"
- Buying train tickets after collecting luggage
- I have been waiting for (...) minutes, where is my bag? = unexplained waiting time
- "I might have grabbed a coffee in the lounge if I knew up-front that I would have to wait more than ten minutes in this area."

Do

- Pick a spot and stay the
- Sit on baggage cart
- Check screens
- Contact family and frien
- Plan follow-up journey
- Where is the exit?
- Where is the train?
- Where is my carousel / i
- Wait for other group m
- Stand next to other pas
- 'Ik woon in Milaan en vl

Pains

- Incorrect expected waiting times and not being updated pro-actively about baggage status during irregularities makes passengers unsure.
- Having no view on the bags on the carousel.
- Other passengers that are blocking the path and causing congestions
- Not enough seating facilities
- No 'priority-reclaim'
- Have no knowledge about what is happening with the luggage
- Wait multiple times in a row
- News is in Dutch

& Feel

regionale luchthavens, dan heb je dit gedonder niet.'
- 'Duurt wel lang he'
- 'Nou, waar dan?!' - all baggage offloaded
- How much time do I still have to wait
- 'What happened to my luggage' anxiety
- My telephone is almost empty, and I need to plan my follow-up journey
- Others make it difficult to reach my baggage

& Do

ere

nds / telephone

is this the right one?
embers
ssengers
ieg tweewekelijks,

See

- The SDD shows that 'All baggage offloaded', while no baggage is being offloaded.
- Flight goes off the screen
- Cannot find handler
- Advertisements / news on the SDD's
- That belt is empty, this belt has 3 flights
- Difficult to see own baggage coming because of others
- Flight goes off the screen
- See baggage in the corridors
- "Weet je gelijk hoe hier met bagage wordt omgegaan" (baggage in hallways)
- Opstoppingen bij de carousel
- Only see information when at that spot
- See others exiting
- Later flight offloaded earlier

vergeleken met andere luchthavens is Schiphol een paradijs.'
- Move in to the carousel once the sound goes off
- Walk to the other side of the carousel
- Ik vind het belangrijk om snel bij mijn bagage te komen als het erop komt.
- Ik wil graag rust hebben
- "Is this an exit?"
- If passengers have to wait for a longer period of time they can be seen sitting/leaning on every object that is available, even the reclaim belt itself.

Gains

- More charging points for electrical devices
- More seating facilities and better adjusted to the passenger segment / travelling party
- Early information provision to reduce uncertainty (and real-time)
- Refresh after a long travel
- Having ample space to move and breathe
- Spending time in an efficient manner
- Let handlers update about baggage process pro-actively
- Show who is responsible for which flight and where they are located
- 'Digital' waiting lines

D. VIDEO TRANSCRIPT

Analyse Time Lapse reclaim

RQ: hoe bewegen mensen om de band
Letten op:
- Mensen met kar bewegen niet meer nadat ze een plek hebben gekozen
- Aankomstzijde drukker
- Kar naar kortste route
- Ankerpunten scherm/uitgifte
- Onproductieve mensen
- Domino-effect

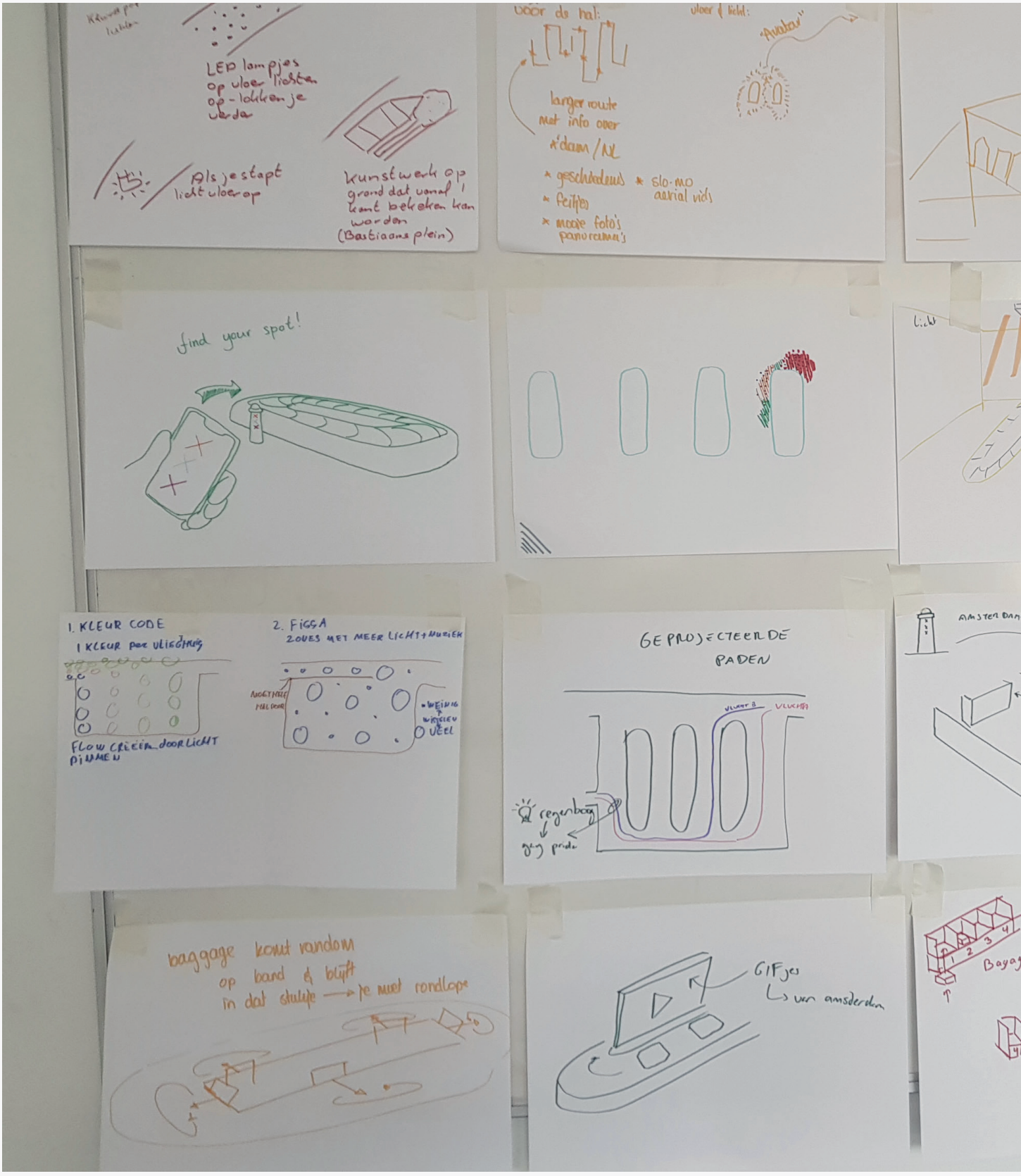
0:00
Camera wordt opgehangen (rond 8:15)
Vooral druk aan rechterzijde.
Er staan 3 mensen met bagagekarren, allen rechterzijde.
Man met draagzak kind op zijn rug (Man-B) staat met bagagekar +/- 2m van band.
Een baxkar is tegen de band geplaatst rechts van uitgiftepunt.
0:10
Man pakt koffer af, loopt naar vrouw (die +/- 1.5 m van band stond te wachten met bax)
Een aantal mensen is bezig koffers te herpakken/op karren te plaatsen.
Op te merken is dat er niemand bij het uitgiftepunt staat. Er zijn 2 clusters aan beide zijden +/- 2 m van 5 pax.
Vier mensen staan op de punt
Een man (Man-G) die eerder in het rechtercluster zat loopt naar het uitgiftepunt
0:20
Man-G staat tegen band aan, heeft kar +/- 1m achter zich. Andere pax hebben min of meer niet bewogen.
2 pax (Stel-R) herpakken bagage bij rek bagagekarren
0:30
Carrousel aardig volgelopen met bagage die nog niet wordt afgepakt dus stagneert een beetje. Er staan 22 mensen om de band verdeeld in 3 clusters (punt, uitgifte rechts-links/rechts+2m.) Één pax staat aan overzijde, één pax staat met kar meer richting rechterhoek.
0:40
Man-G die naar uitgiftepunt ging heeft zijn bax, draait het in één keer op kar achter hem.
Zijn plek is vrijwel direct ingenomen door Man-R die aan komt gelopen vanaf KMAR2.
Een vrouw (partner?) die hem volgt gaat naast hem staan met handbagage. Man-G pakt nog een koffer en zet hem op bagagekar die vast wordt gehouden door Vrouw-G.
Man&Vrouw-G lopen nu weg van de band, 3 bax op kar, 1 bax door vrouw gesleept.
Er komt een nieuwe groep aan (groep-B) Zij gaan op linkerflank punt staan.
Man en Vrouw-Z hebben lopen beiden naar band.
Man-Z geeft bax aan Man-B.
0:50
Man-R blijft voor uitgiftepunt staan. Vrouw-R-links naast hem met 2 bax. Andere clusters zijn nagenoeg hetzelfde gebleven. Cluster punt lijkt een bij elkaar horende groep te zijn. Ze verzamelen hun bax (0:55)
Stel-R loopt nu weg van de bagagekar opstelplaats.
Man-Z pakt koffer, loopt naar bagagekar. Vrouw-Z pakt koffer, loop naar baxkar.
Man-B loopt naar uitgiftepunt.
1:00
Man en Vrouw-Z schikken hun baxkar op eerdere positie baxkar.
Groep-B nemen hun bax en lopen weg.
Man-R staat nog bij uitgiftepunt.
Man-B pakt bax. Legt bax op baxkar rechts van uitgiftepunt.
Man-R pakt bax
1:10
Man-Z en Man-B schikken bax op baxkar rechts van uitgiftepunt.
Man en Vrouw-R praten.
1:20
Man en Vrouw-R lopen weg.
Man-B, Man- en Vrouw-Z en een vierde pax lopen band af richting KMAR3.
Er staan nu nog twee clusters van plusminus 5 pax tussen punt-uitgifte aan beide zijden.
Man-O uit cluster links pakt bax en zet deze neer. Vrouw-O neemt hem mee. Ze lopen band af.
1:30
Cluster links 'lost nu op'. Een duo pax pakt bax en loopt richting douane.
Man-O pakt nog een bax. Man en Vrouw-O lopen richting douane.
1:40
Rest van Cluster links gaat verder van de carrousel afstaan.
Man-P met handbax komt in beeld en loop richting carrousel. Loopt vervolgens een meter of 4 van de band vandaag t.h.v. uitgifte-rechts-rechts.
1:50
Cluster links loopt uit beeld richting douane.
Er staan nu nog 5 pax in cluster rechts die nagenoeg niet hebben bewogen sinds start opname.
Man-P laat handbax staan, loopt zelf richting band. Houdt 50cm afstand.
Vrouw-W pakt koffer, zet op baxkar.
Vrouw-H komt in beeld. Pakt baxkar en zet handbax op baxkar.
2:00
Het is rustig, er staan 7 mensen te wachten (allen rechterzijde). Valt op dat 4 van hen tussen 15 en scherm/uitgifte staan. 2 mannen sta na het uitgiftepunt +/- 50cm van de band. Vrouw-H pakt handbax van Man-P, staat met kar ongeveer 3 meter van de band. Zij loopt met de kar naar het uitgiftepunt. Zij pakken hun koffers en herpakken het vlak voor het uitgiftepunt op de plek waar ze al stonden.
Vrouw-W verrijdt baxkar naar voor uitgiftepunt, daar staat nu 2 rijen dik baxkar.
2:10
Er komt een stel aan met 2 trolleys, handbagage ligt er al op. Ze lopen via rechterzijde.

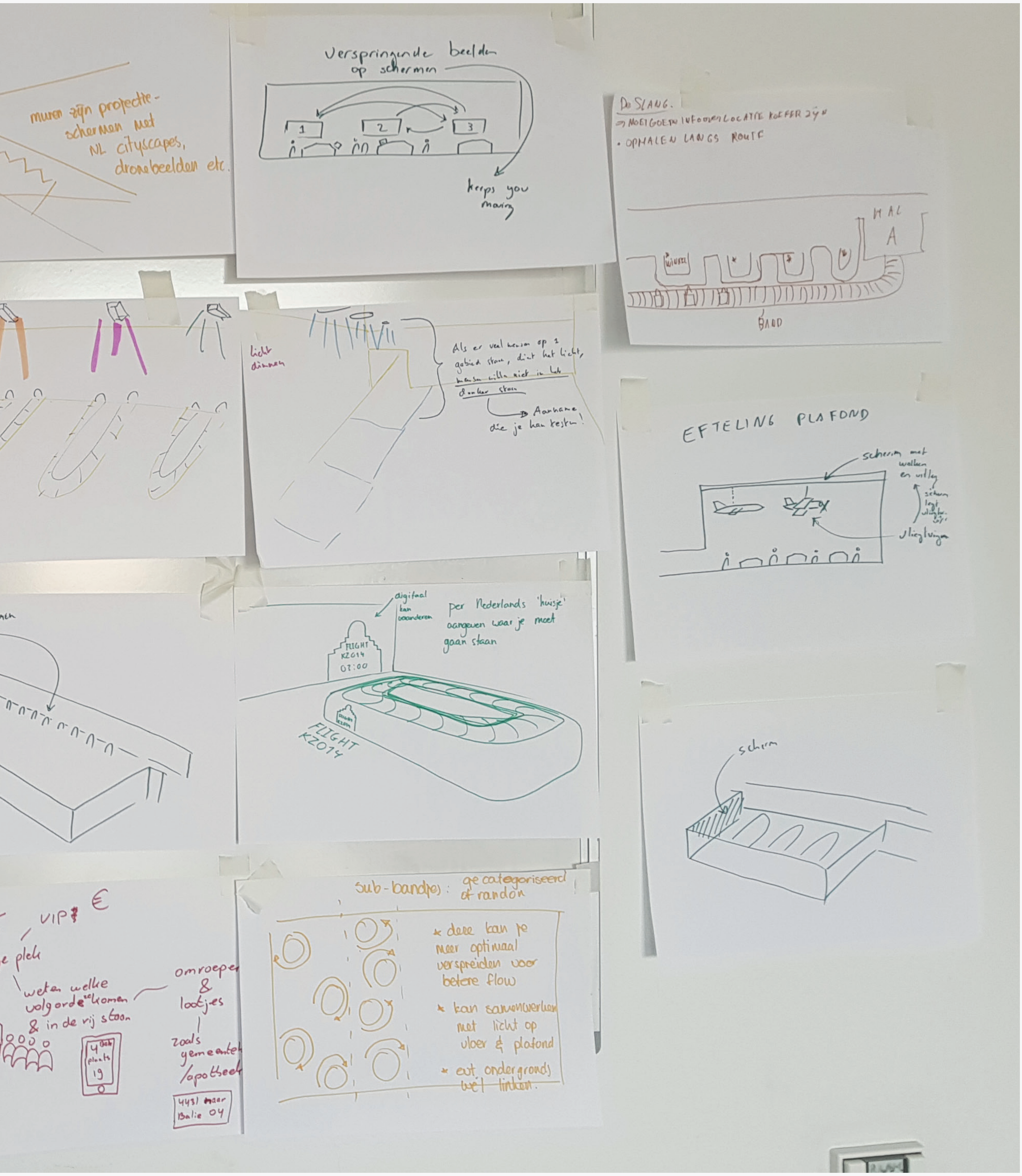
Bagage lag al op band, lopen weer weg met bax.
2:20
Man-P en Vrouw-H lopen met baxkar richting douane.
Duo vrouwen uit cluster rechts loopt weg uit beeld richting douane, zij hebben géén bax afgepakt van carrousel.
2:30
Nieuw duo arriveert bij band, Stel-O.
Nieuw duo arriveert bij band, Stel-J. Kijken naar scherm.
Vrouw-W wacht nog met baxkar 2m voor uitgiftepunt.
Rond deze tijd komen enkele pax naar band waar bax al ligt, lopen direct na afpakken richting douane.
2:40
PRM met begeleiding arriveert. Staan links van uitgiftepunt.
Stel-J loopt richting bankjes. Vrouw-Stel-J pakt baxkar.
Vrouw-W loopt met Kind-W weg van uitgiftepunt, op zelfde lijn maar nu bij punt 15.
2:50
Stel-G loopt naar overzijde carrousel.
Stel-J staat +/- 5 meter van band vandaan. Leunen op baxkar.
PRM staat op zelfde plek.
Begeleider pakt bax PRM.
Jongen-R arriveert. Gaat staan rechts van uitgifte, legt daar ook handbax neer tegen carrousel aan.
3:00
PRM en begeleider gaan richting douane.
Vrouw-Stel-J loop naar band, pakt bax. Man-Stel-J blijft bij baxkar.
3:10
Stel-J verrijdt baxkar naar stoelen. Man-Stel-J gaat zitten. Vrouw-Stel-J loopt weer richting band.
Jongen-R pakt bax.
3:20
Er komen 2 pax aan. Gaan staan tussen punt en uitgiftepunt.
3:30
Jongen-R loopt richting KMAR 3.
3:45-4:15
Carrousel bijna leeg, 2 jongens wachten tussen punt en uitgifte.
Een pax pakt een baxkar, neemt hem een stukje mee. Loopt weer terug en parkeert hem naast het vak. Loopt uit beeld (N.B.: deze pax komt later niet meer terug)
Jongen gaat zitten op rek van karrenplaats, andere jongen staat erbij. Gaan op telefoon zitten.
Andere jongen gaat op kar leunen die was achtergelaten.
4:15-4:30
Er komen veel pax aan die koffers pakken die al op de carrousel lagen. Algemeen beeld: Er is veel ruimte en het is een komen en gaan van pax. Veel lopen direct naar bax (met de stroom van de carrousel mee). Er staan vier baxkarren geparkeerd, allen aan rechterzijde. De baxkar die eerder neer was gezet bij karrenplaats is verlaten. Een groep reizigers (Fam-K) hebben hun drie baxkarren plusminus 1m voor de band gezet tussen punt en uitgifte. Zij lopen er zelf voor en vullen hun karren met bax die langs komen. Kind zit in baxkar.
4:30-5:00
'Wees'-baxkar is nu gepakt door een ander persoon. Die loopt eerst met kar richting scherm, loopt vervolgens naar overzijde carrousel naar uitgiftepunt. Loopt vervolgens weer terug t.h.v. uitgiftepunt rechts op linkerflank. Verdwijnt uit beeld doordat een pilaar het zicht ontneemt.
5:00
Band bijna leeg.
Fam-K loopt richting douane.
Man-Z leunt tegen rek baxkarren, zit op telefoon.
Nog maar één baxkar beschikbaar op opstelplaats.
5:20
Eerste 4 mensen staan links van uitgiftepunt. Twee mannen staan al tegen de band aan bij uitgiftepunt rechts. De andere pax staan +/- 1 meter van de band vandaan.
De ene (vrouw) zit op telefoon, de ander (man) kijkt rond. Een iemand leunt tegen karrenrek. Iemand zit op eigen koffer te wachten tegenover uitgiftepunt van rechts, linkerflank. Het is rustig, wel zijn er stromen mensen vanuit het KMAR3 filter die langs band 15 naar de douane lopen.
Man die tegen rek leunde pakt bax en loopt richting douane.
Vrouw-J kijkt naar bagagerek, kijkt naar man die vertrekt, gaat leunen tegen het bagagekarrenrek, zit op telefoon.
5:50
Jongen-G met baxkar loopt via linkerflank naar man die op bagage zat. Zij laden de bax op de kar.
6:00
Man met 'wees'-baxkar komt achter pilaar vandaan, nog geen bax. Gaat op linkerzijde punt staan.
Vrouw van 5:20 loopt nu met telefoon uit beeld (N.B.: zij was aan het bellen, zien gebeuren). Komt een nieuw persoon aangelopen. Strikt schoen op rand carrousel. Houdt 30cm afstand. Vrouw komt weer in beeld met telefoon aan oor.
6:30
Er komen nieuwe mensen bijstaan. Een individu gaat rechts van uitgifte punt staan.
Een tweetal jongens staat links van uitgiftepunt, 2 meter van de carrousel.
De baxkarren worden aangevuld.
Vrouw-J loopt naar pilaar t.h.v. uitgiftepunt, gaat op handbax zitten, nog bezig met telefoon.
Wat opvalt is dat een deel van de stroom mensen die uit kmar3 door de wachtende pax lopen i.p.v. achter ze langs.
7:00
Vrouw-W pakt baxkar. Rijd uit het vak, loopt langs band richting 3. Vanaf daar niet meer goed in beeld.
7:30
Familie komt aan vanuit KMar2, gaan meer richting punt staan. Vrouw loopt naar scherm om te checken
Na controle terug naar gezin.
Een deel van de pax uit KMar 3 loopt nog tussen de spatiëring van wachtende pax door richting douane.
7:45
Familie blijft op een korte afstand staan van band plusminus 2 meter bij punt vandaan.
Twee mannen die tegen uitgiftepunt stonden lopen nu naar andere kant.
Tweetal jongens beweegt nu meer richting uitgiftepunt, nog steeds 1,5m van de carrousel af.
8:00
Aan de andere kant t.h.v. uitgifte verzamelen zich nu ook meer mensen.
De twee heren die eerder tegen de carrousel bij het uitgiftepunt stonden kijken nu vanaf daar op het scherm.
Een vrouw leunt met haar voet op de rand van de carrousel.
Wat opvalt is dat de rechterzijde afstand houdt, de linkerzijde staat/leunt tegen de carrousel.
8:30
De twee jongens zijn verder naar achter gegaan, leunen nu tegen hek baxkarren.
Vrouw-J zit nog steeds op handbax bij pilaar.
Er is nog een enkele koffer op de carrousel.
8:40
Jongen van familie loopt nu naar scherm om foto te maken. Loopt weer terug.
Vrouw-J staat op en loopt weg richting kmar3, verdwijnt uit beeld.
9:10
Er zitten 2 jongens op het rek van de karren.
Er komt een PRM met begeleiding aan, gaan op punt staan.
Er is een groep mensen gevormd op de rechterpunt van de carrousel, zij houden een kleine afstand.
Gezin staat nog op dezelfde plek.
Groep van 4 individuen clustert tussen punt en uitgifte rechts (en parallel aan overzijde)
Een persoon staat rechts van uitgiftepunt (in 'stroomkant')
Man van gezin verplaatst richting uitgiftepunt.
9:30
Begeleider pakt bax van PRM, was een van de weinige overgebleven bax op de carrousel. Begeleider zet bax naast PRM, pakt een baxkar. Zet baxkar naast PRM. Loopt band af tegen stroomrichting. Pakt bax, neemt mee terug. Ze vertrekken richting douane. PRM-vrouw staat op, duwt zelf de baxkar. Begeleider loopt met rolstoel weg. Ze gaan uit beeld.
Gezin voegt zich bij man, ze houden +/- 50 cm afstand. Man rechts van hen staat op dezelfde plek, is op telefoon bezig.
9:45
Groep van rechterpunt loop nu weg, langs band richting douane. Zij hebben enkel handbax bij zich. Persoonlijke interpretatie: waren op elkaar aan het wachten (na grensfilter), niet op bagage.
10:00
Gezin is dichter tegen band aan gaan staan, ze lijken ergens naar te kijken.
10:20
Bax komen op de band.
Jongens die op rek leunden gaan nu ook naar band, rechts van uitgiftepunt rechts, ze houden afstand.
Een deel van de pax die aan de linkerflank stonden loopt nu via de punt naar rechterflank, zij gaan tussen het gezin en de jongens staan, parkeren een baxkar tegen de carrousel.
Andere pax blijven staan, een cluster van 7 personen tussen de twee pilaren vanaf punt.
10:40
De jongens gaan nu ook tegen de carrousel aanstaan.
Op te merken is dat pax die links van het uitgiftepunt blijven staan waar ze stonden en niet 'stroomafwaarts' gaan.
11:00
Band begint voller te raken.
Een gezin van 4 pax gaat op de punt staan, dicht tegen carrousel. Een persoon die achter hen liep met baxkar maakt een bocht langs hen heen.
11:20
Er komen een aantal pax aan, zij gaan tussen het gezin en uitgiftepunt staan.
11:40

Langzaam komen er meer mensen bij, zij positioneren zich aan de rechterflank. Wat opvalt is dat men links van het uitgiftepunt afstand houdt, rechts van het uitgiftepunt staat iedereen tegen de band. Een enkeling leunt op de carrousel met één voet.
Baxkarren worden tegen de carrousel geplaatst, mensen gaan naast hun baxkar staan (vaak links van de kar, zodat de kar aan hun rechterzijde staat (N.B. eigen interpretatie, een (on)bewuste actie zodat ze dan de koffer met de stroom mee van de band af kunnen halen en direct op de baxkar kunnen draaien)
Gros van de mensen (schat 80%) staat aan de rechterzijde, van punt tot 2/3 rechterflank. M.u.v. het uitgiftepunt wordt er nog niet 'dubbel' gestaan.
11:50
Bax toevoer stopt.
12:00
De jongens gaan weer op het hek van de baxkarren zitten.
Enkele mensen leunen met één voet op de carrousel. Iedereen rechts van het uitgiftepunt staat tegen de carrousel, links houdt men 50cm afstand.
12:40
Groep van punt is opgeschoven naar rechterflank, links van uitgifte. Is opgesplitst, één man uit het gezelschap loopt de band af, keert later weer terug zonder bax. Nog steeds zelfde situatie als beschreven bij 11:40, alleen is de punt nu vrij.
Een 'nieuwkomer' loopt door de wachtende pax aan de linkerzijde van uitgiftepunt rechts tegen de carrousel aan.
12:50
De nieuwkomer loopt vervolgens straks langs de carrousel via de punt naar de linkerflank. Pakt daar bax van de carrousel af en gaat richting douane.
Vrouw-K gaat op de punt staan.
13:00
Er vallen nu wat gaten rechts van uitgiftepunt. Mensen die erbij komen gaan tussen punt en uitgifte inzitten, beginnen een dubbele rij te vormen maar houden afstand.
Vrouw-K gaat een baxkar halen, parkeert deze +/- 4m van carrousel (linkerflank), loopt zelf naar carrousel t.h.v. bord 15.
13:30
Geen nieuwe bax meer toegevoerd. Meeste mensen blijven op hun plek staan.
14:00
Meer individuele pax beginnen tegen baxkar-rekken te leunen/stitten.
Nieuwe mensen vullen gaatjes op aan rechterflank. Linkerflank stabiel gebleven sinds 12:00.
Een man van punt-gezin loopt stroomafwaarts aan linkerzijde. 2 andere leden van het gezin staan voorpunt links.
14:20
Vrouw-Z benaderd band, gaat pal voor de pax staan die al stonden te wachten op linkerzijde uitgiftepunt
14:30
Baggage komt uit andere uitgiftepunt, deel van de pax loopt naar de overkant via punt.
14:40
Een groep Indiërs (?) staat met baxkarren aan de punt, tegen de carrousel aan. Twee van hen pakken de bax en zetten het op de karren. Dit wordt uitvoeriger bekeken.
15:00
Rest van PAX verdeeld zich over flanken van de carrousel, tot 2/3.
Gezin dat voor uitgiftepunt stond heeft nu bax en loopt richting douane.
Indiaas gezin vertrekt, vult één baxkar en laat één baxkar achter op de punt, 1m van de carrousel.
15:30
Plek wordt vrijwel direct ingenomen door stel dat aan kwam gelopen. De man van het duo loopt straks langs de carrousel voor de andere pax langs, gaat voor uitgifte punt staan pal voor de jongens die eerder op het hekwerk leunden.
16:00
Er staat nu een groepje van 3 pax te 'dubbelrijen' tussen punt en uitgifte rechts (eigen interpretatie: kunnen niet naast elkaar staan tussen de andere pax).
Andere pax vanaf band 15 of KMar 2 lopen om de achtergelaten baxkar.
16:30
De wachtende jongens hebben hun bax en lopen richting de douane, zij hebben tussen de 30 en 45 minuten gewacht, waarin zij zich voornamelijk bezighielden met hun telefoon. Bezetting is weer in een 'J'-vorm met zwaartepunt op rechts bij punt en net na uitgifte.
17:00
De baxkar die was achtergelaten door het Indiase gezin wordt nu meegenomen door passerende medewerkers die baxkarren vervoeren (ongeveer 7 minuten nadat hij is achtergelaten)
17:15
Man&Vrouw-I staan al enige tijd begin rechterflank. Vrouw-I stapt tegen carrousel, controleert bagagestukken. Man-I volgt. Ze blijven staan.
17:50
Man&Vrouw-I hebben bax en lopen richting douane.
Nog maar enkele passagiers over, allemaal linkerflank tussen punt en uitgifte.
18:00
Note to self: Mensen hebben baxkarren die eigenlijk niet nodig zijn, bijvoorbeeld maar één bax per kar, maar dan wel twee karren en tegen de carrousel, ruimte innemend voor 4 pax. Zie ook voorbeeld Indiase familie rond 15:00.
Nu weer erg rustig, slechts enkele pax aan linkerzijde, wel redelijk wat bax op carrousel. Paar pax zitten op de bankjes. Twee vrouwen controleren of de bagage die voorbijkomt van hen is, lopen een stukje mee en weer terug. Lijken naar scherm te kijken en te overleggen, pakken bax kar, gaan naar de andere kant, maken een rondje en lijken naar band 16 te lopen. Vallen daarna buiten beeld, vermoedelijk stonden ze bij de verkeerde band.
19:00
Man haalt koffer van band, begint hem uit te pakken (zat folie overheen). Heeft zijn baxkar en rugtas even verderop staan rechts van uitgiftepunt.
20:00
Man komt aan, loopt naar uitgiftepunt, kijkt naar scherm, gaat schoenen strikken (tegen carrousel aan). Loopt bax-stroomopwaarts om de carrousel.
Man die koffer uitpakt heeft folie van bax gehaald en loopt richting baxkar. Loopt naar prullenbak, gooit folie weg. Laat baxkar in de tussentijd staan. Komt terug en blijft wachten.
Komen weer mensen aan (een duo-B en een individu), zij gaan links van uitgiftepunt staan.
Individu gaat naar overzijde band via punt, duo blijft staan.
21:00
Folieman zet bax op kar.
Man van duo-B loopt een stukje bax-stroomopwaarts, checkt enkele koffers.
Stel-A gaat op positie punt-rechts staan.
Folieman loopt weg met baxkar.
21:30
Er staan nu mensen op de achterhoeken, kwamen vanuit kmar3
Mensen houden 40-50 cm afstand van carrousel
22:00
Aankomend cluster mensen gaan t.h.v. punt staan, rechterflank
In dit cluster komen Man-B en vrouw-B aan. Zetten handbax neer. Vrouw-B gaat uit beeld. Man-B gaat met bax dichter naar carrousel.
Mensen die nu aankomen gaan vaak 'stroomopwaarts' naar de andere zijde
Op vrouw van duo-B na wacht iedereen op 50cm afstand, alleen zij staat tegen de carrousel (uitgiftepunt r)
22:30
Man-B pakt bax van de carrousel.
Een tweetal pax staat tussen carrousel en baxkar opstelplek een koffer te herpakken.
Een vrouw pakt een baxkar, loopt naar ¾ rechterpunt. Notitie: Dit is uitzonderlijk ver. Terugkijken leert dat zij van de KMAR3 kant af kwam, vermoedelijk staan daar medereizigers van deze vrouw.
Man-B die bax pakte op de punt en het daar neer heeft gezet, haalt nu baxkar.
Vrouw-M probeert een baxkar te pakken. Man-B doet het haar voor. Pakt baxkar.
Vrouw duo-B loopt weg.
23:00
Man-B laadt bax op kar. Vrouw-M loopt naar overzijde uitgiftepunt links.
Man-B blijft wachten op punt-rechts positie. Leunt op baxkar, 1,5-2m van carrousel.
'Ouder' stel staat tegen het hekwerk te wachten.
Er is een rijtje van pax gevormd aan de linkerzijde, vanaf uitgifte tot punt.
24:00
Man duo-B pakt bax.
Vrouw-B benadert band 15 van andere kant, Man-B gaat er naartoe en ze lopen samen uit beeld.
Opnieuw lijkt iedereen afstand te houden behalve duo-B. Zij staan tegen het uitgiftepunt. Er is meer spreiding dan eerder, van punt tot punt aan de rechterzijde met tussenstukken van 2-3m en een cluster bij uitgifte links.
Twee mannen met baxkarren gaan naast elkaar staan tussen punt-uitgifte rechts.
24:30
Een man pakt bax en loopt weg met baxkar.
Vrouw-J is op de punt gaan staan.
Ouder stel staat nog tegen hekwerk, kijken wat om zich heen.
Meisje-W staat op 'puntpositie rechts'.
Overgebleven man die met baxkar stond loopt naar het verre uiteinde van band 15, daarna niet meer te volgen.
Man duo-B heeft ook tweede koffer gepakt. Het duo loopt uit beeld richting douane.
Notitie: deze koffer was ook zwart, maar lijkt niet op de koffer die hij eerder controleerde rond 21:00.
25:00
Mensen blijven aankomen, gedeeltelijk vanuit KMAR3.
Rechterkant: Familie-Q gaat op punt-rechts positie staan. Jong stel gaat voor uitgiftepunt staan. Middelbaar stel ertussenin. Linkerkant staan vooral groepen mensen,

verder van de band verwijderd. Meisje-W is verplaatst naar puntpositie-links.
Vrouw-Z pakt baxkar, gaat tussen de stellen staan. Zij staat aan de rechterkant van haar baxkar.
26:00
Fam-J benadert de band. Vrouw blijft met buggy en kind in draagzak staan t.h.v. bax-kar-rek. Man loopt met baxkar naar band en verzameld bax. Vertrekken weer.
Familie op puntpositie verzameld langzaam bax.
Er staat nu niemand voor het uitgiftepunt.
Er zijn ca. 40 pax, die over het algemeen 50cm afstand houden van de carrousel
26:15
Er komt nieuwe bagage.
Er komen nieuwe pax bij (een man en een stel) die voor het uitgiftepunt gaan staan.
De man gaat direct tegen de carrousel aanstaan. Het stel volgt even later.
Mensen gaan dichter op de carrousel staan. Twee meiden staan tegen de band (rechts van uitgifte) en leunen naar voren met hun gezicht stroomopwaarts. Achter hen gaan mensen ook dichter tegen de band aan. Links van uitgifte wordt er meer afstand gehouden, m.u.v. een familie met kinderen op puntpositie links.
26:30
De mensen bij het uitgiftepunt houden nu meer afstand, ca. 50 cm. De meiden staan nog tegen de carrousel.
27:00
Er zijn ca. 50 pax, die over het algemeen 20cm afstand houden van de carrousel.
Familie op punt vertrekt, aardig wat bax maar geen kar. De punt is nu leeg.
Man sluit aan, gaat tussen de andere pax staan links van uitgifte, kijkt richting scherm.
Andere man komt aan. Gaat t.h.v. bord staan tussen een vrouw met baxkar links en het stel bij het uitgiftepunt.
Ouder stel staat nog tegen hekwerk.
Er staat een vrouw met baxkar tussen punt en uitgifte. Er komt een man met baxkar aan die ca. 1m achter haar en 0.5m rechts van haar gaat staan.
Komt een familie op puntpositie rechts staan.
27:30
Het begint drukker te worden. De aankomende omschrijvingen zullen globaler van aard zijn. Er wordt minder ingezoomd op individuen en meer op drukte per positie. Dit zal worden weergeven in afbeeldingen die representatief zijn voor de bezetting per tijdseenheid.
Langs de hele carrousel staan nu mensen. Een gat zit op puntpositie links. Er is nog wel 'opvulruimte', ca. 2 meter per pax cluster.
2 Mannen komen met baxkarren, zij vormen een dubbele rij tussen bord en uitgifte rechts.
Een PRM arriveert met begeleider, staan rechts van de twee mannen, 1,5 meter van carrousel. Begeleider pakt baxkar, zet deze rechts van PRM.
Er nadert een nieuw duo vanuit KMAR3, een van hen heeft een rollator, de ander een baxkar. Ze besluiten op de punt te gaan staan, de persoon met rollator gaat erop zitten. Voor hen staat nog een groep pax op puntpositie rechts. Tegelijkertijd loopt Vrouw-Z tussen hen door die op puntpositie links gaat staan. Er sluit nog een derde vrouw aan bij het duo.
28:00
Het wordt nu gauw vol.
PRM en begeleider vertrekken.
Veel passagiers met baxkarren, gaan allemaal tussen punt en uitgifte staan, hebben baxkar gehaald bij opstelplaats bij 15. Hier wordt nu een rij van 3 pax dik gevormd. Om de punt staat het 2 dik. Linkerflank heeft nog veel gaten, rechts staat 1 lijn dik. Kopse kant heeft nog gaten.
Baxkarren worden bijgevuld.
28:43
Interessant moment 'muurvorming' baxkarren, die als een halve cirkel van punt tot uitgifte loopt.
29:00
Er staan 13 bagagekarren in de 'J' van punt-uitgifte rechts.
Veel 'kruisend' verkeer en pax vanuit KMAR 3
Opgooien bax stagneert, ondanks dat er veel mensen om de carrousel staan om af te pakken.
30:00
Er blijft tussen carrousel en opstelplaats baxkarren +/- 1,5m flowruimte over: tegen carrousel 2-3 mensen dik mensenrij gevolgd door 3 geparkeerde baxkarren. Gaat 1 pax+bax per keer doorheen.
31:00
Man parkeert zijn baxkar elders, er is nu meer flowruimte ontstaan (+/- 2m)
32:00
Iedereen staat dicht op de carrousel
PRM vertrekt. Zit nog een man in een rollator aan de puntpositie rechts. Top van drukte is rechts van het uitgiftepunt rechts.
32:30
Het gros van de baxkarren vertrekt, nu een tijdelijke rij bax karren die gehele weg blokkeert.
PAX die eerder bij punt stonden trekken nu richting uitgiftepunt. Tegenovergestelde stroom mensen aankomend-vertrekkend bij band 15.
Oudere vrouw probeert bax te pakken, moet aardig stuk meelopen. Andere mensen moeten hiervoor naar achteren stappen. Hierna doen mensen weer een stap naar voren.
35:00
Pax staan nu 2-3 rijen dik te wachten aan rechterflank. Linkerflank is vrij rustig. Er staat een grote groep linkerzijde punt. Baxkarren zijn afgenomen, er staan er drie op het stuk punt-uitgifte.
Een vrouw met baxkar en bax staat te wachten bij opstelplaats
36:00
Alle mensen met baxkar staan rechts van hun kar. Mensen staan erg dicht op de carrousel.
37:00
Wat opvalt is dat veel mensen het lastig vinden om een baxkar te pakken, lijken niet te snappen dat ze het in moeten knijpen. Een enkeling geeft het zelfs op.
Het wordt nu erg druk op het punt tussen carrousel-kar opstelplek. Er staat een groep te wachten, enkele personen willen er met een baxkar doorheen (stroomafwaarts).
Het staat 3 rijen dik bij het uitgiftepunt. Weer is op te merken dat de andere zijde aanzienlijk drukker is. Zwaartepunt ligt van puntpositie tot 2/3 bandlengte rechterflank.
37:30
Groep is inmiddels vertrokken en er loopt weer 'een pad'. Wel gestremd door tegenovergesteld verkeer. Er zijn meer baxkarren bijgekomen rondom punt rechterkant.
38:00
Ze staan als een soort piramide tegen de band. Er spelen wat kinderen rondom de baxkar aan de rechteronderzijde.
39:00
Moeder probeert kinderen in de buurt te houden. Kinderen lopen naar vader bij carrousel. Groep wachtenden begint uit te dunnen, nog maar 1-2 rijen dik.
40:30
Nog maar 1 rij dik, er komen weer gaten.
Als het rustiger is beginnen mensen weer te lopen, man van kinderen verplaatst zich naar uitgiftepunt. Vrouw met kinderen en baxkarren gaan erachteraan, houden 1,5m afstand van carrousel. Staan nog wat mensen om de punt, hoogste bezetting rondom uitgiftepunt.
41:30
Er arriveren nog nieuwe mensen, zij vullen de gaten op. Ouder stel met beiden baxkar gaat op puntpositie rechts staan. Houden wel wat afstand. Andere vrouw-H staat met baxkar tegen band. Achter hen staat een gezin hun bax te laten op een kar, op dezelfde positie als de vrouw die daarvoor op die plek met haar kinderen stond te wachten. De man die als eerste er ging staan kwam 'van onder' de camera, onbekend waar hij vandaan kwam. Om 41:44 zijn ze klaar dus ze stonden er ongeveer 1 minuut stil.
42:00
Er staat weer een hele rits baxkarren (zeker 6 stuks) tussen punt-uitgifte, nagenoeg aan één stuk aangesloten.
Veel mensen schikken hun bagage op de kar terwijl ze bij de carrousel staan. Weinig mensen doen dit op een afstand of na het pakken van hun bagage. Rond dit tijdstip haalt een vrouw een baxkar minimaal uit de opstelplek en zet ze haar bax op de kar. Hierna loopt ze uit beeld.
43:00
Het staat ongeveer 1 rij dik, van punt tot punt aan rechterzij, met een rits baxkarren van punt tot uitgifte. Bijna niemand rondom punt, cluster linkerpunt en enkele clusters 2-3 pax aan linkerzijde.
45:00
Er staat weer een vrouw te wachten op de plek waar eerder ook mensen op elkaar wachten.
Zwaartepunt ligt nu op punt, er vallen wat meer gaten. Er staat vrijwel niemand aan de linkerzijde.
46:00
Band is nu bijna leeg, punt is ook leeg, de mensen die er staan, staan van uitgifte-rechterpunt eind.
Er staat een meisje te wachten op een ander meisje op weer dezelfde plek als waar de anderen stonden. Eigen vermoeden: dit is het breedste punt buiten de hoofdflow. Ik ken geen reden bedenken waarom mensen in het midden gaan staan i.p.v. tegen de rand/hek van de baxkarren.
48:00
Sporadisch staat nog iemand. Vooral punt-uitgifte. Er komt een familie aan die ongeveer t.h.v. eerste scherm loopt, blijven daar staan op enige afstand. Nu het weer rustiger is zie je ook dat de meeste mensen meer afstand nemen van de carrousel.
50:00
Weer kiest een vrouw die ene plek als wachtplek. Ze doet nog enkele stappen naar links. – Einde filmpje

E - CREATIVE SESSION




muren zijn projectie-schermen met NL cityscapes, dronebeelden etc.
Verspringende beelden op schermen
keeps you moving
De SLANG.
• OPHALEN LANGS ROUTE
BAND
Als er veel mensen op 1 gebied staan, dimt het licht, mensen willen niet in het donker staan
Aanname die je kan testen!
EFTELING PLAFOND
scherm met wolken en wolken
vliegtuigen
digitaal kan veranderen
per Nederlands 'huisje' aangeven waar je moet gaan staan
FLIGHT KZ014 07:00
FLIGHT KZ014
scherm
VIP €
omroepen & lootjes
weten welke volgorde ze komen & in de rij staan
sub-band(jes): gecategoriseerd of random
deze kan je meer optimaal verspreiden voor betere flow
kan samenwerken met licht op vloer & plafond
evt. ondergronds wel linken.

F - IDEAS

Reclaim hall A-terminal

Experimental set-up

jelmer.kok@schiphol.nl

TU Delft Schiphol

Introductie

Aangenomen wordt dat passagierswaardering een belangrijke indicator is voor Schiphol's concurrentiepositie. Kijkend naar het aankomstproces scoren de reclaimgebieden al jaren onder target. Naast de daadwerkelijke wachttijd is de evaluatie van het wachten zelf van belang voor een goede waardering.

Dit project richt zich op het laatste, en dan met name het dringen rond de band en opstoppingen/drukte in de ruimte. Vanuit het oogpunt van een passagier verminderd drukte en dringen het gevoel van controle en kwaliteit. Dit leidt tot een negatieve perceptie van het wachten en dus ook tot een negatieve evaluatie van het aankomstproces. Daarnaast kan de drukte zelfs een veiligheidsrisico vormen. Voor Schiphol is het dus zaak om de passagiersstromen in goede banen te leiden.

Het wordt verwacht dat er in het reclaim-gebied van de A-terminal soortgelijke problemen zullen ontstaan. Het vooronderzoek leert dat enkele problemen veroorzaakt worden door de interactie van passagiers met de omgeving. Aan de ruimtelijke beperkingen van de huidige hallen en de A-terminal kunnen we helaas niet zoveel doen, maar wél aan hoe passagiers zich door de ruimte bewegen. Met andere woorden: wanneer zij de ruimte *'efficiënter'* gebruiken kan dit opstoppingen en gedrang voorkomen. Hiervoor is een "gedragsverandering" nodig bij de passagiers.

De insteek is om dit te doen door middel van 'nudging'. Heel kort door de bocht zijn nudges omgevingsfactoren die (onbewust) menselijk gedrag beïnvloeden. Met mijn afstudeeronderzoek wil ik kijken *of* en *hoe* dit toegepast kan worden op Schiphol.

Dit document presenteert (in het Engels) **zes ideeën** die resulteerden uit een creatieve sessie met studenten op de TU Delft.

Elk idee wordt weergeven door een illustratieve schets, een korte begeleidende tekst en hoe ik het zou kunnen/willen testen. **Gevraagd wordt om A) de ideeën te beoordelen op haalbaarheid, effectiviteit en wenselijkheid en B) mee te denken met de uitvoering van de test.** De ideeën zijn expres zo min mogelijk uitgewerkt: het is belangrijk om vooral te kijken naar het *achterliggende* idee. Vanaf 27 augustus wil ik stapsgewijs gaan beginnen met het testen van enkele ideeën. Hiervoor kies ik situaties in de huidige reclaimhallen die veel gelijkenis hebben met de toekomstige A-terminal.

Het geven van feedback kan door het bijgevoegde document in te vullen. Dit zal ik meenemen in het besluit welke principes/ ideeën zullen worden getest. Het lezen en invullen kost naar schatting **30 minuten van je tijd**, maar levert mijn eeuwige dank op. Da's dan toch weer mooi meegenomen.

Blader dit document lekker op je eigen tempo door en laat je inspireren! Ik zou het zeer waarderen jouw feedback **vóór 18 augustus** tegemoet te zien in een mailtje naar: **jelmer.kok@schiphol.nl**.

Met vriendelijke groet,

Jelmer

Intervention 1 - Floorsticker

Problem
Passengers standing at the 'top-side' of the carrousel cause congestions in the main flow and block exits.
Example: The current situation in reclaim area 3, at belt 16/17 in front of customs.

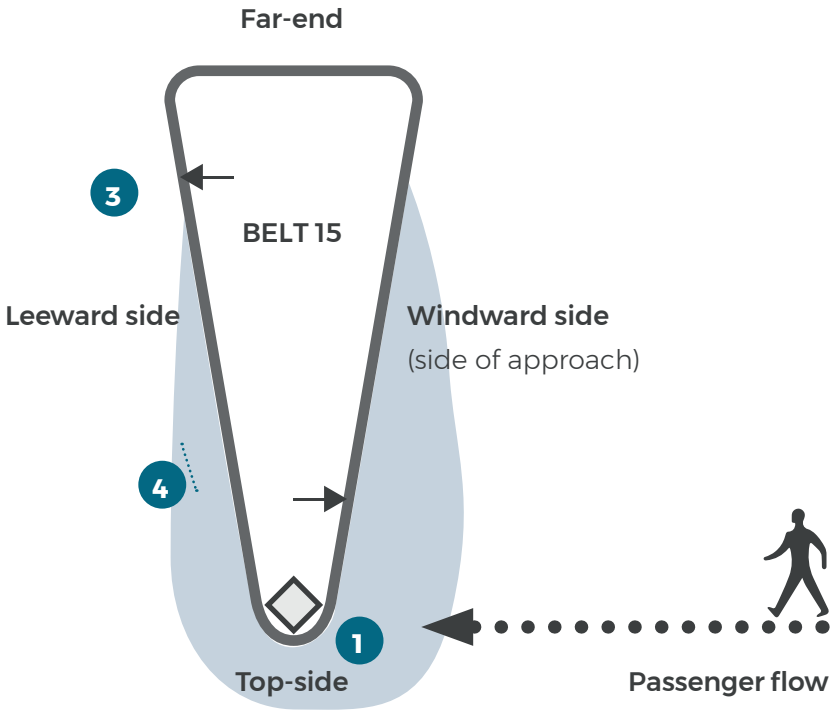
Description
Making it a social norm not to stand here might prompt people to avoid waiting at this spot.
The intervention will be in the form of a floor sticker that evokes a 'known script'. Some ideas are making it a 'people with remote mobility only' area, an area for airline staff or simple a cross.

Hypothesis
Passengers will see the sticker and avoid standing on its surface area.

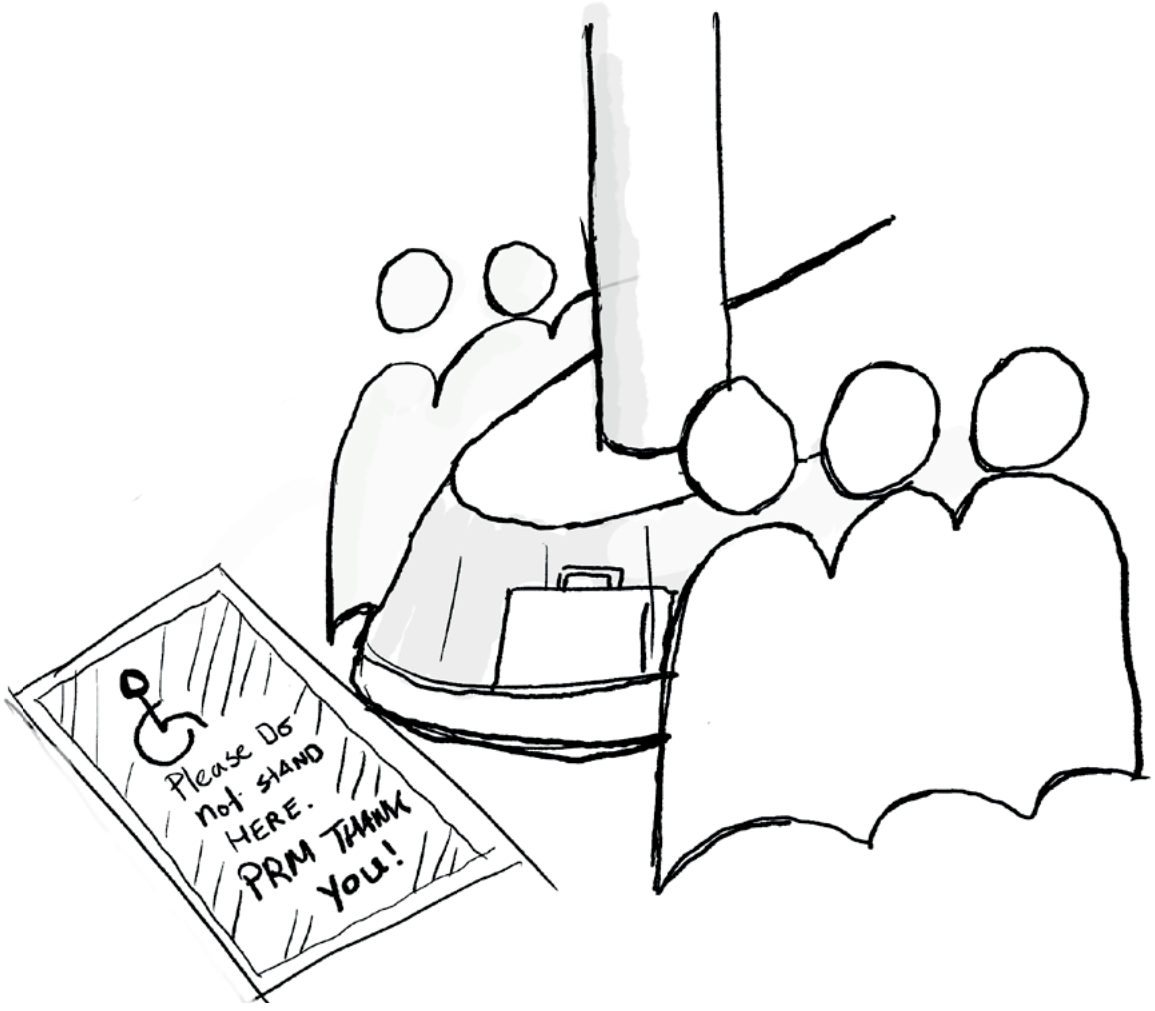
How to test
Qualitatively by observing passenger behaviour: It is known that passengers will take a position here without an intervention present.

It might be followed up by a questionnaire/interview to inquire whether or not they have seen/understood the sticker.

Required
Floor sticker




Arrivals Exit
First aid
Toilets
17
17
18

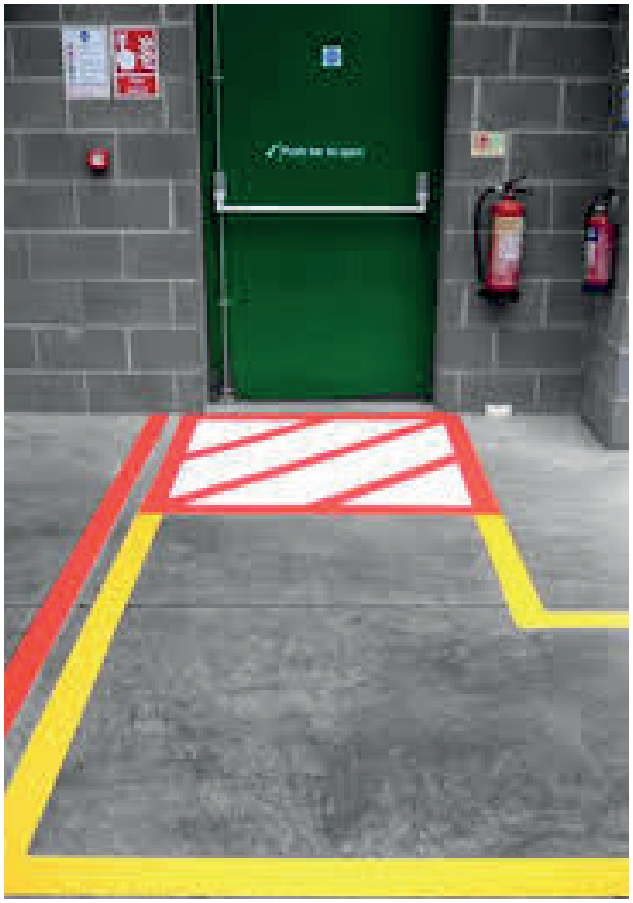

Please Do not stand HERE. PRM Thank You!

Intervention 2 - Exit

Problem
Passengers in reclaim area 1 tend to use only one out of two exits, causing a messy customs process and stagnation (albeit for a short time cycle). Two things play a role:

1) They are unaware of the other exit (I even saw some passengers moving from the 'empty' exit to the queue)
2) people prefer the shortest route.

It is expected this will also be problematic in the future reclaim area.



Description
Floormarkings suggest the route to the second exit and lead passengers to it.

Another idea is to make the exits more salient/visible.

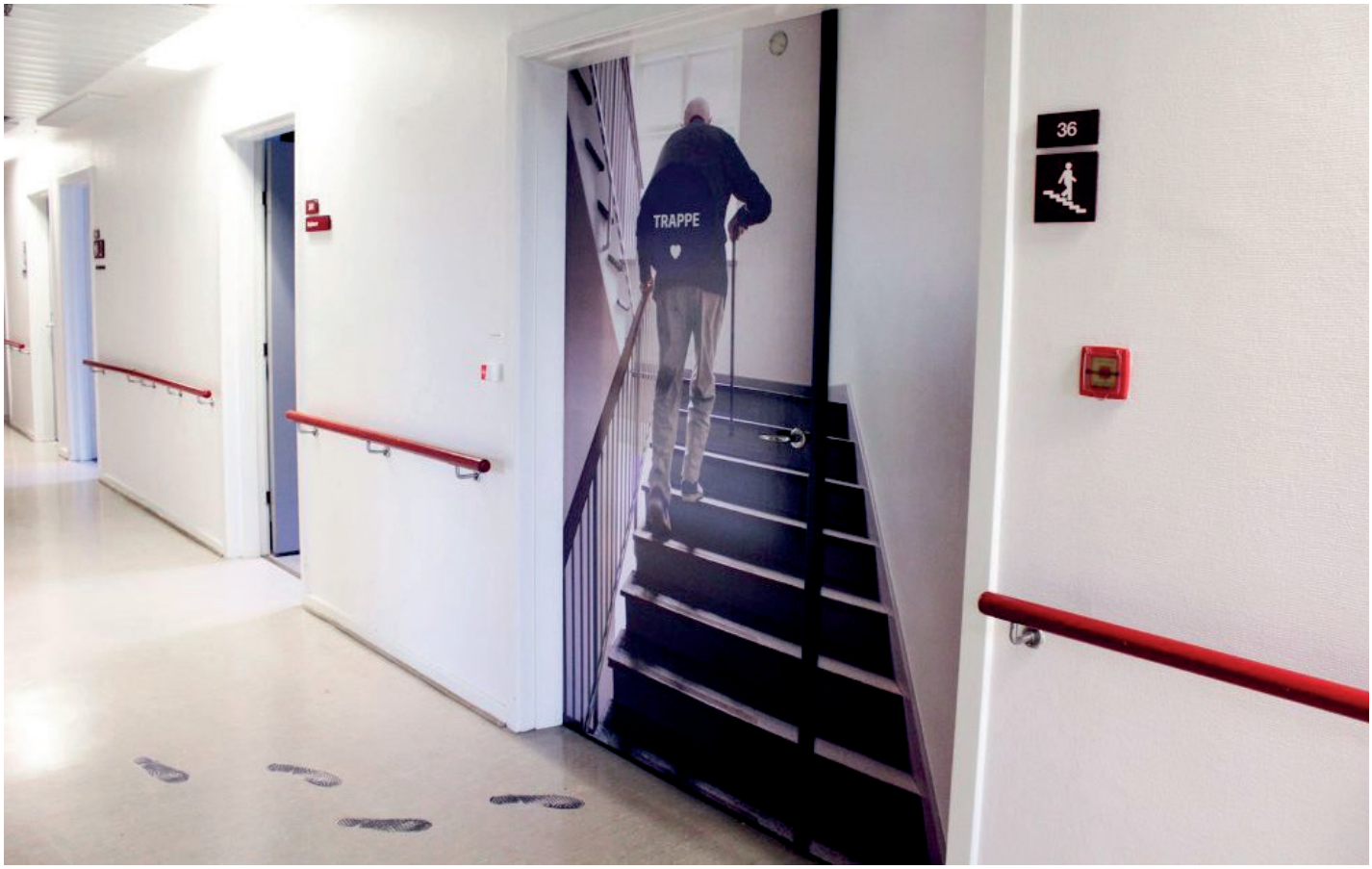
Hypothesis
When floormarkings are applied, the number of passengers that use the second exit will increase compared to the normal situation *(especially in case the first one becomes busier.)*

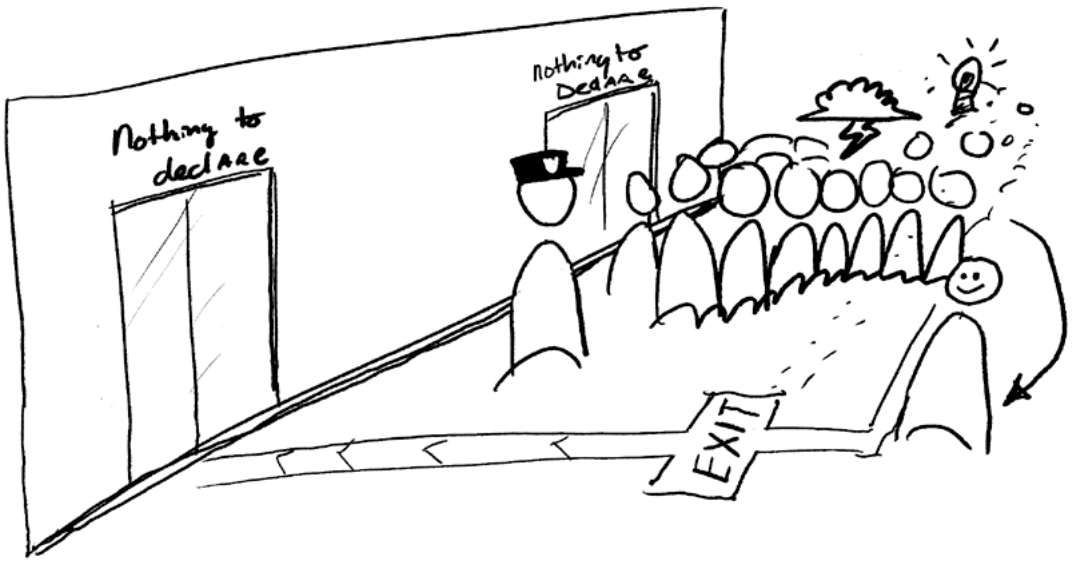
How to test
A combined qualitative and quantitative analysis:

Quantitative
For two timeblocks (normal vs. intervention) that have more or less the same conditions, count how many people make use of each exit in area 1 and compare the relative differences.

Qualitative:
Observe if people see the lines and how they response at the choice-point.

Required
Time and date with comperable passenger numbers
Floor tape
Video camera
Additional observer would be nice to have.


36
TRAPPE


Nothing to declare
Nothing to declare
EXIT

Intervention 3 - Default path

Problem
People tend to take the shortest route or path of leas resistance. This causes people to mass on a small amount of floor surface (the 'top-side' and 'windward' side, the side on which people approach the carrousel). To encourage a better distribution it is interesting to see how people can be prompted to walk to the 'leeward' side of the carrousel.

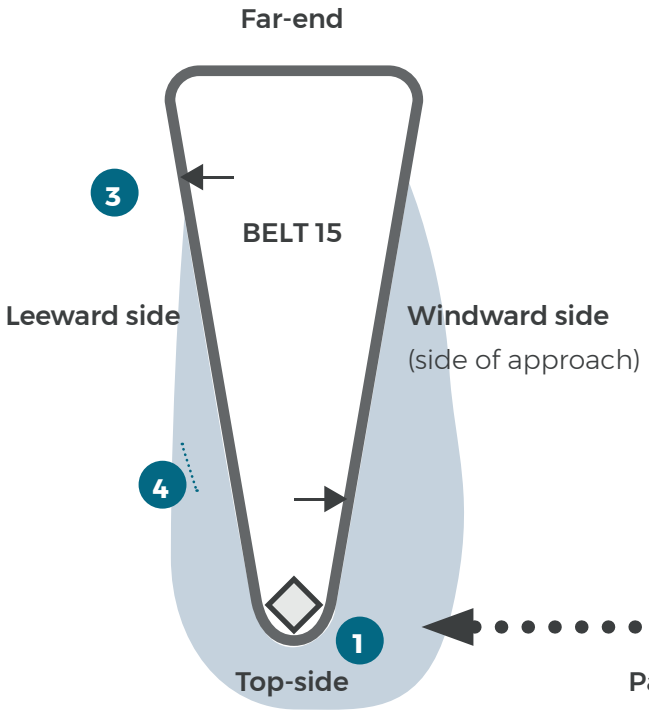
Description 3.1
Idea 3.1 is to propose a 'default path' suggested with floormarkings and an 'end goal'. It will lead passengers to the leeward side.

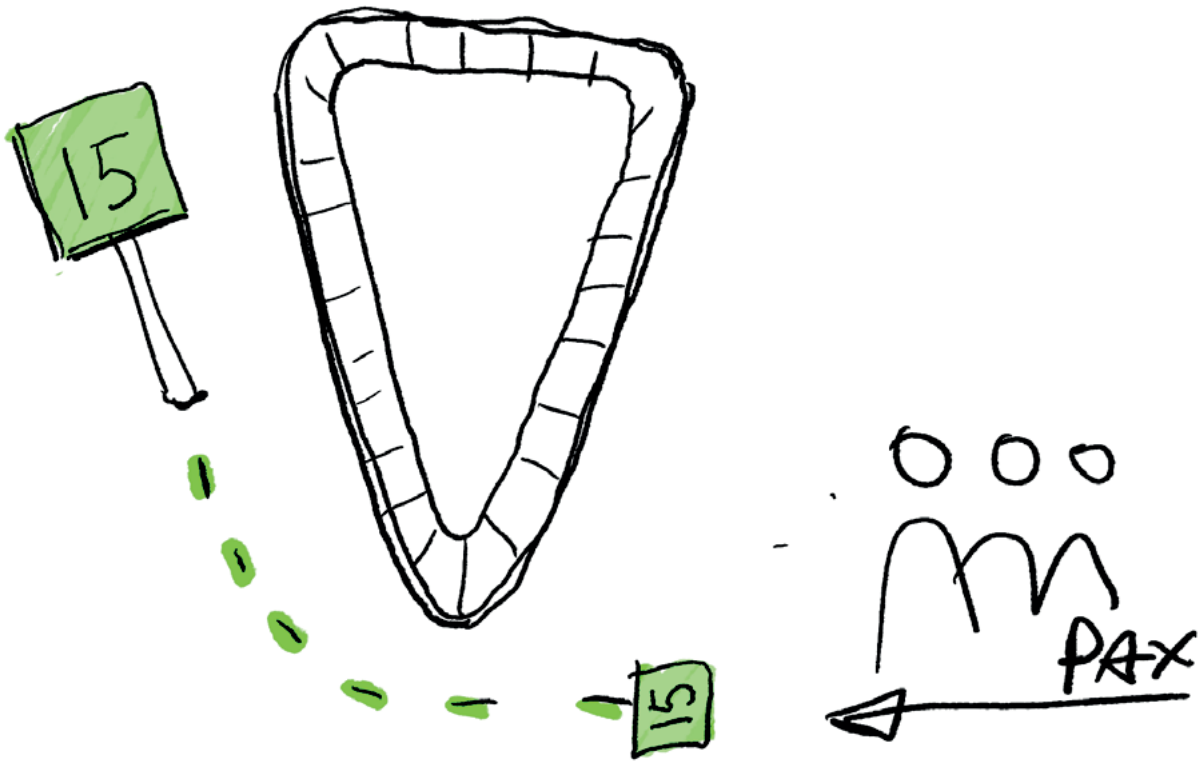
Description 3.2
Idea 3.2 is to close one ejection point of the carrousel and make sure it is very clear that the ejection point is on the other side. Passengers that want to be close to this point might take the additional effort.

Hypothesis
When the intervention is applied, an increased number of passengers will go to the 'leeward' side compared to the normal situation.

How to test
In reclaim area 3. Two video observations during two subsequent days. Plot a 'raster' over the ground and count the position of passengers during multiple turnarounds.

Required
Time and date with comperable passenger numbers
Floor tape
Video camera
Additional observer would be nice to have.





assenger flow

Idea 4 - Wait-here lines

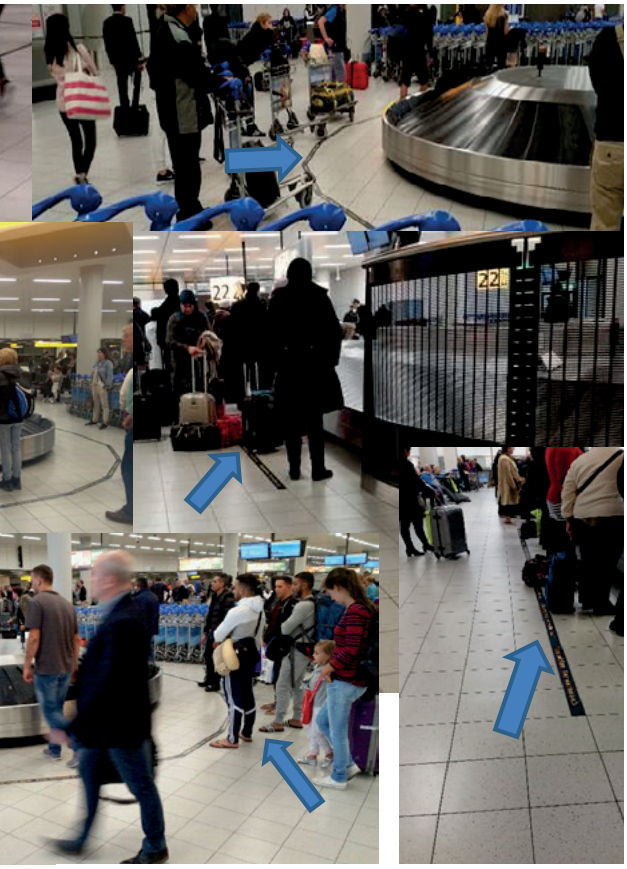
Problem
Passengers (and baggage carts) crowding at the carrousel limit each other's sight and ability to grab their belongings from the belt.

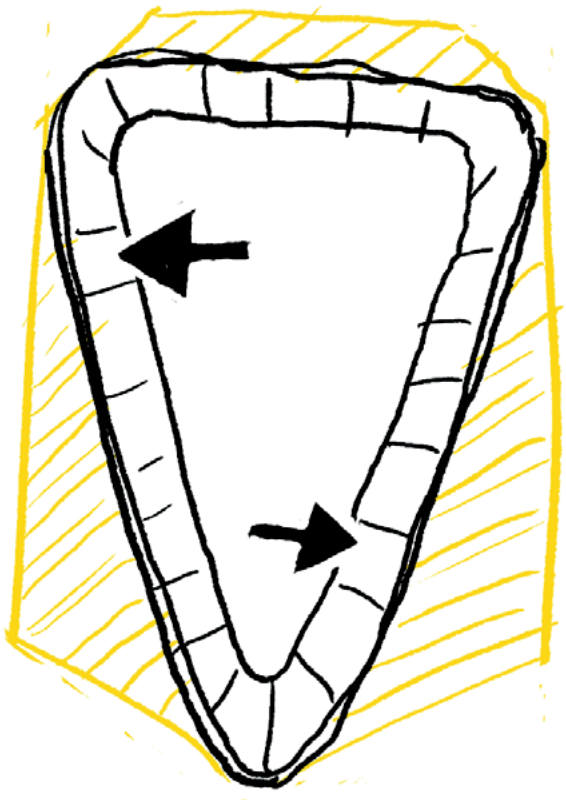
Description
A wait-here line can create a default suggested distance and social norm. It is quite commonly applied by other airports. Schiphol piloted this before but it did not have the desired result. I contacted Stockholm Arlanda airport and they said it actually works for them. I propose to re-try it, using a more salient stroke.Additional attention should be given to the distance and shape to avoid negative side-effects as encoutered in the previous pilot.

Hypothesis
If the line is salient enough passengers will notice it and will be inclined to adopt the default distance.

How to test
It is known people stand against the belt in the current situation. So only testing the effectiveness of the intervention is sufficient.. Test in reclaim area 3.

Required
Placement of camera
Suitable date and time
Floor tape





of voetstapjes

of enkel op baggageKARREN

Intervention 5 - Later, baggage cart

Problem
Some passengers get their baggage cart way upfront, occupying scarce space around the carrousel. Baggage carts rapidly lead to congestions and blockades, while they are not necessary until a passenger actually has his/her belongings.

Description
A very clear and salient poster at the cart ‘parking spots’ that conveys the issue and asks to be courteous to fellow passengers. Making the problem understandable and appeal to the moral self-image.

“Hypothesis”
More people will grab a baggage cart after taking their luggage / less people will grab a baggage cart / less people will stand around the belt with a luggage cart.

How to test
In a qualitative way t.b.d. based on hypothesis.

Required
Something to place signage on.


CARTS Block
access for
other PAX
Please Keep distance

Intervention 6 - Attractor

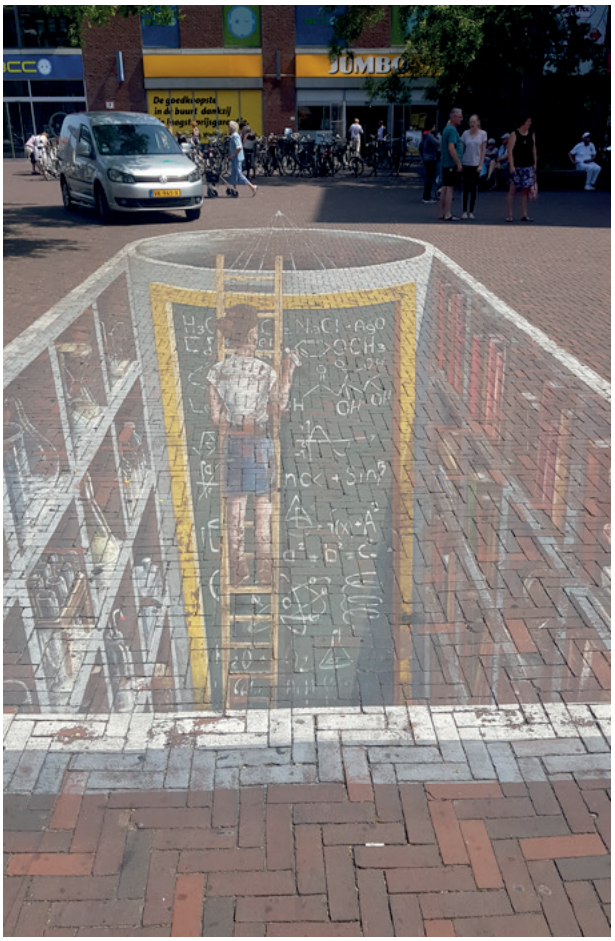
Problem
Same underlying problem as Intervention 3, only now the objective is to encourage walking further down the carrousel. Passengers will take additional effort if they perceive something as value adding.

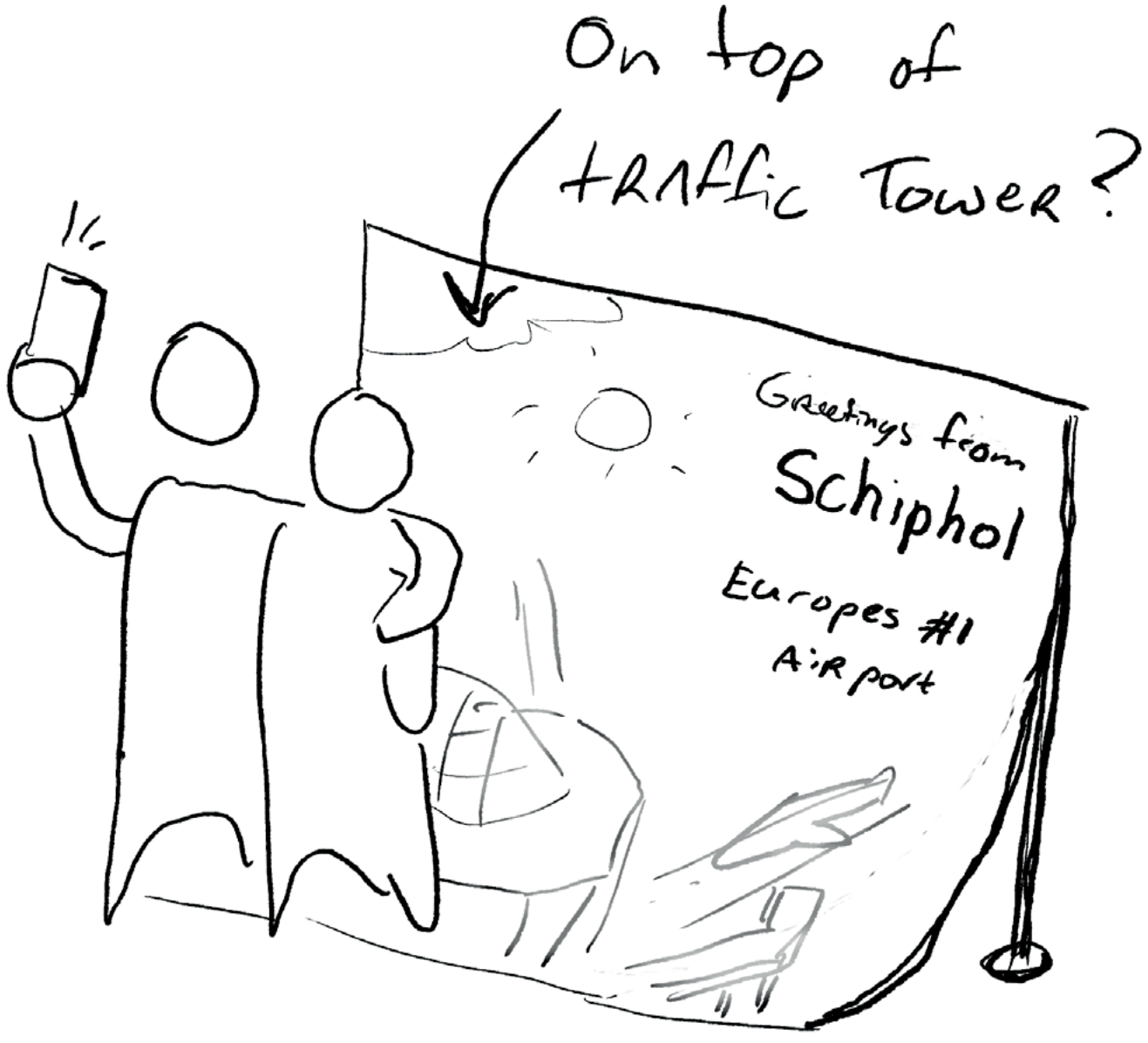
Description
During the research the most commonly heard need was for charging points. I highly doubt I'll be able to test this. However, it was found that people would like some passive distraction. A suitable idea with a fun-factor originated in a creative workshop: A 'selfie' wall where passengers can make a Schiphol/Amsterdam themed 'greetings card' with their own phone. It can keep passengers occupied and can be used as AAS branding.

Hypothesis
If this intervention is placed at a strategic location people will purposefully move to an area which normally would be avoided.

How to test
In reclaim area 1, at a 'deserted' location.
Place object & observe what happens.

Required
A suitable location
Budget and clearance
Roll-up banner
Furniture of some sorts




On top of
traffic Tower?
Greetings from
Schiphol
Europes #1
Airport

G - EXPERIMENT CARD

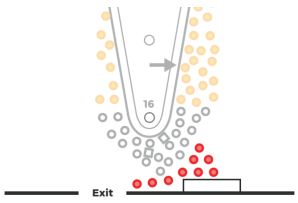
BD Experiment Baggage Belt

Schiphol

Schiphol PX Team

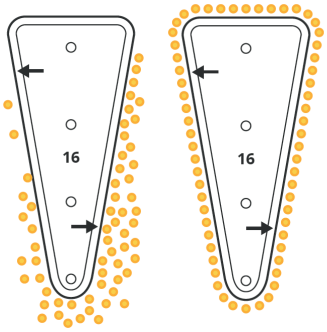
3 Problems

1



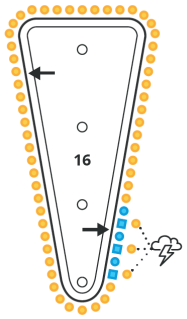
Passengers waiting for baggage can cause congestions when standing at specific locations. Case: the customs exit in reclaim hall 3

2



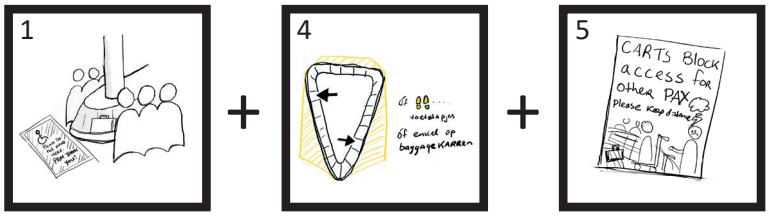
Passengers don't distribute evenly over the belt and stand too close against it. This is blocking other passengers' access to- and view on the belt. Passengers experience this as crowding and hassle.

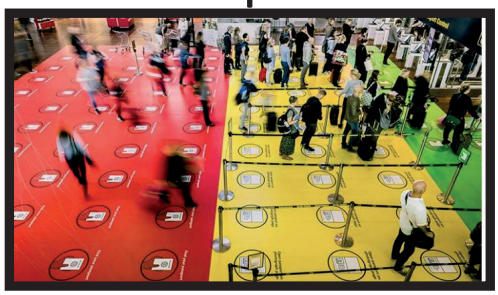
3



Passengers put their baggage carts too close to the belt, occupying scarce space and blocking other passengers' access to the belt.

Combining interventions





Nudging with Stickers

Effective? It reduced the border check waiting time during peak hours reduced by 18% (!) at CPH

1 Flow

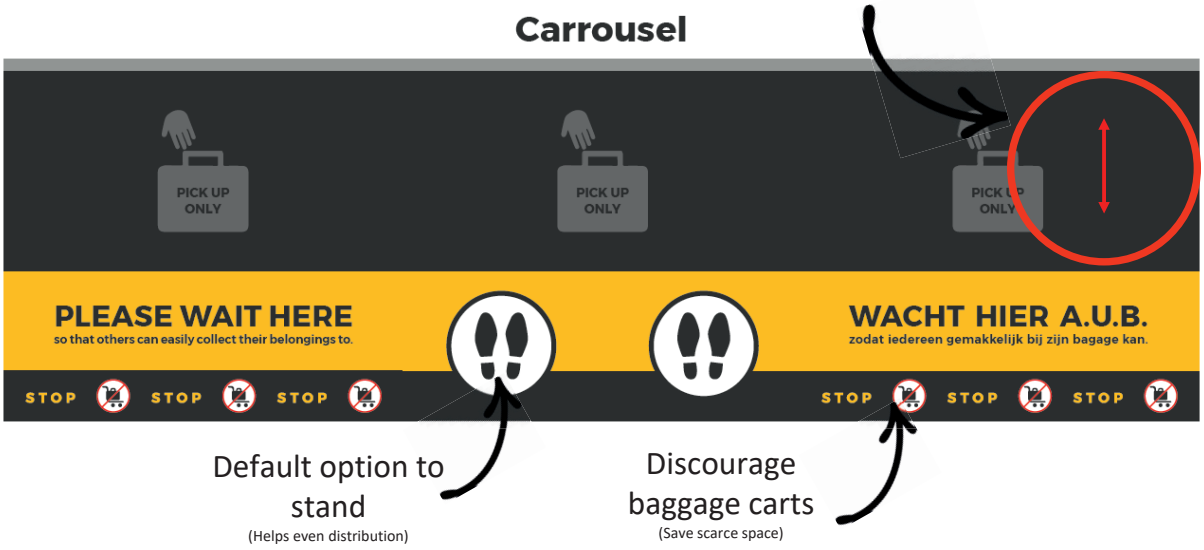
- Sociale normen hebben een zeer sterke invloed op gedrag.
- Invalide parkeerplaatsen zijn internationaal bekend.
- Verwacht wordt dat door het de norm te maken om deze plek vrij te houden, mensen hier niet zullen wachten. Dit zal opstoppingen voorkomen.
- Bijkomend voordeel is dat deze plekken nu ook daadwerkelijk door de PRM assistenten gebruikt kunnen worden.

Improve the flow sympathetically
(Family Lane learning)

= Handicapped only

2 3 Distance & Carts

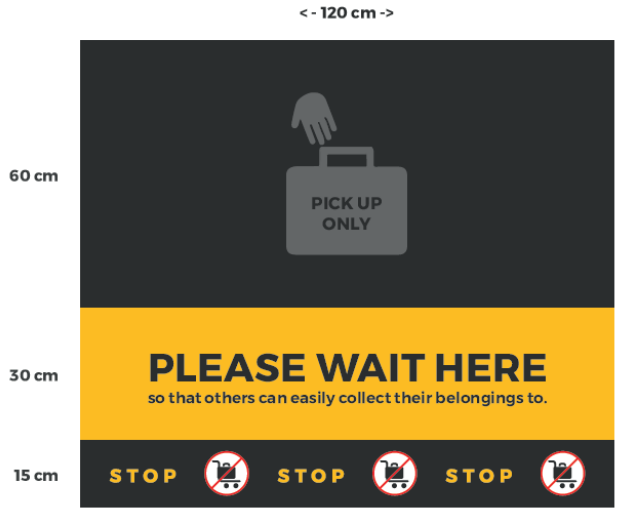
Distance helps Passengers to pickup their baggage & improves the view on the belt



Default option to stand
(Helps even distribution)

Discourage baggage carts
(Save scarce space)

Details



- Schiphol kleuren
- Gebaseerd op tegelraster 30x30 in reclaimhal 3
- Contrast zorgt ervoor dat het eerder wordt gezien
- Een duidelijk verschil met de rest van de vloer zorgt dat het opvallend is en dat er duidelijk
- Korte zinnen en iconen worden automatisch gelezen en begrepen

- Vraag aan Reklaspits; wat is de meest praktische manier om zoiets te drukken? Eventueel kan de bovenste zwarte strook worden weggelaten, het geheel dan op 60cm* afstand worden geplaatst van de voet van de reclaimband.

- *= N.b.: 60cm kan als 'veel' afstand klinken, maar de band helt wat over en op beelden is te zien dat dit een natuurlijke afstand is die mensen houden.

Combined

PX Design Principles

Ik ben in control

Het proces is overzichtelijk en voorspelbaar
Het proces voelt intuïtief en de ingezette middelen bieden overzicht waardoor ik het proces gemakkelijk doorloop. Ik weet wat de duur van de stappen in het proces zijn, en van het proces in zijn geheel.

Informatie is begrijpelijk en beknopt
De informatie op Schiphol is juist, simpel en eenduidig; digitaal, analoog en face2face zijn geïntegreerd. Informatie is zoveel mogelijk op maat, zodat ik begrijp wat de informatie voor mij betekent.

Het is zo efficiënt en naadloos mogelijk
Schiphol en haar partners maken het proces zo efficient mogelijk en de stappen binnen het proces sluiten onderling naadloos op elkaar aan. Zo worden tijd en inspanning voor mij geminimaliseerd.

Ik voel mij welkom

Het voelt vriendelijk
Schiphol is gastvrij: medewerkers van Schiphol zijn benaderbaar, vriendelijk en behulpzaam. Ook in stressvolle situaties.

Het voelt vertrouwd
De medewerkers en de voorzieningen op Schiphol zijn herkenbaar en voelen vertrouwd.

Men doet voelbaar moeite voor mij
Schiphol ondersteunt mij aansluitend op mijn kennisniveau, ervaring en mogelijkheden. Er is respect voor wie ik ben ongeacht mijn achtergrond, leeftijd, taal of cultuur. Zelfs als dat iets meer moeite kost.

Ik ben onbezorgd

Het voelt veilig
Er is op Schiphol veel aandacht voor veiligheid waardoor deze gewaarborgd is, op een wijze die voor mij prettig aanvoelt.

Ik ondervind kwaliteit
Alles op Schiphol voelt als kwaliteit. Zo hoef ik mij tijdens mijn verblijf op Schiphol geen zorgen te maken over mijzelf en mijn eigendommen.

Men komt voor mij op
Schiphol is rechtvaardig: als er iets mis gaat behartigt Schiphol mijn rechten en wordt voor een creatieve en persoonlijke oplossing gezorgd waardoor ik verder kan met mijn reis.

Ik ben geïnspireerd

Er is ruimte voor schoonheid en design
Schiphol kijkt met het oog van een architect en designer. De voorzieningen zijn “typisch Schiphol”. Met af en toe een verrassende Nederlandse twist voel ik dat ik in Nederland ben, zonder dat dit vervreemdt.

Er is een spraakmakend aanbod
Schiphol biedt ruime keuze aan spraakmakende voorzieningen afgestemd op de plek, tijd en doelgroep. Dit maakt dat ik met plezier terugdenk, graag terugkom en positieve ervaringen deel met anderen.

Er is voldoende ruimte voor rust
Hoewel een vliegveld een hectische omgeving kan zijn, zorgt Schiphol voor rust en comfort op plekken en momenten die dit toelaten zodat ik zowel mentaal als fysiek kan herstellen van mijn reis.

Experiment Card 1/2

Naam concept

Staanwijzen - markeringen bij de carrousels

Omschrijving / wat is het idee?

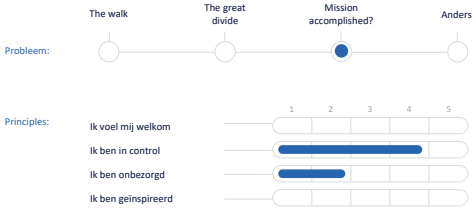
Drukte en dringen bij de bagagebanden in de reclaimhallen is een veelgehoorde klacht. Vanuit het oogpunt van een passagier verminderd drukte en dringen het gevoel van kwaliteit en controle over de situatie. Het gaat er dan met name over de ergernis dat passagiers niet (gemakkelijk) bij hun bagage kunnen omdat anderen in de weg staan en opstoppingen in de ruimte.

Passagiers staan in veel gevallen (al dan niet met een bagagekar) tegen de carrousel aan. De eerste passagier die tegen de band staat ontneemt het zicht voor de andere passagiers, wat resulteert in een domino-effect. Dit maakt het voor iedereen lastiger om 1) te zien of zijn/haar bagage eraan komt en 2) zijn/haar bagage van de band af te nemen.

Na observatie-onderzoek is ook gebleken dat passagiers zich concentreren op bepaalde plekken in de ruimte. Dit resulteert in opstoppingen in de flow; de drukte voor de douane-uitgangen in reclaimhal 3 bij band 16/17 is hier een goed voorbeeld van. Dit ontstaat door wachtende passagiers die zich aan de 'kopse kant' van de carrousel ophopen.

Het doel is om het proces van bagage reclaim (vanuit het passagiersperspectief) soepeler te laten verlopen. Dit is echter sterk afhankelijk van het gedrag van de passagiers zelf, dus het idee is om te experimenteren met behavioural design. D.m.v. vloermarkeringen moeten passagiers '*genudged*' worden om:

a) Een zekere afstand te houden van de carrousel
b) Niet op de kopse kant te gaan staan
c) Geen bagagekarren tegen de carrousel te parkeren



Impact / wat is het doel dat we willen bereiken?

De verwachting is dat de vloerstickers bijdragen aan de verbetering van de volgende zaken:

1. Het proces is overzichtelijk en voorspelbaar
Passagiers zullen intuïtief begrijpen wat er van hen verlangd wordt, en dat dit ten goede komt aan een soepel proces.

2. Het is zo efficiënt en naadloos mogelijk
Het draagt bij aan het minimaliseren van inspanning door het gemakkelijk te maken bagage af te pakken en opstoppingen in de passagiersflow te voorkomen.

3. Informatie is begrijpelijk en to the point
De markering geeft 'het goede voorbeeld' en wordt juist geïnterpreteerd door de passagiers, zie ook punt 1.

4. Ik ondervind kwaliteit
Het gevoel van drukte/dringen verminderd aantoonbaar de perceptie van kwaliteit en controle (bijv. Epstein, 1982). Het proces zal rustiger verlopen en passagiers zijn beter in staat hun bagage af te nemen. Zij hebben beter zicht op hun bagage op de carrousel en hoeven zich geen zorgen te maken of ze er wel tijdig bij kunnen komen.

Experiment Card 2/2

Hypothese / wat is de verwachting?

'Wait here' strook
- Passagiers zien én begrijpen de markeringen
- Passagiers houden zich aan de aanbevolen afstand totdat hun bagage voorbij komt
- Passagiers laten hun bagagekar achter de markering
- Als iemand zich niet aan 'de norm' houdt, wordt die hier op gewezen.
- Als iemand zich niet aan 'de norm' houdt, volgt er een domino-effect.
- Het zicht en gemak om af te pakken verbeterd door afstand te houden.

PRM gebied
- Passagiers zien én begrijpen de markering
- Passagiers zullen vermijden om in het blauwe 'PRM gebied' te wachten, in plaats daarvan zullen zij een plek kiezen aan de lange zijde van de carrousel.
- Hierdoor zal de doorstroom in de hal en bij de douane uitgangen verbeteren; er ontstaan geen opstoppingen in de flow door wachtende passagiers op de kopse kant.

Hoe te valideren / hoe zetten we het experiment op?

- D.m.v. een A/B test wordt de effectiviteit van de markeringen getest.
- Er wordt getest bij reclaimband 16 in hal 3, over een tijdspanne van in ieder geval 2 dagen. De 'normale' situatie wordt vergeleken met een situatie waarin de markeringen zijn geplaatst om zo inzicht te verkrijgen in de effectiviteit. D.m.v. stickers worden de markeringen aangebracht rondom de carrousel
- Tijdens deze dagen wordt gefilmd en geobserveerd. Dit wordt geanalyseerd en met elkaar vergeleken. Ook zal er gelet worden op eventuele neven-effecten.
- Er wordt een enquête gehouden onder passagiers die zojuist hun bagage hebben opgehaald.

Meetpunten en instrumenten / hoe gaan we resultaten meten?

- Door middel van (camera)observaties wordt er op kwalitatieve wijze gekeken naar het gedrag van passagiers (n.b.: er staat al een aanvraag/overeenkomst uit voor het maken van videobeelden m.b.t. privacy en security). Hierbij worden de situaties ten opzichte van elkaar vergeleken, maar ook wordt er gekeken hoe passagiers omgaan met de markeringen: *Zien ze het? Wordt er iets over gezegd? Wanneer werkt het wel/niet?*

- Door middel van een korte enquête worden passagiers gevraagd of zij drukte/dringen hebben ervaren. In geval van het experiment wordt hen ook gevraagd naar de vloermarkeringen. De vragen worden gebaseerd op de priority principles en beantwoord op een 7-punts Likertschaal (helemaal oneens/helemaal eens).

Criteria / wanneer is het experiment geslaagd?

- Zolang de markeringen gezien worden, houden mensen zich aan de aanbevolen afstanden.
- De markeringen moeten werken in situaties dat passagiers daadwerkelijk moeten wachten tot hun bagage arriveert; als zij in het loopje direct hun koffer kunnen pakken op rustige momenten is het niet van belang dat zij de markeringen overtreden.
- Passagiers geven in de enquête aan dat ze de vloermarkeringen hebben gezien, begrepen en waarderen.
- Passagiers gaan niet *wachten* op het PRM gedeelte (er overheen lopen kan geen kwaad).
- Er ontstaan geen opstoppingen in de flow die te wijten zijn aan wachtende passagiers op de kopse kant van band 16.

H - SPSS OUTPUT

14 VS 20

			Door		
			Left	Right	Total
Condition	Control	Count	3073	28799	31872
		Expected Count	3032,1	28839,9	31872,0
		% within Condition	9,6%	90,4%	100,0%
		% within Door	53,5%	52,7%	52,8%
		% of Total	5,1%	47,7%	52,8%
	Intervention	Count	2672	25845	28517
		Expected Count	2712,9	25804,1	28517,0
		% within Condition	9,4%	90,6%	100,0%
		% within Door	46,5%	47,3%	47,2%
		% of Total	4,4%	42,8%	47,2%
Total		Count	5745	54644	60389
		Expected Count	5745,0	54644,0	60389,0
		% within Condition	9,5%	90,5%	100,0%
		% within Door	100,0%	100,0%	100,0%
		% of Total	9,5%	90,5%	100,0%

Chi-Square Tests

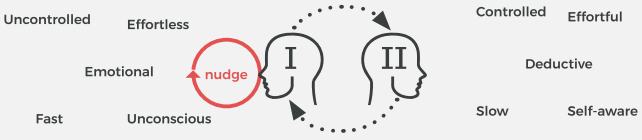
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1,292[a]	1	,256	,261	,131
Continuity Correction[b]	1,261	1	,262		
Likelihood Ratio	1,293	1	,256	,279	,131
Fisher's Exact Test				,261	,131
Linear-by-Linear Association	1,292[c]	1	,256	,261	,131
N of Valid Cases	60389				

INTRODUCTION

This booklet is part of my graduation project at Schiphol airport, where I explored the possibilities for behavioural design interventions to reduce crowding within the reclaim areas. This handbook can act as a guide for experiments with behavioural interventions for issues or processes that are dependent on passenger behaviour. It summarizes the most important findings from my thesis and describes how to incorporate the BASIC approach 2018 within the Schiphol PX method.

Behavioural economics

From a pure economical perspective, people would always make their decisions based on all available knowledge and make the most optimal choice. However, humans constantly make unconscious decisions, some of which are not in our best interests. These unconscious (and/or irrational) decisions and behaviors are often explained by the dual-system theory. The theory suggest that the human brain has two mind-states: the subconscious System 1 and the conscious System 2.



The automatic System I
Requires little engery
Read a snappy sentence
Routine tasks
Habits and impulses

The reflective System 2
Requires energy and attention
Studying a book
Unfamiliar situations
Important decisions

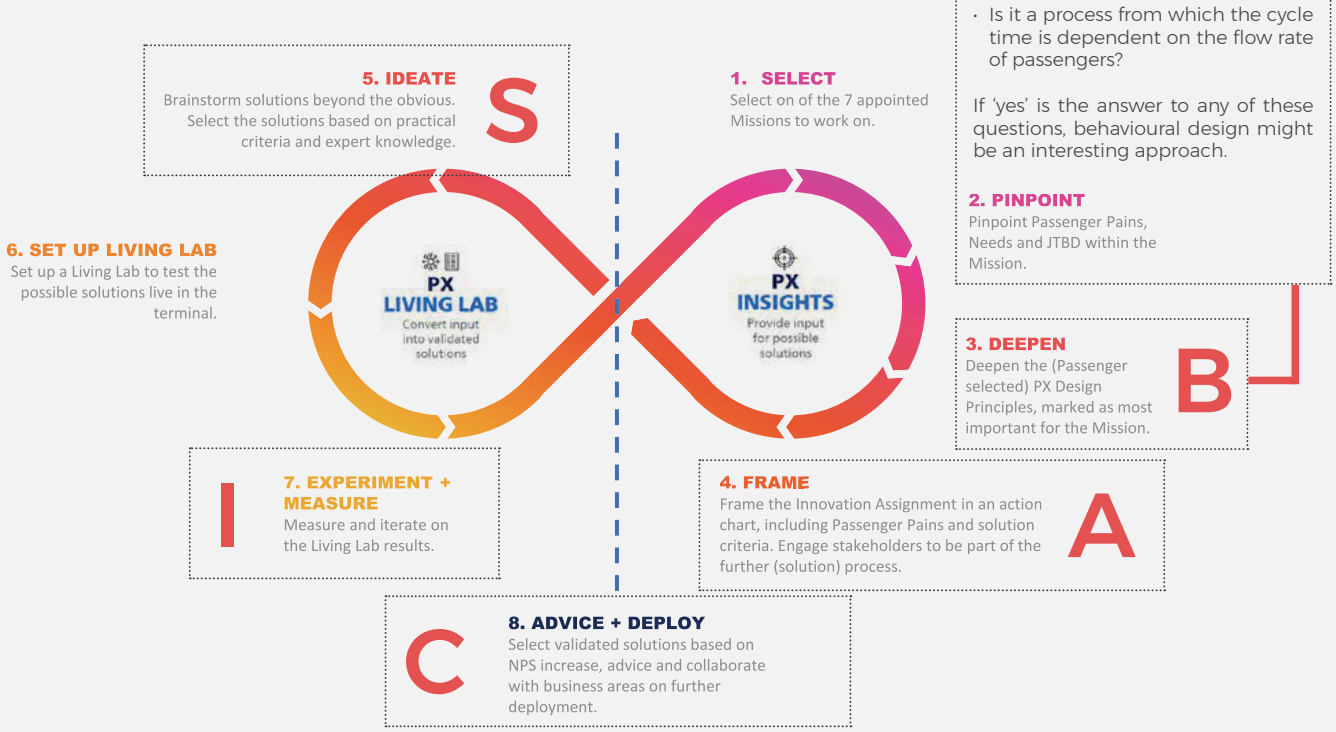
Most of our behaviour follows from subconscious decisions made by System 1, based on mental shortcuts. Behavioural interventions can be used to steer these automatic decisions by *nudging* the desired behavior. *Nudging* is any attempt to alter people's behaviour in a predictable way by making use of the same cognitive boundaries, biases and routines that System 1 thinking bases its decisions on.

The approach is this booklet is based on BASIC approach as developed by iNudgeYou. It contains five steps:

Behavioural mapping - Identifying relevant behavioural patterns
Analysis - Pinpointing the cause of the behaviour
Solution mapping - Ideation for behavioural interventions
Intervention - Apply, test and evaluating the intervention
Continuation - Monitoring and maintenance

LINK WITH THE PX METHOD

When the passenger's Pain or Need has been selected, the first question should be whether a passenger is or would be able to exert influence on it. If so, the project might be an interesting lead for behavioural design.



BEHAVIORAL MAPPING

In order to influence behaviour it is key to understand it. Hence, the first step of the BASIC approach focuses on gathering user data. Spending time within the service environment is in many cases the only way to truly understand the issues passengers encounter. Albeit time-consuming, observations allow to document and research these issues as they occur. Moreover, observations are useful for identifying instances in which passengers say 'A' but do 'B'.

Start with initial observations with a clear mind by observing the situation. Try to grasp what may be of influence. For example:

- Do demographics play a role?
- Does time play a role?
- Do objects play a role?
- Does wayfinding play a role?
- Is it multiple actions in a row?
- Are there different types of approaches?
- Are there any noticable behaviours?

Establish the points of interest and create an observation sheet for more structured observations. Try to create quantifiable categories that can measure frequency or cycle time.

ANALYSIS

The second phase is about answering the 'why'. How can the data that was gathered explain differences among people or the issue at hand. Why are people (not) acting in the (un)desired way? Consider the following:

- Affordances of objects
- Unawareness
- External barriers
- Social proof / herding behaviour
- Economy of effort

Optionally, additional literature should be consulted. Clearly define the unwanted behaviour.

SOLUTION MAPPING

The unwanted behaviour is the starting point for the solution mapping. What is the desired alternative behaviour? How could passengers be nudged to act like it? Make sure to focus on the behaviour, and not on the outcome. During ideation, consider how the EAST-method[1] might help: make choices Easy, Attractive, Social and Timely.

EASY

- Harness the power of defaults
- Reduce the hassle factor
- Simplify messages

ATTRACTIVE

- Attract attention
- Design rewards

SOCIAL

- Show the desired behaviour
- Use the power of networks
- Encourage commitments

TIMELY

- Prompt people when they are likely to be most receptive
- Consider the immediate costs and benefits
- Help people plan their response

INTERVENTION

The fourth step is to test the intervention in a field experiment. The goal is to collect quantifiable evididence for the effects of the intervention.

Make sure to exactly define what the expected outcome of the intervention will be resulting from the change in behaviour. How can this be measured, and how can this be attributed to the intervention?

It is wise to be physically present during the intervention in order to witness noticable behaviour and interactions with the intervention. It can help to determine whether iterations might strengthen the effect.

CONTINUATION

In the continuation phase a plan is made for the implementation of the intervention. Moreover, it includes monitoring the effects and possible unwanted side-effects. Practicalities like ownership and maintenance should be dealt with here.

Effects of the intervention might wear off. For example when the lay-out of the facility has changed. As the succesrate of nudges is highly context dependent, adjustments should be made if required.

1 = http://www.behaviouralinsights.co.uk/wp-content/uploads/2015/07/BIT-Publication-EAST_FA_WEB.pdf)

Master thesis | Jelmer Kok, October 2018