Thesis

Methodology for crowd management measures

A study to define and apply a methodology to create crowd management measures suited for Hubs under (re)constructions while business is performed as usual

R.W. Leutscher

Technical University of Delft

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Case: Rotterdam The Hague Airport

by

R.W. Leutscher

Student number:	4260961	
Project duration:	Februari 14, 2017 – August 31, 2017	
Thesis committee:	Prof. dr. ir. S. Hoogendoorn,	TU Delft, supervisor Transport & Planning
	Dr. Ir. W. Daamen,	TU Delft, Transport & Planning
	Dr. J.A. Annema,	TU Delft Transport & Logistics
	Ir. S.M. Van der Kleij,	Rotterdam The Hague Airport, Manager Information, Capacity and Policy

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TU Delft

Preface

This document contains the research results for the final research (thesis) for the Master Transport, Infrastructure and Logistics, part of the faculty Civil Engineering and Geosciences, Delft Technical University. The project has been performed at Rotterdam The Hague Airport, which was used as a case study for this research.

The content of this report reflects on designing and testing a methodology. This methodology is used to generate crowd management measures, specifically for hubs under construction.
I would like to thank my university committee: Prof. dr. ir. S. Hoogendoorn, Dr. Ir. W. Daamen, Dr. J.A. Annema and company mentor Ir. S.M. Van der Kleij for their academic support, J. Vleugel from the department of Transport & Planning for helping during the thesis preparation, colleagues of Rotterdam The Hague Airport and specifically C. Lonis and E. Nobel as part of my daily support, and finally my family, friends, team mates and student colleagues for their overall support.

R.W. Leutscher
Delft, February 2, 2018

Summary

After a certain amount of years, a hub requires maintenance, mandatory reconstruction to fulfil new requirements or expansion due to insufficient capacity. To do so, there are two approaches in transforming from the current state to a future state: (1) Close the building for (re)constructions or (2) keep the building opened for 'business as usual' while performing the mandatory work around the operations & services. To reduce inconveniences for passengers/visitors and/or all parties that are operating as usual, or when the (re)constructions will reduce the hubs' capacity while the demand is (almost) critical, appropriate crowd management measures should be applied. These measures can then be used as a response on loyalty and post-behaviour of passengers or visitors (Chen and Chen (2010)).
To create such measures, this thesis attempted to create and test a methodology that is able to deliver such crowd management measures. To do so, a research question has been formulated:

What is a suitable and applicable methodology to create practical, feasible and efficient crowd management measures to deal with passenger flows that could be used during (re)construction work at a hub, while business is performed as usual?

From literature study within this research, it was found that no methodologies were available to create crowd management measures, specifically applicable at hubs under (re)constructions. As a result of this, a transition have been made towards the literature of product design. The relation with prescriptive product design methodologies lays within analytically way of determining solutions (Cross (2005)), where the measures were assumed to be solutions to crowd management issues (Baelde (2016)).
To create design solutions, the essentials of rational methodologies and design methods from product design have been used to create a new methodology, which originate from: 4-stage model, Main Design Core, VDI2221, System Engineering and Rational Design Process and creative methods (brainstorming, synetics, enlarging the search space or creative process).
Next to the literature study, three unstructured interviews were performed at three different projects: expansion of Utrecht Central Station, building extension to increase visitor capacity of the Van Gogh Musuem (Amsterdam) and the Schiphol Amsterdam Airport project ONE-XS: the centralisation of the security filter. These interviews were used to determine what kind of methodologies were applied in the creation of crowd management measures in real life cases. The initial feedback of interviews did not provide specific methodologies to create measures for crowd management, but contained complementary information about project approaches that could be used within a new methodology.
The use of a new methodology was intended to make use of a structural and transparency approach to create crowd management measures such that no important elements and the real crowd management issues are identified (Cross (2005)) or overlooked. Upon that it ensures why measures should (not) or can(not) be applied, what limits the creation of measures, and how it should be communicated.

From the literature study the content of product design essentials (an analytic step to collect information, discussing and specification of design limitations, creation of solutions and the delivery of an end product), a new methodology has been created. This methodology should be capable of creating practical, feasible and efficient crowd management measures for hubs under (re)constructions. To do so, it contains a start procedure and 4 main steps: 'Collection of information', 'Specification of measure limitations', 'Creation of measures' and 'Delivery of measures', each containing supportive actions and questions to fulfil the main steps (fig. 1).

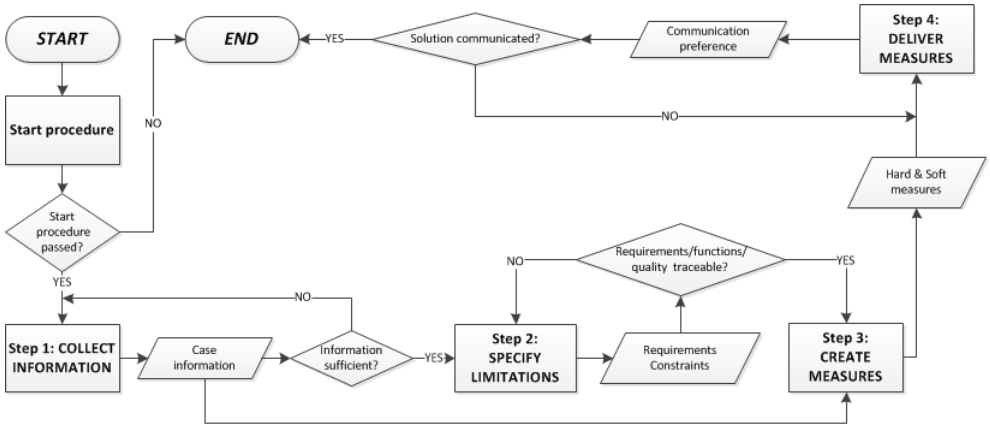

Figure 1: Main methodology structure

The start procedure provides questions that assure the methodology is only applied on cases that comply to: a hub, (re)constructions, (re)construction planning is available, crowd management measures are needed and business is performed as usual. 'Collection of information' covers the actions and questions that are used to create the crowd management measures' purpose, information, content and limitations. 'Specification of measure limitations' is included to perform a specification on requirements and constrains. Creation of measures' is dedicated to the creation of crowd management measures. In this particular step first hard measures are created then soft measures, which are applicable for general purposes at the hub and/or complementary to the already designed hard measures. Finally, the step 'Delivery of measures' is used to deliver the crowd management measures such that these are understandable for the case problem owner.

To determine whether the methodology is able to create crowd management, two assessment indicators have been used: (1) the methodology ability to perform all steps and (2) qualification of practical, feasible and efficient crowd management measures.
The methodology ability to perform all steps can be indicated by the execution of the methodology step: (i) methodology step can be performed, (ii) a step is not performed as initially intended but adjusted and creating the possibility to continue to the next step, or, (iii) methodology step cannot be performed, making it impossible to perform the next step. As long as all steps can be performed and one is able to continue with the methodology, is assumed that the methodology performs as intended and can deliver an end product. This is only assessed once and is only related to this particular research.
To qualify the product as practical and feasible measures, it was assumed that the created measures should cover the characteristics: the 4 traffic management principles (Hoogendoorn (2011)), identified crowd management issues, limitations in resources, location applicability, factors of influence, and, communication and application by the problem owner. The qualification of measure efficiency can be determined by case dependent location, legislation and other requirements. As long as the measures fit with the set characteristics and efficient compliance's, it is assumed that that the mea-

sures are qualified as practical, feasible and efficient. This qualification however, should be executed every time the methodology is used. Without this qualification it is not possible to determine whether the measures can be qualified as practical, feasible and/or efficient.
To determine whether the newly designed methodology, and all new steps perform as intended and deliver practical, feasible and efficient crowd management measures, it has been applied and tested on the case of Rotterdam The Hague Airport. With the use of the methodology, a set of hard and soft crowd management measures has been created (tables 1 and 2). Where the hard measures are identified by the physical modifications of the area of interests and soft measures are used to 'inform, advise and guide' the area users (Baelde (2016) p.10).

Table 1: Allocation of hard measures per specified area - Case: extension of the departure area of Rotterdam The Hague Airport

Location	**Expected issues** ***(reference)***	**Measure** ***(suitable resources)***	**Part of traffic management**
1. Buffer temporary central security filter (B-TCSF)	Spill back of queues Blockage arrival area *Expected situation similar as figure D.21*	Creation of variable buffer that could variate in terms of supply/demand w.r.t arriving/departing passengers *Grid floor plan* *(indicated by stickers)* *Bank lines*	1. Avoid spillback of queues 2. Increase throughput
2. temporary central security filter (TCSF)	Low capacity may lead to spill back *Expected situation similar as figure D.41*	Creation of strategic lane positions for optimal use of capacity *Current equipment* *Temporary wall*	2. Increase throughput 3. Divide over network
3. Buffer new central security filter (B-CSF)	Spill back of queues Blockage arrival area *Expected situation similar as figure D.21*	Creation of variable buffer that could variate in terms of supply/demand w.r.t departing passengers and passagehal passageway *Grid floor plan* *(indicated by stickers)* *Bank lines*	1. Avoid spillback of queues 2. Increase throughput
4. Passenger route	Reduced walking speed Spill back of queues *Expected situation based on insufficient view of walking path (B. Wiggers)*	Space reservation (IATA Level: C) for passenger flow versus contractors work space *Temporary walls*	2. Increase throughput 4. Limit inflow
5. KMAR-buffer	Spill back of queues Blockage of passageway *Expected situation similar as figure D.41*	Creation of variable buffer that could variate in terms of supply/demand w.r.t departing versus passing passengers *Bank lines*	1. Avoid spillback of queues
6. Current shop	Blockage of passageway *Expected due to 'uncertain frustration zones' (J. Slingerland)* Decrease of throughput due to shoppers *Assumed by author*	Minimal space reservation (IATA Level: C) for passenger flow versus shopping area *Current shelves*	2. Increase throughput
7. Temporary construction	Blockage of passageway *Expected situation similar as figures D.27 and D.29*	Minimal space reservation for passenger flow versus waiting area *Temporary restaurant facilities* *New/current furniture*	2. Increase throughput

Table 2: Additional soft measures to table 1

Location	Measures	Expected result	Part of traffic management
1. Buffer temporary central security filter (B-TCSF)	Perform boarding pass check before entering (T)CSF instead at buffer entrance and inform about procedure (Inform by signage or floorwalkers)	- Reduction of spill back in Passagehal - Increase of throughput of Passagehal	1. Avoid spillback of queues 2. Increase throughput
2. temporary central security filter (TCSF)	Use of an employee to assign a security filter lane (Guidance by security member)	- All security lanes are equally occupied	1. Avoid spillback of queues 3. Divide over network
3. Buffer new central security filter (B-CSF)	Perform boarding pass check before entering (T)CSF instead at buffer entrance and inform about procedure (Inform by signage or floorwalkers)	- Reduction of spill back in Passagehal - Increase of throughput of Passagehal	1. Avoid spillback of queues 2. Increase throughput
4. Passenger route	Hold passengers before entrance of Passenger route (Guidance by floor walkers)	Less crowded corridor, increasing safety and passenger experience	2. Increase throughput 4. Limit inflow
5. KMAR-buffer	Inform passengers about the buffer location and what to expect of procedure (Inform by signage or floor walkers)	- Reduction of time the passenger is at the KMAR-counter	1. Avoid spillback of queues
6. Current shop	N/A	N/A	N/A
7. Temporary construction	N/A	N/A	N/A

Together with the assessment of the methodology steps, crowd management measure qualification and tables 1 and 2, it it was possible to conclude that the methodology can be used to create practical, feasible and efficient measures. However, it was found that 2 methodology steps could not be performed and 6 additions/adjustments had to be applied to create and deliver the crowd management measures. The step 'improvement of conceptual hard measures iteration - 2', was found unnecessary, because the content was already covered by the preceding steps and the 'creation of detailed designs' was not performed due to outsourcing to the Technical Department of Rotterdam The Hague Airport. The 6 additions/adjustments that were performed reflect on the sub-steps of 'Collection of information' and 'Creation of measures'.
Within the 'Collection of information', the adjustments are found in the sub-step Exploration, covering: (1) the initial question about available resources was considered too broad and had to be made more specific to capture the resources within the problems owners possession, budget and interests. (2) A question was added to determine waiting areas, creating the possibility to derive specific dedicated areas that could be used to identify waiting behaviour. (3) Three new questions had to be added to determine crowd management issues' time frame, cause and interfaces. The three adjustments were found complementary to make the Exploration-step results more specific.

In the step of 'Creation of measures' it was found that an addition (4) of a evaluation process had to be implemented to select conceptual measures. This will provide a more supportive way of selecting a suitable measure concepts, where the discrete method of the Multi-Criteria Decision-Making (MCDA) (Mateo (2012)): Multi-attribute decision-making (MADM)
(Zanakis, Solomon, Wishart, and Dublish (1998)) could be used. (5) For the creation of soft measures, problem statements for the creative design method of brainstorm sessions had to added to to trigger the brainstorm session participants. Finally, it was found complementary to the detailed design phase to (6) include validation, summative or comparison testing, depending on the methodology user's preference.

The found pros of the methodology reflect on: (1) the ability to determine specific measure(s) per crowd management issue, (2) create hard measures based on the resources available and (3) match soft measures based on the hard measures and create general applicable soft measures separately. As a result of the transparency of the methodology, it is found that the methodology does not have any structural cons. However, worth mentioning are (1) the missing evaluation process, (2) the missing state of the art techniques regarding sensing and modelling, and (3) the in-ability to deal with changes in (re)construction planning.
In terms of the missing evaluation/decision process, it was found difficult to determine whether the created hard measures were chosen such that it made it possible to continue with the subsequent steps. In this case it is assumed that the occurrence of the missing evaluation process is rather incidental and is added as indicated, making this only one-off. Secondly, within this research no study was performed regarding state of the art techniques regarding sensing, simulation or modelling to predict crowd movement measures. To determine the whether these techniques are complementary to the outcome the methodology, these techniques should be included and investigated by future research, and are therefore also assumed to be one-off. Finally the methodology inability to deal with changes in (re)construction planning, was first assumed to be a con. However, due to the fact that the methodology is created such to have a structural and transparent approach to create crowd management measures, it is advised to re-perform the methodology as a whole. This to avoid mistakes in mismatching information, limitations, determined measures or communication content and exploit the transparency.

In all, this research has shown that a new methodology, based on the principles of product design, is capable of creating crowd management measures suitable for hubs under (re)constructions while business is performed as usual. Where the structured approach and its transparency in processes, allow the methodology user to trace inputs, decisions and actions to be performed to create and deliver practical, feasible and efficient crowd management measures.

However, it should be discussed that the newly designed methodology of this research is only applied and tested by a single case at Rotterdam The Hague Airport. This makes this research rather limited, due to the fact that the methodology is validated and adjusted to the characteristics of the case. By increasing the amount of cases, it is possible to validate each step and substantive process. To do so, this can be performed by a comparative case study, with the hierarchic method (Verschuren and Doorewaard (1999)) allowing to find and explain similarities and differences of the methodology application, steps and delivered crowd management measures. Therefore more research is recommended to determine the feasibility of methodology application at hubs that are under (re)constructions and business is performed as usual.

The recommendations of this research reflect on practice specifically for Rotterdam The Hague Airport and future research. First, the relocation of the boarding pass check (irrespective of the old, temporary or new Central Security Filter), mentioned in table 1. The relocation will avoid the boarding pass check queue to: (i) merge with the queues of the check-in counters, (ii) form a blockade of the entrance/exit and (iii) block the passageways (to the toilets). Additionally the relocation will be similar to the future plans, where the boarding pass check will be automated just in front of the security process.
Secondly, by locating the Fast and Crew Lane at the new Central Security Filter nearby the elevator, one create (i) the possibility for crew or employees to enter the security lane directly from the elevator with the shortest path, (ii) the fast lane can be used for passengers categorised as People Reduced Mobility, and is easily accessible by avoiding possible spill back of the buffer and (iii) the buffer lane of the fast lane creates a distance between buffered passengers and relatives.
In the context of future research, it is recommended to: execute different creative methods to determine whether these methods deliver similar quality and quantity of soft measures, that the noticed adjustments/additions are applied to the methodology to determine the complementary value of these adjustments/additions (including state of the art techniques), use of a structured methodology to determine crowd management measures have positive influences/effect on passenger loyalty and post-behaviour and validate the methodology on multiple cases such that it is not validated by only one particular case.

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Abbreviations

Abbreviation	Description
CSF	Central Security Filter
- B-TCSF	Buffer Temporary Central Security Filter
- TCSF	Temporary Central Security Filter
KMAR	Koninklijke Marrechaussee
KPI	Key Performance Indicator
RTHA	Rotterdam The Hague Airport

1

Introduction

Public areas such as stations and airports (so called hubs) have to deal with large passenger flows, valuable assets and multi-actor usage. Design and construction of these buildings from scratch, require major planning and logistical issues to overcome. Both the planning and logistical issues can be discussed, analysed and changed before construction, without inconvenience.
After a certain amount of years, a hub requires maintenance, mandatory reconstruction to fulfil new requirements or expansion due to insufficient capacity. To do so, there are two approaches in transforming from the current state to a future state: 1. Close the building, stop all operations & services, perform the mandatory work, finish, open the building for all operations & services, or 2. Keep the building opened for 'business as usual', while performing the mandatory work around the operations & services. To reduce inconveniences for passengers/visitors and/or all parties that are operating as usual, appropriate crowd management measures should be applied.

The latter will be applied at Rotterdam The Hague Airport. Starting from November 2017, the airport wants to extend their departure area to comply with increasing passenger demand and decreasing level of service. To do so, they would like to make the transition towards the new departure area without closing for operations, due to avoidance of monetary losses. To deal with expected inconveniences, the airport requested for hard and soft measures that would be applicable on passenger handling on a crowd management level.

To create such measures, this thesis attempts to create and test a methodology that is able to deliver such crowd management measures. The creation of the methodology is based on literature originated from product design and feedback of interviews. To test the methodology, it was applied on the case of Rotterdam The Hague Airport. The results of this application provided a qualification whether the methodology can provide practical, feasible and efficient crowd management measures, and specific measures for the case.
Further explanation about research goal, questions, approach, contribution and structure are presented in the following sections.

1.1. Research goal

The goal of this research was to create and test a methodology which is capable of delivering practical, feasible and effective crowd management measures, applicable at hubs under the specific circumstances of (re)constructions while business is performed as usual.
To do so, the methodology was designed and tested based on the case of Rotterdam The Hague Airport. How the methodology was designed and tested is discussed in the report. The outcomes of the methodology are related to the case are presented in the appendices.

1.2. Research questions

To achieve the main deliverable, the following research question is formulated:

What is a suitable and applicable methodology to create practical, feasible and efficient crowd management measures to deal with passenger flows that could be used during (re)construction work at a hub, while business is performed as usual?

To do so, this research is build up by four parts: (1) study of existing methodologies, (2) design of a new methodology, (3) case application of the methodology and (4) evaluation of the methodology.
Part one focuses on the search of existing methodologies that are able to deliver crowd management measures specifically suited for hubs under the circumstances of performed (re)constructions, while business is performed as usual. This was first performed by a literature study. In addition, interviews were be performed with managers of (re)contractual projects at hubs or locations with high valued visitors.
As a result of part one, all information was collected and compared, which gave a base for part two. In this part, an elaboration will be presented that will cover the exploitation of the new methodology and its respective steps.
In part three the execution of the newly created methodology is discussed, which was applied on a real life case: the expansion of the departure area of Rotterdam The Hague Airport. At the case all steps and supporting elements of the methodology were applied. As for the practical results of the methodology, these are the measures Rotterdam The Hague Airport demanded to combine their operations and crowd management.
In part four the adjustments/additions of the methodology, validation by the problem owner and, pros and cons, are discussed.
To achieve these parts, six sub questions are formulated. The questions are presented below (indicated in *italic*):

1. *What methodologies, that are able to create crowd management measures applicable in circumstances of (re)construction while business is performed as usual, are found in literature?*

   Before the methodology was created, it was important to perform a literature search on what methodologies already exist. The answer delivered literature of methodologies that are able to create measures, from a crowd management perspective. And if these specific methodologies do not exist, what type of methodologies cover the potential to create specific crowd management measures.

   To fill the gap of methodologies that were missing from literature, existing projects were investigated by unstructured interviews. This brought up the second question.

2. *What were the methodologies (that can create crowd management measure) applied at other hubs in the Netherlands, where business was performed as usual, while under (re)constructions?*

   The aim of this question was to determine what kind of methodologies were applied in real life at different projects with the same circumstances. The feedback could provide lessons learned or additional information with respect to missing literature.

   The results of these interviews were combined with the information of literature. This created a theoretical base for a potential method, resulting in the next question:

3. *What are the steps that identify the structure of the methodology?*

   From literature and related cases a methodology was set up. The methodology exists of certain procedure(s) and core activities. The answer of this questions covers the content, argumentation and contribution of the methodology structure.

   To test the potential methodology, it has been applied on a real-life case: Rotterdam The Hague Airport. This brings up the next question:

4. *To what extent does the potential methodology result in practical, feasible and efficient crowd management measures to keep the hub open while it is reconstructed?*

   Each step of the potential methodology has been performed. The outcome of the application of the methodology delivered a collection of measures the case holder (Rotterdam The Hague Airport) can use.
   Once all measures are delivered and qualified as useful, the next step was to evaluate the methodology. This was performed using these two questions:

5. *What are the adjustments and improvements necessary to apply the methodology on other similar cases?*

   The lessons learned from the case application and result of these questions deliver an overview of how the new methodology should be adjusted such that it can be applied on similar cases. The adjustments and future testing leave room for following research.

6. *What are the pros and cons of the new designed and tested methodology?*

   Finally, with all steps introduced, the adjustments discussed, the pros and cons of the methodology are discussed. These are supported by the methodology performance from the case of Rotterdam The Hague Airport.

To find answers on all sub-questions and the general research question, different research strategies have been used. This will be discussed in the following section.

1.3. Research approach and deliverables

To deal with the sequence of research questions of the previous section, a suitable research approach was required. This approach was supported by a literature study, unstructured interviews and applied research on a single case study. The combination of these studies are captured in figure 1.1.

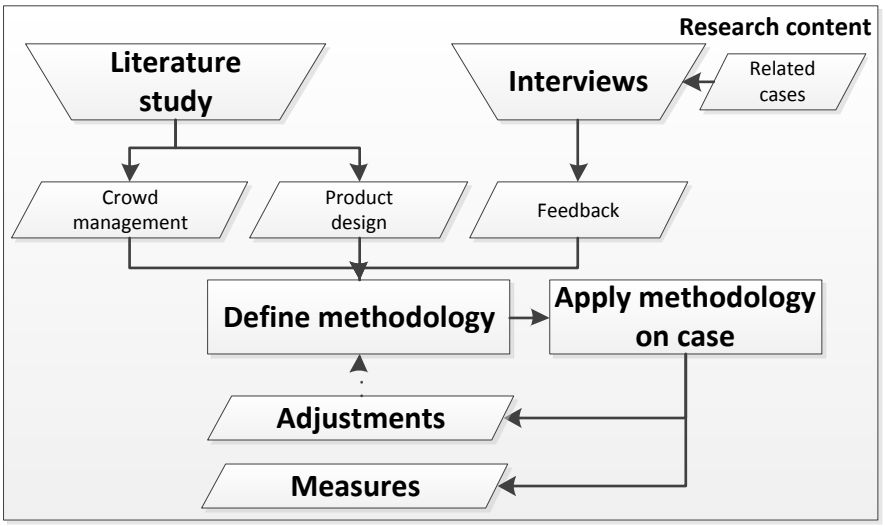

Figure 1.1: Research outline

This research starts with a literature study. The result of the literature may leave gaps regarding knowledge about methodologies that create crowd management measures. To fill those gaps, the information about methodologies was supported by experiences from practice. This information was collected from related cases performed by unstructured interviews.
The results of the literature study and interviews were used to design a methodology structure and content. Where the methodology is capable of creating crowd management measures applicable at hubs during (re)constructions while business is performed as usual.
The methodology was then tested on one particular case, based on the principle of single case study. The choice of this approach was to exploit the characteristics of a single case study: a small domain (one hub: Rotterdam The Hague Airport), personal approaches (management of mandatory processes at the hub), in-depth research (detailed information about the project), location review (location visits and experiences) and qualitative data research (data from the responsible stakeholders of mandatory processes) (Verschuren and Doorewaard (2007)).
To deal with this type of research approach it was found useful to get information about methodology applications of related projects (Verschuren and Doorewaard (2007)), preferably with the same case characteristics. This was covered by the information gained during the interviews of section 2.2.
The results of the case application resulted in two deliverables: the adjustments/additions of the methodology and delivered crowd management measures as a product of the methodology. The adjustments, are assumed to be applicable/complementary in adjusting the methodology for future applications, whereas the measures are specifically applicable at Rotterdam The Hague Airport.

Overall the deliverable of this thesis the presentation of a new methodology that is able to create crowd management measures for hubs that are under (re)construction where business is performed as usual. The methodology contains the steps required to perform a case analysis and use the information gathered to create and deliver crowd management measures for the case. This report covers the results of a literature study, feedback by unstructured interviews, case study results of the methodology application and adjustments of the methodology. Complementary a separate advisory report is delivered to Rotterdam The Hague Airport, containing the recommendations based on the created crowd management measures as a product of the methodology case application.

1.4. Research contribution

The research contribution exists of two parts: scientifically and practical. In case of the scientific contribution, this reflects on the design and delivery of a methodology that is able to create specific crowd management measures applicable at any hub, under the specific circumstances of mandatory (re)constructions and while business is performed as usual. At this moment there is no specific methodology known that is capable of creating such specific measures (see chapter 2). It is therefore a contribution to science to create and test a methodology that is based on theory and similar existing projects.
Eventually adjustments were necessary to adjust the methodology such that it could delivered the measures as initially demanded. These adjustments are mentioned, but were not applied due to limited time of this research. The applied adjustments therefore leave room for further research.
The practical contribution of this research is to deliver Rotterdam The Hague Airport crowd management measures that keep the area users satisfied, let (mandatory) services and operational parties operate as 'business as usual', while mandatory (re)construction works is been done.

1.5. Report structure

The outline and mutual relation of main subjects of this report is presented in figure 1.2. Chapter 2 is dedicated to two subjects. A literature study, presented in section 2.1, focuses on finding information about crowd management and methodologies to create measures. The second subject covers interviews. These were used to fill any gaps in literature, discussed in section 2.2. The combined information of these two subjects was used to create a potential methodology. This potential methodology is elaborated in chapter 3.
The potential methodology was then applied to a real life case, that of Rotterdam The Hague Airport. This is discussed in chapter 4. The evaluation and discussion of the methodology are discussed in chapter 5.
The conclusion and recommendations are presented in chapter 6.

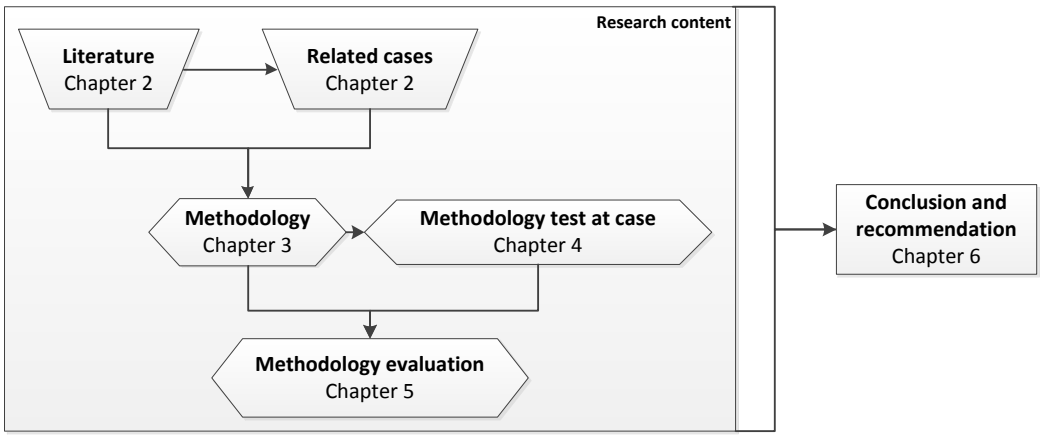

Figure 1.2: Report outline visualised

As the research goal, respective questions, approach, contribution and outline of this thesis are presented, the next chapter is dedicated to the first part of the research content: literature study and related cases analysis. In the respective chapter, the literature study is focused discussing excising methodologies that are used to create crowd management measures. The analysis of the related cases is used to fill the gap of missing respective literature, which is performed by discussing the feedback of unstructured interviews. The results of the literature study and case analyses are used to determine what methodologies could be used or support the creation of practical, feasible efficient crowd management measures, specifically applicable at hubs that are under (re)constructions where business is performed as usual.

2

Literature study and related cases analysis

This chapter is dedicated to the literature study and evaluation of the unstructured interviews. The goal was to find and discuss the methodologies that are used to create crowd management measures under the specific circumstances, in this case hubs under (re)construction while business is performed as usual. So it is about the processes required to come up with practical, feasible and efficient crowd management measures rather than the content, representation or specifications of measures itself.
The choice of using a literature study was to perform a desk research to find existing methodologies that are able to create crowd management measures. Where the content of measures is left out of scope. In support of the literature study outcome, unstructured interviews were performed to obtain non-published inside information about the methodologies used to create crowd management measures in real life cases.

First a literature study among two subjects of methodologies were performed: crowd management and product design. Within the theme of crowd management it occurred that there is a lack of literature about methodologies that can be used in the creation process of measures, specifically regarding hubs under construction while business is performed as usual. Consequently, the second part of the literature study focused on the search of methodologies on a more abstract level on creation of measures, which is the theme of product design. The content and relation of crowd management and product design are discussed in section 2.1.

The second section of this chapter covers the evaluation of unstructured interviews, performed at three different projects: expansion of Utrecht Central Station, building extension to increase the visitor capacity of the Van Gogh Musuem (Amsterdam) and Schiphol Amsterdam Airport project ONE-XS: the centralisation of the security filter. The purpose of evaluating these interviews was to determine what kind of methodologies were applied in the creation of crowd management measures in real life cases. The results are presented in section 2.2.

Finally the information gained in the literature study and in the interviews were compared. With the use of sub-questions, the results of the literature study and interviews were made specific. This is discussed and summarised in section 2.3.

2.1. Literature study

This section captures an introduction about the search strategy within literature, followed by the results of this literature search. The presentation about the search strategy is necessary to explain why a transition was made from crowd management measure methodologies to methodologies in content of product design. The results of this search approach are discussed afterwards.

2.1.1. Literature search approach

To perform the literature study, a step wise approach of enlarging the search space was used to find methodologies that are able to create crowd management measures. From the authors perspective at least three methodologies were demanded. This number of methodologies would give the possibility to mutually compare the methodology similarities or differences in preparation approaches, structure and type of deliverables.

Initially the start of the literature search existed of five search tags. The search tag of 'Methodologies' was assumed to be mandatory to find any methodologies in literature, whereas four additional search tags were used to make the search of methodologies specific:
1. Measures for crowd management
2. hub
3. Business performed as usual
4. (Re)construction

The combination of these search tags were found too specific, the results are presented in section 2.1.2. Eliminating the four complementary search tags would not provide the demanded results of suitable methodologies that could be used to create crowd management measures.
To react on the lacking results of this approach, a different complementary search tag was added to the steer the search of methodologies.
In this case 'product design' was chosen as the theme from the authors perspective and educational experience. To explain the transition towards product design, a recapture on the main research deliverable was performed.
As stated in section 1.1 the outcome of the methodology should cover crowd management measures that will be performed within a specific area under specific circumstances. So in other words, it is about how these measures can be created. In this case it was assumed that with certain step wise approach or design process one is able to do so. Such structured processes were found design of products (Cross (2005)). It was therefore that product design was taken as a theme.

As a result of solving a problem from product design view, the content of product design methodologies have been used as a theme. The content is discussed in section 2.1.3. In total six methodologies (2 simple, 1 general and 3 detailed methodologies) are discussed that originate from product design. This includes the why and how these are incorporated as a base for the methodology of designing measures. Upon that pros and cons are discussed, and examples are given.
In the last part of this section the content of literature is reviewed (section 2.1.4.)

2.1.2. Measure methodology application in crowd management

This section is used to discuss the literature regarding methodologies that are used to create crowd management measures. First the results of the literature study, performed by the 4 main search subjects, are discussed. Afterwards, literature that was found complementary for the creation of measures is presented.

Methodology for measure determination

For the search of methodologies, the four key subjects were used to find suited literature (listed below). However, even widening of the search space with synonyms, at search engines: Scopus, Google Scholar, Web of Science and IEEE, did not provided suitable literature regarding three different methodologies that can be used to create measures.

- Main search tags
  - Method(s)
  - Methodologies
  - System(s) (thinking)
- Theme:
  - Passenger
  - Crowd(s) (management)
- Location:
  - hub
  - Airport(s)
  - Terminal(s)
  - Station(s)
  - Museum
  - Public spaces
- State:
  - Business as usual
  - Open store
- Specific state:
  - construction
  - Renovations
  - Expansions
  - Reconstruction

As (Martella, Li, Conrado, and A. Vermeeren (2017)) states: '...There is no general recipe to produce a plan in crowd management...[]...the content of the plan is the outcome of all the decisions that should eventually steer the crowd towards that desired behaviour during the event.' As also stated is 90% of the effort of an event reflects on preparation, where one focuses on: '...factors that should be taken into account: (i) understanding visitor profiles, (ii) considering location, (iii) client management, (iv) institutions cooperation, (v) choosing personnel, (vi) accounting event type and (vii) preparing for weather...' (Martella et al. (2017)). So the content of a crowd management plan is known, yet no specific approach is available that is used to create crowd management measures. Confirming the gap of a missing methodology/approach to create crowd management measures.
In the literature content on airport(s) (design) researchers as: N. J. M. S. W. Ashford et al. (2011), Kazda and Caves (2007), N. Ashford, Stanton, and Moore (1997), Horonjeff et al. (2010), Halt (1991), Wells and Young (2004) and Caves and Gosling (1999), only focus on the concept of airports, covering overall master planning, strategic decisions and management. But no specific subjects are mentioned that relate to frameworks or methodologies to create measures with respect to crowd management.
Regarding railway stations (Ross (2000)) only captures a structural approach of designing train stations, but nothing to do with specific creation of crowd management measures. The design approach however, captures the content of planning, designing and building, which has similarities with product design (Cross (2005)). This makes the transition towards the subject of product design methodologies even more logic, from the authors perspective.
There was however, literature found that was complementary for this research: measure application for traffic systems. Despite the direct missing literature regarding methodologies, this literature was used to determine content of measures. This is discussed in the next paragraph.

Measure content

To steer a traffic system, (Hoogendoorn (2011)) introduces four principles that are able to deal with reduced throughput in a certain area, covering: avoid spillback of queues, increase throughput, distribute traffic total 'network' and limit the inflow.
To apply these principles or maintain a preferred state of the traffic system, users should be influenced on their decisions or behaviour. This can be done with three different categories by (Baelde (2016) p.10): '...Inform and advise allows the attendee to give their own interpretation to the message. The attendees are still free to decide if they will follow the information or advice. Guidance allows less freedom in the decision, the attendees are guided towards their destination or away from their current location. Physical modifications to the environment are used to increase the throughput by making changes to the area...'. As a result of this statement, a difference of hard and soft measures can be introduced: hard measures reflect on the physical modifications and soft measures on to 'inform, advise and guide' the users.

Although the missing link on how measures can be generated, it can be concluded from the authors perspective that the output of a methodology should cover hard and soft measures.

2.1.3. Product design methodologies and methods

The relation of creation of crowd management measures and product design methodologies is discussed in this chapter introduction. In this section a literature study was performed regarding these methodologies and methods, coming from product design. Before going into detail about these methodologies first an intermezzo paragraph is provided about terminology of methodologies and methods.
In the paragraphs that follow, six methodologies are discussed. The first two that are discussed are: the 4-stage model and Main Design Core. This followed by the methodology of the Rational Design Method, which creates the bridge between simple methodologies and those that cover more detail per step. Those more detailed methodologies are System Engineering, VDI2222 and VDI2221.
Per methodology paragraph the content is discussed, including the why and how these methodologies could be interesting for this research, supported by pros and cons. Per discussed methodology an analogy is provided to clarify the potential content of the respective methodology, indicated in *italic*.
The last paragraph covers the options of design methods.

Intermezzo: difference between methodology and methods

To inform the reader, this intermezzo is provided to elaborate on the difference between methodology and methods.
Literature clearly makes a notification of the difference about the approaches in product design. Design methodology relates to the concrete design procedures at the level of processes and activities. These methodologies are systematic approaches on the design that cover: clarifying objectives, establishing functions, setting requirements, determining characteristics, generating alternatives and improving details (Cross (2005)). Which was also relevant for this research.
Design methods relate to the design of specific objects (or artefacts) and specifically related to a particular step in the process of creating a certain deliverable (Tomiyama et al. (2009)). Therefore the term methodology is the correct term for this research, indicating the steps and processes to create measures.
The following paragraphs provide an elaboration on the methodologies and design methods.

4-stage model

The first methodology is the '4-stage model', which is a descriptive model of the design process, created by (Cross (2005)). This model was found useful for this research, due to its simplicity. It only captures the basic steps required to create a certain design. Therefore it could be hold as a basis of steps how measures could be created. A suitable example regarding this model in generating measures could be:
Perform research about the area of interests, determine the location of temporary construction walls, test if the walls will suit the location - if not: go in the feedback loop, and finally the walls are ready for placement.
Due to its simplicity, the descriptions of which processes or activities should be performed are missing. It was therefore interesting to find other methodologies that could supplement the details about the processes and activities.

Main Design Core

The second methodology found for generating a certain product, is the Main Design Core originated from the Total Design: Integrated Methods for Successful Product Engineering (Adams (2015)).
Eventhough the Main Design Core shows some similarities with the 4-stage model, this model is more focused on 'market' and 'sell' of products. The market theme of this model is a little odd in this case because the Main Design Core intention is to create products instead of measures. However, the sequence and iterative steps make the model interesting for this research: Market, Specification, Concept Design, Detailed Design, Manufacture, Sell.
Despite the 'market', this part of the model was still assumed to have the the potential of contribution of determining measures. An analogy regarding 'market' could be:
The digital signing used at Central Stations seems to have a positive influence on the passenger experience. This type of signing was therefore interesting for aviation buildings as well.
By performing such research in the market, it is possible to respond to the expectations or needs of the user.

Rational Design Process

Design methodologies focus on a systematic approach of the design. As (Cross (2005)) captures this approach acts as a base sequence of making designs, which exists of 4 main milestones and 7 steps in a rational manner. The steps that are found complementary to the 4-stage model and design core are: establishing functions, setting requirements, determining characteristics. Establishing functions was used to '...establish the functions required, and the system boundary, of a new design.' (Cross (2005) p.57). For example: *The temporary walls should separate users from construction work.*
The requirements relate to the performance requirements of a product. For example: *The walls should hold x-amount of pressure and should reduce noise nuisance with x-amount of decibel.* The step of requirement notification was assumed to be useful due to its potential in limiting the solution space.
The last step that is different compared to the earlier discussed methodologies is that of determining the characteristics. This step was used to define the engineering characteristics of the product. An example could relate to satisfy the user requirements. From the authors perspective, this should be taken into account in the overall problem description or objective.
However, the descriptions, mentioned by (Cross (2005)), remain brief. But from the authors perspective the line of reasoning regarding the rational approach, was assumed to be clear and consistent to act as useful information about methodologies.

System Engineering

A more abstract description regarding rational methodologies is System Engineering. This methodology could be applied in large- and small-scale systems, new (product) development and improvements
(Department of Defence (2001)). Here the System Engineering Process (SEP) is the underlying process that defines the System Engineering.
Despite the abstract level of this methodology, the way of approaching a certain solution finding process was assumed to be rather useful for this research. Along the document of (Department of Defence (2001)), each step is extensively described. Reducing the abstract level of the System Engineering Process by the use of the document of (Department of Defence (2001)), the model becomes more understandable.
A suitable example of the application of the System Engineering Process could be:
Information about the area, needs and preferences are collected, during the process input. Then all information is divided by the requirement and functional analysis. Eventually the design synthesis covers the creation of temporary walls, that comply with requirements and functions. Eventually the designed walls will be delivered as part of the output.

VDI2222 and 2221

The VDI2222 and VDI2221 both are methodologies focusing on creating a solution with respect to a task (Jänsch and Birkhofer (2006)). These methodologies origin from Germany, where VDI stand short for Verein Deutscher Ingenieure. Because these two models are related to each other, they are discussed together in this paragraph.
The notification of VDI2222 was interesting due to the clear sequence of activities to be performed. Especially the use of 'task' and 'solution' was assumed interesting in creation of measures.
With the definition of tasks, a clear description can be defined about how the measures should work or what they need to do. For example: *The task of the measure should separate users and construction work.*
Whereas the solution reflects on how the task can be covered. For example: *The use of temporary walls.*
Other steps in this methodology are similar to the previous discussed models.
The notification of VDI 2221 is interesting due to the statement of Jänsch and Birkhofer (2006): "...The goal of this guideline is to propose a general methodology for designing technical systems and products and to support a methodical and systematic designing, in order to produce a more efficient working style." (p.49).
Both the VDI 2222 and 2221 have a similar sequence of activities: define a task, determine specifications, search/create preliminary solutions and combinations, create a definitive layout based on feedback of requirements and finish with operating construction and future realisation. However, there are slight differences:
VDI2221 focuses on product development processes, including methodical, systematic design and creating a more efficient working style, while VDI 2222 focuses on conceptual design (Tomiyama et al. (2009)) and education (Jänsch and Birkhofer (2006)).
In case of the application in determining measures, the principle VDI 2221 was therefore more suitable.

Creative design methods

The methods that are discussed by (Cross (2005)) relating to creative methods only reflect on the design part of methodologies. Methodologies such as System Engineering or VDIs capture the step of design synthesis or search for solutions. This is where the design methods appear and reflect on (Cross (2005)): brainstorming, synthetics, enlarging the search space and creative process. In this paragraph explanation is given about these four the creative methods and their purpose. The subjects may be discussed separately, but from the authors perspective these are captured as options within creative methods, so therefore discussed together.

- Brainstorming
  A method to create large number of solutions by a group of 4 to 15 people (Boeijen et al. (2013)), preferably each person with another expertise. Points that should be taken care of are: during the session no criticism is allowed, large quantity of ideas is wanted, crazy ideas are welcome, keep ideas short and snappy and try to combine and improve ideas of each other.

  The main advantage of using a brainstorming is the statement of: '...a widely known-known design method ...' (p. 48 (Cross (2005))). Besides this, brainstorming delivers a large variety of ideas due to the different backgrounds of participants.
  Possible disadvantages mainly relate to the influence of group processes: social loafing (taking the easy way out and letting others speak up) (Millerd (2016)), non-constructive contributions and support (Academie (n.d.)), or non-prepared ordering for processing all ideas (Floor (2017)).
  These disadvantages can be suppressed by keeping the group non-hierarchical with one session leader and correct preparation (Cross (2005)).

- Synectics
  A design method based on the idea of seeing parallels or connections between apparently dissimilar projects. This type of analogical thinking is also known as 'synectics'. The similarities in this method, compared to brainstorming are that the session is performed by a group, where criticism is not desirable and where the group members try to come up with creative solutions to the problem. Differences of this method are that all group members work towards one particular solution. Within synethics there are 4 types of analogies;

  Direct analogies - Usefully found by biological solutions to a similar problem

  Personal analogies - Groups members should think of oneself as part of the system

  Symbolic analogies - Use of poetic metaphors

  Fantasy analogies - Impossible wishes to be achieved in a magical way

  This switch may confuse participants, due to their experience with brainstorming. However, this process may be new and could have a positive influence in generating ideas. In this case the same pros and cons of brainstorm occur, due to the fact that this session is performed by a group.

- Enlarging the search space
  There are four techniques to overcome mental blocks during the creative process:

  Transformation - Apply verbs in the problem description

  Random input - Creative ideas can be triggered by any type of source

  Why? Why? Why? - Apply a string of 'Why's', which helps to think further

  Counter-planning - Create ideas that counter potential solution

The advantages of this method is that it enlarges the search space. By increasing the effort of applying different techniques on finding solutions, these may cover a whole different solution space.
Literature provides no specific examples of disadvantages. From the authors perspective these techniques are probably already applied unconsciously. For instance the 'Why? Why? Why?'. This approach may already be performed due to educational background of the person that is searching for a solution.
So although the creative methods could create a wider range of solutions.

- Creative process
  The techniques above are used to 'turn on' creative thinking. However, creating creative ideas sometimes occur spontaneously. This approach can be achieved by; recognition-preparation-incubation-illumination-verification. Where the illumination is often referring to the creative leap.

  This technique could be similar to the 'Random Input' of the previous method, but even can take more time due to the missing 'Ah-Ha moment'. For example: one experiences a certain happening walking downtown, triggering just that idea someone needed. But to respond on the time one need for this moment, previous techniques should be applied in an earlier state. This helps to avoid any time consuming thinking.

From the authors perspective, these methods are assumed to be more applicable for the creation of soft measures. Especially group sessions are found useful to create ideas, solutions or measures that relate to the expectations of users. By performing these sessions, participants with different expertise will be able to come up with different visions of how information, advise or guidance can be interpreted or shared. It was therefore that these sessions result in general applicable soft measures or which can be complementary to the hard measures.
The use of 'Enlarging the search space' and 'Creative process' may also be used to create hard measures.

2.1.4. Review of literature study results

From the search of methodologies that could create crowd management measures, no direct literature was found. However, the indirect literature regarding measures can be used to support the methodology outcome of hard and soft measures. The measure content, representation or specifications was left out of this study.
In terms of the literature of product design, the rational methodologies were assumed to be suited for the design crowd management in a structured manner. Especially the hard measures, which require a structural plan to create solutions that fit requirements and constrains.

Each of the methodologies that were discussed in the theme of product design covered similarities in step wise approaches to deliver a certain solution. By comparing each step of the individual product design methodologies in sequence, a pattern becomes clear. In this case 'Exploration' of the 4-stage model, 'Market' by the Main Design Core, determination of 'Overall Problem, Objectives, Functions' by the Rational Design Process, 'Input Process' by System Engineering and 'Tasks' by VDI, are all assumed to be an analytic step of the methodologies. This is assumed to be the first in a sequence of steps to create solutions and defined by the author as 'Collection of information'. This kind of similarity was also found in discussing and specification of design limitations, creation of solutions and the delivery of an end product. Similar patterns also return in context of the 'Design Innovation Process': Research, Analysis, Synthesis and Realisation (Kumar (2013)) and 'Creative Problem Solving': Explore the challenge, Generate Ideas and Prepare for action (Boeijen et al. (2013)). As a result of the overlap in sequence, table 2.1 was used to conceptualise this pattern from the authors perspective.
In case of the creative methods, these were assumed to be more applicable in a softer level of measures and are part of the creation of solutions. These are therefore not included in table 2.1.

Despite the missing link with the theme of creation of crowd management measures, the overall similarities of the categories from table 2.1 were assumed to have a potential to create a methodology for this research.
Due to missing literature to validate this assumption, existing projects were investigated. The goal was to determine what kind of methodologies were used to create crowd management measures in practise. The feedback could then be used to validate the assumption of the overall sequence of product design methodology steps by category.

Table 2.1: Literature of product design methodology steps categorised by the authors perspective

Product design methodology	Steps per methodology			
4-stage	Exploration		Generation/ Evaluation	Communication
Main Design Core	Market	Specification	Concept/ Detailed Design	
Rational Design Process	Overall problem/ Objectives/ Functions	Requirements	Alternatives/ Evaluating/ Improving	Overall solution
System Engineering	Input process	Requirement analysis	Design synthesis	Ouput
VDI	Task	Specification	Concepts/ Priliminary lay out/ Detailed design	
Overlapping step sequence categorised	**1: Collection of information**	**2: Specification of design limitations**	**3: Creation of solutions**	**4: Delivery of solutions**

2.2. Related cases of areas that were kept opened during (re)constructions

This section is dedicated to the evaluation of interviews about existing projects gained from existing projects. The goal of the interviews was to determine if any methodologies were used to create crowd management measures. To collect this information unstructured interviews ((Wilson, 2014)) were performed with project managers. These managers were involved in projects that had to do with crowd management and (re)construction work. Additionally measures that were introduced at the respective projects, are discussed in section 2.2.2. A total of three projects were conducted, each located in the Netherlands due to the fact that these could be visited during the this research period:

1. Utrecht Central Station. The aim of the constructions was to expand the station to handle the increasing passenger numbers. This project was included in this research due to the hub function and construction work performed during regular operations when business is performed as usual. A point of interest is that the frequent user is visiting the location everyday - and so knows the area by heart.
2. The project of the Van Gogh Museum (located in Amsterdam) was executed to extend the visitor capacity, create a better and more hospitable way of receiving guests (NOS (2015)). The added value of the Van Gogh project for this research was related to the involvement first time visitors, paying customer for service at that particular location and construction work performed during 'operations'. The main difference in this case is that the Van Gogh museum is a destination, rather than a transfer location of transport of any kind.
3. Schiphol was included with respect to the project ONE-XS: the centralisation of the security filter. The characteristic that stand out is that of being an airport (hub) and work performed in areas that of business as usual. In case of differences, this project only covered a part of the whole airport building - and so did not influence the whole process of a departing/arriving passenger.

In the following sections the interviews are discussed, followed by the applied tools in crowd management. Finally a conclusion is presented that reflect on the evaluation of the interviews.
The preparation and minutes of these interview are presented in appendices A.1, A.3 and A.5 respectively, written in Dutch.

2.2.1. Project approaches and methodologies

In this part of the section the interviews regarding the project approaches and methodologies are discussed. A brief explanation is given about the feedback, followed by the weighting of suitability regarding methodologies. And if not, what way of thinking of these approaches can be used in determining measures.

Utrecht Central Station

Starting with the feedback of interview with Mr. Wiggers, Rail System Engineer at ProRail, regarding the expansion of Utrecht Central Station. It turned out the project approach of Utrecht Central Station did not use System Engineering explicitly, but "...had something to do with system thinking (Jackson (2003))". By making mutual appointments, with stakeholders (service providers and users) and contractors about: project, boundaries (and monitoring), clear 'building blocks', (multiple) interfaces, the project stayed manageable as a whole. With the use of integral coherency of system thinking, one was able to monitor all projects and their interfaces which then could be used to determine and allocate measures applicable within the area of interests.
From this it was assumed that determination of suitable measures for different scenarios was a product of interconnected process, depending on many inputs. But yet a structured process of all preceding steps was still not mentioned.
From experience and practice, system thinking is not always successful (Wiggers). It seemed hard to introduce the 'You are part of an aspect-system' to all executive parties. Especially smaller contractors just started with their work without correspondence. Typical examples of not communicating,

was that external contractors blocked important pedestrian aisles, which could have led to dangerous situations. How these problems were solved was not clear from the interview. A suitable assumption could have been that a 5 minute job did not have to take 45 minutes, due to paperwork. And therefor contractors ignored the level of communication.
Another point of attention, was the use of a stakeholder analysis (performed before the project). This analysis was found useful to determine empathy, relation and influence of other parties that were involved in the project.
In all, the interfaces and their coherency, mutual sharing and communication with(in)/of projects, were leading factors to keep the project manageable an was useful to allocate and create measures for Utrecht Central Station.
In reflection to this research it becomes clear that system thinking was a useful tool to create and keep an overview of every step.
In the end no specific methodology was found, but suitable feedback may relate to: system thinking (allowing to localise and assign crowd management measures to specific areas) and stakeholder analysis. How the system thinking can be used will be discussed in section 3.5. How a stakeholder may contribute to this research will be discussed in section 3.3.

Van Gogh Museum

The second interview was performed with Mr. Slingerland, Head of visitor service of the Van Gogh Musuem. At this project a different approach was used: OGSM (Objective, Goal, Strategy and Measures). In this case the creation of 'measures' within this approach did not explicitly cover a description methodology that has to do with this research. However, a lesson learned from this type of approach was to keep in mind the mission of the company. By doing so one was able to wraps measure(s) such that it stands for the product a company wants to emit to visitors.
Next to this approach, this project was internally divided into so called work packages and the strategic plans to tackle crowd management problems. Each of the work-packages for this project, covered a different subject and/or particular action (e.g.: 'The opening and start of the new entrance' - covering operations on what to perform to open the new entrance, but also what happens to the old entrance?). So within each package own measures should be created.
In all, information gained during this interview was mainly related to 'Communication of information' reflecting on the 'experiences of crowds' by (Victoria, Eason, Waterson, and Haslam (2017)) and not on the creation of measures. The points of the feedback that could be interesting for the potential methodology: strategic plan method and objective, goal, strategy, measures (OGSM).

Schiphol ONE-XS

Finally the interview performed at Schiphol with Mr. B. De Zwart, Head of project ONE-XS.
The project approach at the Schiphol project was managed by PRINCE2 by AXELOS (AXELOS (2017)). This project approach was not explicitly used to determine measures, but was mainly focused on quality and keeping the project manageable.
Points of attention were mainly based on 'surprises'; initial planned work or interfaces always turn out to be assumed too narrow. Meaning that there were always more parties or contractors involved. As well as planned work which always led to encounters when performing construction work, such as non-documented cables, fixes or short comings.
One particular measure that was noticed during this interview had to do with strategical crowd management. When performing mandatory (re)construction work in a certain hallway or corridor, make sure that the work was only performed parallel to the passenger flow.
As for the results of this interview, same as the previous interviews, this interview did not delivered a specific example of measure package creation.
In short the possible additions to the potential methodology could be: learn from previous projects and quality requirements.

2.2.2. Crowd management tools applied in practise

The feedback regarding the interviews did not deliver specific methodologies on how to deal with certain scenarios, circumstances or create measures. However, in the contrary of the methodologies, all interviewees mentioned tools they used and applied to deal with crowds within their projects.
For the tools that were mentioned, these were divided according the principles found by (Baelde (2016)) and will be presented in the following list. In appendix A the argumentation of the application of these tools are further elaborated.

- Inform and advise
  - Ask people to come on time to proactive reduce peak hours
  - Avoid making excuses to avoid reduction in passenger experience
- Guide
  - Focus on logical wayfinding and signing
  - Application of ground stickers (e.g. arrows, guiding lines)
  - Do not overcompensate with signing
  - Use a corporate identity to respond on experience and recognition
  - Determine route dominance to determine strategic signing placement
- Physical modification of the environment
  - Make the area of visit logical
  - Determine frustration zones
  - Apply a lighting plan
  - Keep fire safety in mind
  - Act on performance requirements
  - Act on level of service
  - Keep in mind the People Reduced Mobility
  - Minimise nuisance
  - Shielding the construction site

It should be notified that these tools are not categorised as measures, but rather complementary tools that can be used when specific measures should be defined.

2.2.3. Related cases review

As can be concluded from the interviews, there were two subjects that were covered in the feedback. The first one were the project approaches, which were used as the backbone for projects: System Thinking, OGSM and PRINCE2. These project approaches were assumed to be approaches in terms of project management and solving problems in general, instead of creating measures. It should however be notified that the crowd management measure allocation is assumed to be a too specific feature of system thinking, rather than a definition of a certain approach or methodology. It is therefore assumed that the allocation will be taken into account within the creation step of a new methodology.
Despite the missing link in creating measures; stakeholder analysis, objectives, goals and strategy, learnt from previous projects (also supported by (Martella et al. (2017)) may contribute to the analytic step of a new methodology for this research: 'Collection of information'.
Secondly notified were the tools mentioned during the interviews, which could be used to steer passenger flows. However, these more reflect on general application to deal with crowds, instead of determining measures. So these tools were used in creating crowd management measures for the particular case of Rotterdam The Hague Airport, but not to build up a methodology.
In all, the feedback of interviews did not provide the content which could be used to validate the assumption of the step categories of the literature study.

2.3. Literature study and interview review

In this section the suitability of the content of the previous sections is discussed. Covering a conclusion that reflects on answers of the sub research questions of this chapter.
In the end all content is captured in one table to determine any correspondences, which is used as a base for the following chapter.
The first sub question: *What methodologies, that are able to create crowd management measures applicable in circumstances of (re)construction while business is performed as usual, were found in literature?* can be answered as followed:
No literature was found in content of crowd management that relate to methodologies that could create specific crowd management measures. As a response on the missing literature, a search of methodologies in product design delivered different methodologies that could be used for a new methodologies.
To create solutions, rational methodologies from product design may function as methodologies to create hard measures. These rational methodologies contain steps that are useful for the creation of hard measures: 4-stage model, Main Design Core, VDI2221, System Engineering and Rational Design Process. For soft measures, design methods are assumed to be useful. These methods should be performed during the process of the rational methodology, which cover brainstorming, synetics, enlarging the search space or creative process.

The second sub question was defined as: *What were the methodologies (that can create crowd management measure) applied at other hubs in the Netherlands, where business was performed as usual, while under (re)construction?*
For this question, the answer can be captured as:
The information of the feedback from the interviews, regarding the project approaches did not provide specific methodologies to create measures for crowd management.
However, the project approaches of these projects are assumed to be useful. System thinking is used to due to the rational thinking allowing to assign crowd management measures within the area of interests as a response on project monitoring, stakeholder analysis for the tractability of stakeholders regarding their influences, interests and empathy, OGSM useful supporting the way measures should be achieved, learned from previous projects to avoid unnecessary scenarios and quality to support measures in applications level. In all stakeholder analysis, objectives, goals and strategy, learnt from previous projects are assumed to be a contribution to the step of 'Collection of information' of the determined categories of product design methodologies (tab.2.1).

As part of the literature study, the similarities in methodology steps of product design were assumed to have the potential to act as a base for a methodology to create crowd management measures. These base steps exists of 'Collection of information', 'Specification of measure limitations', 'Creation of solutions' and 'Delivery of solutions'. In this case, no specific literature regarding crowd management nor the feedback of interview was suitable to reject this assumption.
Consequently, the base steps are used to create a methodology that should be able to create crowd management measures. To keep within the theme of crowd management measures, the 'solutions' in the base steps are changed towards 'measures'.

As this part of this research is finished, the next chapter is used to discuss and exploit the base steps to create a new methodology which should be capable of creating crowd management measures for hubs under (re)constructions while business is performed as usual. This will be supported by the methodology purpose and description of measure characteristics.

3

Methodology to design measures

This chapter is used to discuss and exploit the methodology base steps of previous the chapter: 'Collection of information', 'Specification of measure limitations', 'Creation of measures' and 'Delivery of measures' into a usable methodology. To do so, first the main purpose and a brief explanation about the methodology is presented.
In the sections that follow, each of the steps are elaborated on regarding the content, why that particular step should be performed and how it should be performed in real-life. These are supported by suitable examples regarding this research.
In the last section of this chapter a review of the methodology structure will be presented, covering the answer of the sub question: *What are the steps that support the structure of the methodology?*

3.1. Methodology purpose, deliverable and appearance

Before introducing the appearance of the methodology it is useful to discuss the purpose of the methodology. With the use of a schematic presentation, it was possible to determine the influences and consequences of the methodology. As a result, it was possible to determine how the methodology should perform.
Knowing the purpose, the methodology appearance can be presented. Which will be done in section 3.1.2.

3.1.1. Methodology purpose and deliverable

As discussed in section 2.1.2 is that measures are used to steer a certain traffic system, where the use of a methodology should deliver such measures. It was here that the use of a methodology can provide the origin and purpose of the measure. To do so, the influence of measures was used to explain the purpose of the methodology. From this the deliverable of the methodology becomes clear.

Methodology purpose

To steer the traffic, an option is to apply measures that will have an effect crowd management issues that occur due to (re)constructions at a hub that is performing as usual. In case of these measures, these reflect on hard and soft measures, which may affect three themes that influence the experience in crowds: Physical design of crowd spaces and facilities, Crowd movement, Communication of information (Victoria et al. (2017)). As a result of applied measures, these may consequently affect the experience of crowds and so the loyalty and post-behaviour of passengers or visitors (Chen and Chen (2010)). Which in this case relate to a possible returning and/or increase of passenger demand and therefore assumed to be positive for the hubs operation and '...company's long-term viability or sustainability...' (p.31 Chen and Chen (2010)).

So making the influence and consequences of measure application transparent, it was preferable, from the authors perspective, to create a methodology structured and transparent as well. The use of a transparent methodology ensures that, the design of measures is fully understood, no important elements are overlooked and the real crowd management issues are identified (Cross (2005)). In addition, from the authors perspective, a transparent methodology ensures the user of the methodology and problem owner to trace why measures should (not) or can(not) be applied, what resources limit the number of measure possibilities, which constrains limit the dimension of measures, which legislation or requirements limit the possibility to apply measures, tractability of location application measures, factors of influence, and how it should be communicated and applied with the problem owner. So the use of a methodology creates the tractability and origin of the measures.

Methodology deliverable

With the purpose of the methodology discussed, the next subject to be discussed is the deliverable of the methodology: practical, feasible and efficient measures. To explain the deliverable of the methodology, a recapture of the main research question was performed: '...create practical, feasible and efficient crowd management measures...'. With this statement it was assumed that the to be delivered measures should cover these characteristics. In terms of creating practical and feasible measures, it was assumed that these should relate to both soft and hard characteristics of measures: included elements (the 4 principles by (Hoogendoorn (2011)), identified issues, limitations in resources, location applicability, factors of influence, and, communication and application by the problem owner. Whereas the efficiency of measures is a description of the performance of measures, which can be provided by the dimensions of the location, legislation and other requirements. So the deliverable of the methodology should cover crowd management measures that are practical, feasible and efficient. Which in turn reflect on the transparency characteristics, compliance with the limited of resources, identified issues and efficiency limits. In the following section the methodology appearance is provided. This will give an overview which steps should be performed to make the methodology, and making the measures traceable.

3.1.2. Methodology structure

With the introduction about measure transparency and the purpose to present a methodology with the same characteristics, this part of the section is dedicated to the introduction of the methodology. The methodology is initially based on the literature subjects of table 2.1. The result of the combined subjects are presented in figure 3.1. The presentation of this figure capture the main steps of the methodology as a flow diagram.
The pre-step of the methodology is covered by starting procedure. This procedure helps the user to determine whether the methodology conditions are met. If so, the methodology may be applied on a case. This decision process is explained in section 3.2. When the start procedure is done, it is possible to continue with the methodology.
The first main methodology step covers 'Collection of information' and are discussed in section 3.3. The content of this step relates to the collection of information regarding case information. Its purpose is to collect and distinguish information that will be used in later methodology steps.
The 'specification of measure limitations', are discussed in section 3.4. The purpose of this step is to determine (quality) requirements and constraints. The support for this phase is derived from the System Engineering Standard ('IEEE P1220, Standard for Application and Management of the Systems Engineering' Department of Defence (2001) p.12).
When the preceding steps are finished, the next step is 'Creation of measures', presented in section 3.5. This part of the methodology is fully dedicated to the creation of the measures. Which is identified by the steps required to create hard and soft crowd management measures that are assignable to specific or all areas, within the area of interests.
The last step of the methodology is dedicated to 'Delivery of measures' and are discussed in section 3.6. This step covers the communication preferences of the measures.
When all internal steps of Collection of information, specification of measure limitations, Creation of measures and Delivery of measures are discussed, the methodology can end. This is discussed in section 3.7.
It is up to the user of the methodology to perform all steps before the (re)constructions are performed. This enables to correspond the creation of measures with the issues expected, determined from the (re)construction planning. To gain more understanding about the processes internally or content of a certain step, the textual explanation is assisted by flow schemes.

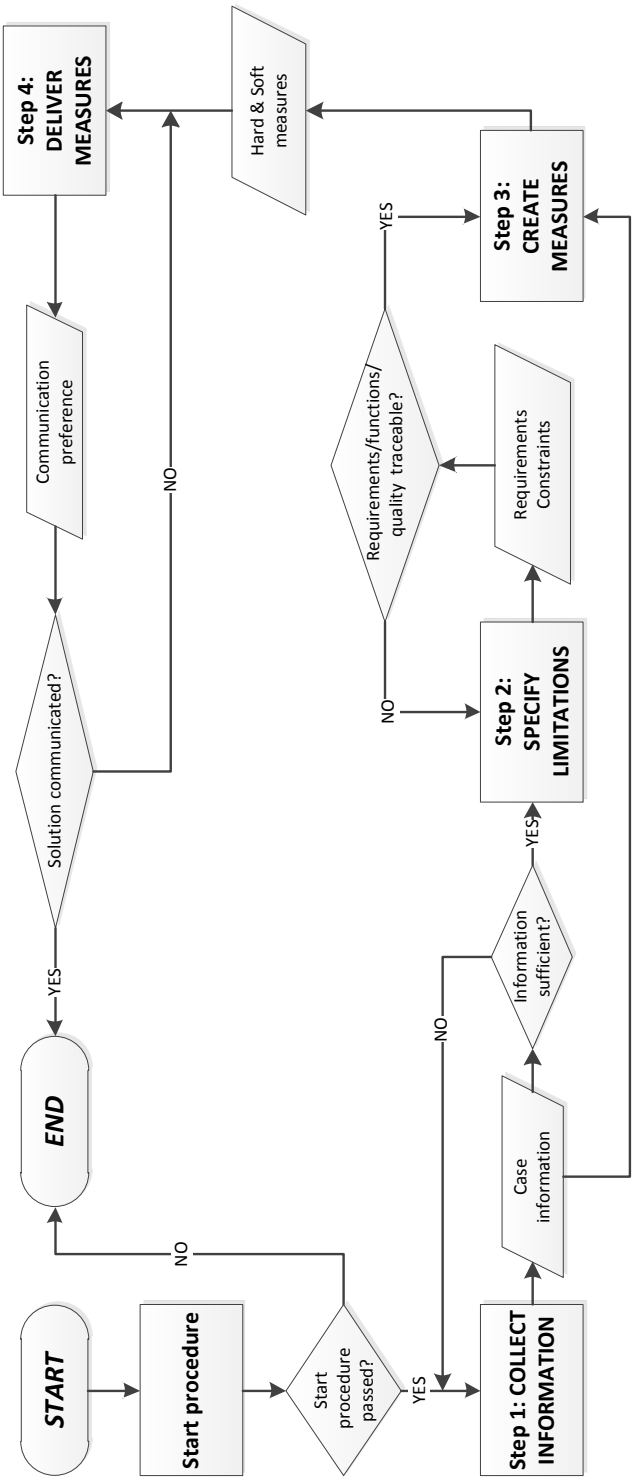

Figure 3.1: Methodology structure covering the main steps

3.2. Start procedure of the methodology

This section is used to discuss the start procedure of the methodology. By questioning the user about conditions of the methodology, one is able to determine whether the methodology can be used for their case. To do so, figure 3.2 is used to support the process of questions.

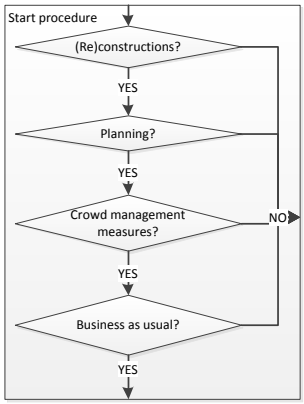

Figure 3.2: Start procedure of the methodology, applicable for hubs

The questioning used, relate to the main core of the methodology: '...create practical, feasible and efficient measures to deal with passenger flows that could be used during (re)constructions at a transfer hub, while business is performed as usual...' (research question of section 1.1). Assuming one will use the methodology at a hub, the subjects that should be questioned are: crowd management, business performed as usual and (re)constructions. The sequence of these questions become clear with following line of reasoning.
The first question of the start procedure reflects on (re)constructions. This question is cited as: 'Are (re)constructions performed at the hub?'. This is asked to determine whether there are any (re)construction work is performed at the hub. If 'Yes', one may proceed. If 'No', the methodology will not be suitable and one is ended with this methodology.
In addition to the question about the (re)constructions, a planning is required. Without a future plan or construction planning, there is no expectation about any scenario that may occur. As determined from section 2.1.2, scenarios are the base of triggers and decisions to apply measures. So any plans about future scenarios are mandatory to determine measures. Therefore the question of: 'Future plans or construction planning available?' is included. If this can be answered 'Yes', one may start with the methodology to determine measures. If there is no planning available, one should stop and end the procedure.
The third question is related to crowd management. Due to the (re)construction work of a particular phase, the user may expects the need of measures to deal with the inconvenience for parties such as: contractors or users (service providers, passengers or visitors). To respond on this, the condition of expected measures should be taken into account. Therefore the question: 'Expected need for measures to deal with crowd management?' is asked. 'Yes', one may proceed. If 'No', one should end with this methodology.
Finally the question of 'Business as usual?'. This question is added to validate whether the area is really used as business as usual, instead of e.g.: reduced passenger occupation due to fire limitations. Again, with a 'Yes' one may proceed. If 'No', one should stop.
These four questions are mandatory for any possible user of this methodology. Once all questions are passed with a 'Yes', one may proceed with the Measure methodology.

3.3. Methodology - Step 1: Collection of information

This step is the first of the four main steps and covers the content about the 'Collection of information' step (fig. 3.3). This step is used to collect information about the case that identify the crowd management measures occurrences, limitations and possibilities. This content is covered by the following subjects.

- The Goals, Objectives and Strategy help to state where the location stands for, what should be achieved and how, could help steering to a suitable solution or collection of crowd management measures.
  These are based on the OGS (without M) of the Van Gogh Muesuem.
- Task and functions are included and based on the concept of System Engineering.
  By dividing the main function into smaller tasks, under laying problems could become visible, that could help to identify crowd management issues.
- Exploration is included and based on the concept of the 4-stage model and Main Design Core. The purpose of this step is to analyse the location. Who and what are responsible for a particular situation or scenario and what are the limits of possibilities to apply crowd management measure.
- Lessons learned is taken into account as part of the feedback of Schiphol One-XS and principle of System Engineering (as part of the process input according to (Department of Defence (2001)).

When the information is collected and processed, one may proceed to the question that is required to proceed to the next step.
In the following subsections detailed information about the previous points is discussed.

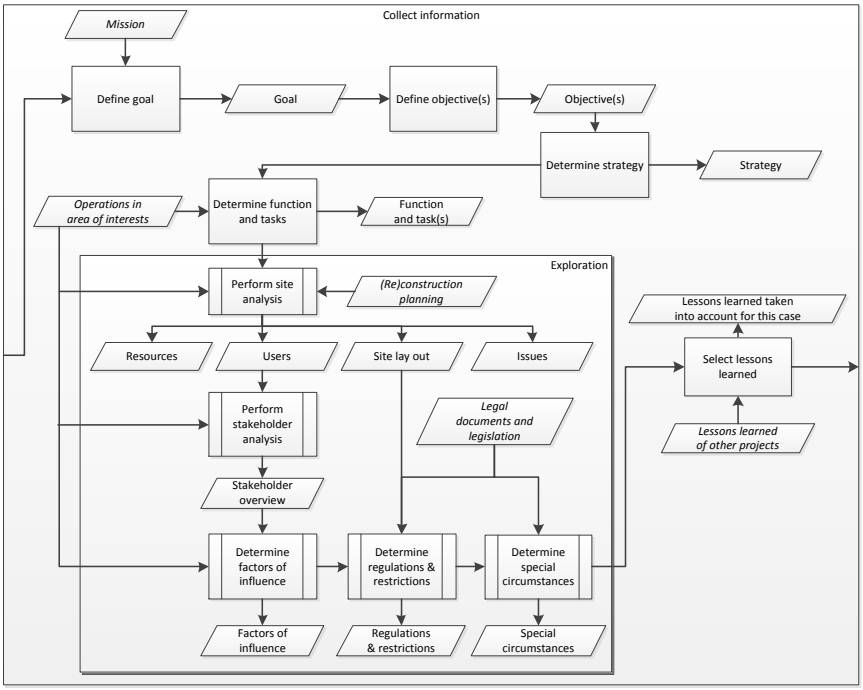

Figure 3.3: Step 1: Collection of information - including sub-steps

3.3.1. Goals

By creating a goal, the user of the methodology can test whether the outcome of crowd management measures perform as initially meant. A goal can be drawn from the mission of the case owner, is set for a longer period of time, should be SMART (Specific, Measurable, Achievable, Realistic, Time, Specific) (Conchúir (2014)) and can be answered with YES or NO .
An example is presented about a fictional small airport, followed by a suitable goal: Mission: *Connecting people with the airline world by efficient passenger handling in a high class departure area.*
As a result of this mission, the airport would like to connect the passengers with airlines, in a efficient way. To react on that, a goal particular for a (re)construction period can be set up. For example: *The passenger area should be able to handle 900 passengers during the peak period, despite the (re)constructions*
It is specific, due to its relation to the area and time. Measurable due to the fact that the amount of passengers can be measured along the process. It can be achieved because the airport is now also performs the same services as during the (re)constructions. If it is realistic depends on the current status of the area. If, for example, the airport is now able to handle 1100 passengers, with (re)constructions it could be realistic in fulfilling this goal. And finally, time. The goal specifically captures a time frame: the peak-period.
So the question that should be answered regarding this subject is: **What is the company goal?**

3.3.2. Objective

In order to make the goal more achievable, objectives can be used to divide the goal into feasible pieces. Same as the goals, the objectives should be SMART. Also these objectives should be set by the case owner. Setting these objectives, same as goals, should be SMART as well. And should be set by the case owner (Turkay (2014)).
Continuing with the example of the Goal section, examples about objectives could be:
Reduce spillback of the ticket counter and *Avoid reduction of current throughput due to constructions.*
With the combination of objectives, the goal can be achieved eventually. So the main question that should be answered regarding this subject is: **What are the objectives, supporting the goal?**

3.3.3. Strategy

To achieve the goal and objective, it is up to the case owner to decide how these can be achieved, and is therefore based on strategy. The strategy determines what kind of resources can be used to achieve the goals and objectives. This may variate per department, however this should reflect on the objectives decided previously.
Continuing with the same example, a strategy example of the department of ground handling: *Focus on training staff with communication skills to deal with passengers more quickly.* This reflects on improving the speed of passenger handling (objective) and in general help to achieve the goal.
An example reflecting on the terminal management: *Make a robust plan to track the banking lines inside the departure area.* - by knowing the locations of banking lines this reduces the time to set up buffer for waiting passengers.
The main question that should be answered regarding this subject is: **What strategy can be identified within the applicability of crowd management measures?**

3.3.4. Operational and area tasks and functions

The task includes the specific description of the components that describe the function of space and should be based on the operations performed at the area of interests. By dividing the function into specific tasks it is possible to identify possible sub-problems. This can be performed by looking to the main function of the problem location, divide the function of the location into separate tasks (Department of Defence (2001)).

A suitable example of dividing tasks from the main function, with respect to the preceding examples: Function:
The airport is a building that is dealing with supply and demand. Demand: *Passengers willing to travel or use a certain corridor to go from A to B within building.* Supply: *The supplier of services and area to handle such demand.*
Tasks:
The task of the check-in desk is to provide the passengers of their ticket and, if required, process luggage.
In the latter, the subscription of the task is part of the function. To fulfil the information about this subject, the following question could be useful: **What are the function and task of the area?**
This question is fulfilled sufficient if all (mandatory) processes within the area of interest are captured. In the end the results can be used to identify crowd management issues or help to assigning measures.

3.3.5. Area of interests analysis

The step of exploration is based on the 'Exploration' of the 4-stage model and Main Design Core, and are used to perform an analysis at location. From the authors perspective these include a site exploration, stakeholders analysis, determining the factors of influence, finding out the regulations & restrictions and special circumstances. To elaborate these subjects, each are discussed.

Site exploration

The site exploration should be performed to get a clear view of site lay out and current issues, which is related to: "The characteristics and layout of the area play a big role in positioning of measures" (Baelde (2016)).
This exploration should provide information about; the resources available, which in turn determine the applicability and feasibility of measures, the area users where problems now exist and which areas are influenced by the (re)construction phase. In the latter this is covered by the planning.
Upon that it should be mandatory of this methodology to find crowd management issues. To identify these issues, these flow patterns should match waiting, queuing (Campanella (2016)) or congested situations (Daamen (2004)). From looking at different areas in the focus area, it becomes clear that some physical limitations or process are the cause of aisle blockage. A process example could be: *The process of check-in does not match the demand during peak hours, resulting in queues that block certain aisles.*
So the main questions that should be answered regarding this subject are: **What are the available crowd management resources? Who are the users? What is the lay out of the area of interest? What are the issues regarding throughput?**

Stakeholder analysis

The stakeholder analysis could provide an overview that is able to indicate how stakeholders can influence decisions. This process is based on on the found users of the site analysis and operations. This could play a part in determining choices to adopt or reject certain measures.
The analysis should be performed at the focus area by a Power-versus-Interest grid (Bryson (2004)). By capturing the stakeholders one captures the 'community' that operate and use the focus area. Enable the possibility to determine the weight of influence of stakeholders that have any effective on crowd management (Baelde (2016)).
The outcome of the grid could help to determine a certain idea of which stakeholder can 'steer' the decisions and can be used for coorperation between different operators/stakeholders (comparable to (iv) institution cooperation (Martella et al. (2017))) for example:

The design team and Koninklijke Marechaussee have large power and large interests. The passenger has low power, but high interests. So the temporary walls are placed on the west side, due to safety and at the expense of passenger experience. So could painted to serve the point of passenger experience.
The main question can be stated as: **Who are the stakeholders and what is their power/interest?**

Crowd experience factors of influence analysis

The analysis of factors of influence is used to '...(i) understand visitor profiles...' (Martella et al. (2017)) and track influences of the user perception. Whereas the perception is part of the behaviour in crowds (Victoria et al. (2017)) and can be influenced by operations and different stakeholders.
This analysis can be performed by making and/or analysing customer journeys (Nenonen et al. (2008) and NIPO (2017)).
With the use of this analysis, the influence levels of the decisions made by stakeholders can be determined - based on the power vs. interest grid of the previous step.
An example could be: *The customer journey shows that leisure passengers are very nervous at the security check.* This information can than be used to do, e.g.: something about the process at the security check, or reassure passengers by floor walkers.
The question that can be used to determine the information could be described as: **Which factors have influence on perception?**

Defining regulations & restrictions

By defining the regulations and restrictions of laws, a design space can be defined. Thus, no-go measures or certain solutions can be avoided in advance. To come up with this information the lay out of the area is important including corresponding documentation. One could use the following question to determine the regulations and restrictions that could influence measures: To what extent are the regulations and limitations can influence the measures?
For example: *From legislation about (re)constructions of the the Dutch law, noise may not exceed 90 decibel* This description therefore reflects on the mandatory application of isolated material. This to protect hearing by those outside the construction area.
The question that covers this subject is described as: **What are the regulations and restrictions that limit the crowd management measures?**

Define special circumstances

The final part of exploration should be performed to determine if special circumstances can influence the measures (Baelde (2016)): "The effectivity of a measure is not only based on its characteristics, but it is also dependent under the conditions it is applied to reduce the risks within the crowd."
To analyse these circumstances, this can be supported by information about the lay out and by desk research regarding legal documents and legislation. It could be, however, that these special circumstances are already part of the regulations and restrictions.
An example of special circumstance could be: *As the fire evacuation document describes is that there should not be any blockage of aisles but objects higher and wider than 2 meter.* This description therefore can dismiss any measures such as: temporary walls placed perpendicular on aisles should be avoided.
The final question of the subject under exploration should be stated as: **What are the special circumstances that may reduce the design space with respect to the creation of measures?**

3.3.6. Lessons learned

Lessons learned should be included to avoid mistakes made in previous projects and reduce unnecessary (preparatory) work or hazardous situations.
This analysis can be performed by reviewing previous projects. An example of this lessons learned comes from the interview at Schiphol: *Perform work on one side of the corridor. So you create a smaller passage and no blockade.*
The final question of the total 'Collection of information' regarding lessons learned is stated as: **Which lessons learned could be taken into account, regarding this particular area and (re)construction work?**

This is the last step within the 'Collection of information'.

3.3.7. End of collection of information

With all information collected one may almost can start with the next step. However, before that, first a question should be answered: 'Coverage of information sufficient for specification of limitations?'. This question asks the user to reconsider all information and determine whether all blocks of the Collection of information step are totally fulfilled.
With the following questioning list the user can check the output of the 'Collection of information' step:
- Is there a goal?
- Are there objectives, supporting the goal?
- Is there a strategy?
- Are the function and task of the area clear?
- Are the resources known? Are the users defined? Is the area of interests visited and recorded? Are the issues of the area known, preferably regarding throughput? - Are the stakeholders known, including and power/interest?
- Is there an overview of influence levels?
- All regulations and restrictions of involved stakeholders taken into account?
- Special circumstances found?
- Is there a list of lessons learned that should be taken into account, regarding this particular area and (re)construction work?

If all questions can be answered 'Yes', the question of information coverage can be answered by a Yes and one may proceed.

3.4. Methodology - Step 2: Specification of measure limitations

The 'Specification of measure limitations' is the second step of the methodology and is dedicated to the requirement and constrain analysis. This allows to create traceable boundaries that should be taken into account and wherein the measures should be designed.
To elaborate on the content of requirements, an explanation is presented regarding the level of generality of the solutions, reflecting on the type of requirements needed. With this knowledge the analysis is further explained in the following paragraph, supported by the Rational Design Process (Cross (2005)) and System Engineering (Department of Defence (2001)).

For the determination of requirements, (Cross (2005)) identifies 3 levels of generality: product alternatives, product types and product features (from high to low respectively).
The choice between these levels is necessary to determine the appropriate level of detail of requirements needed for the solution space.
Due to the fact that the 'product types' only reflect on appliance (e.g.: temporary walls of wood or Styrofoam) and 'product features' on specific description of details (e.g: blue walls, metal wall supports). These are therefore applicable in terms of detailed descriptions of measures.
Initially the classification level of generality should reflect on the methodology performance and output: a collection of measures for crowd management. Which in other words are alternatives. So therefore 'product alternatives' is taken as the level of generality, making a new suitable generality level description for the measure design methodology: 'measure alternatives'. Details should be added in a later stage.

In the following sub sections the content of the requirement analysis will be covered; input, what should be performed, why, what, output and if these influence on hard or soft measures. The layout is presented in figure 3.4.

3.4.1. Requirement specification

For the determination of requirements (Department of Defence (2001)) defines System Engineering Standard ('IEEE P1220, Standard for Application and Management of the Systems Engineering' Department of Defence (2001) p.12) to perform a requirement specification. This specification is rather focused on product design, but captures interesting sequence of determining requirements. Therefore this procedure was assumed to be useful for this methodology.
In figure 3.4 the processes to determine requirements by (Department of Defence (2001)) are modified from the authors perspective such that the procedure can be applied within the theme of crowd management. All steps that are were found useful for the creation of measures are presented as a flow diagram, covering 12 of the 15 main activities.
Initially the figure seems complex, however it exists of the main activities (**bold**), each requiring different inputs. In the paragraphs that follow, all activities are discussed including why particular inputs are necessary.

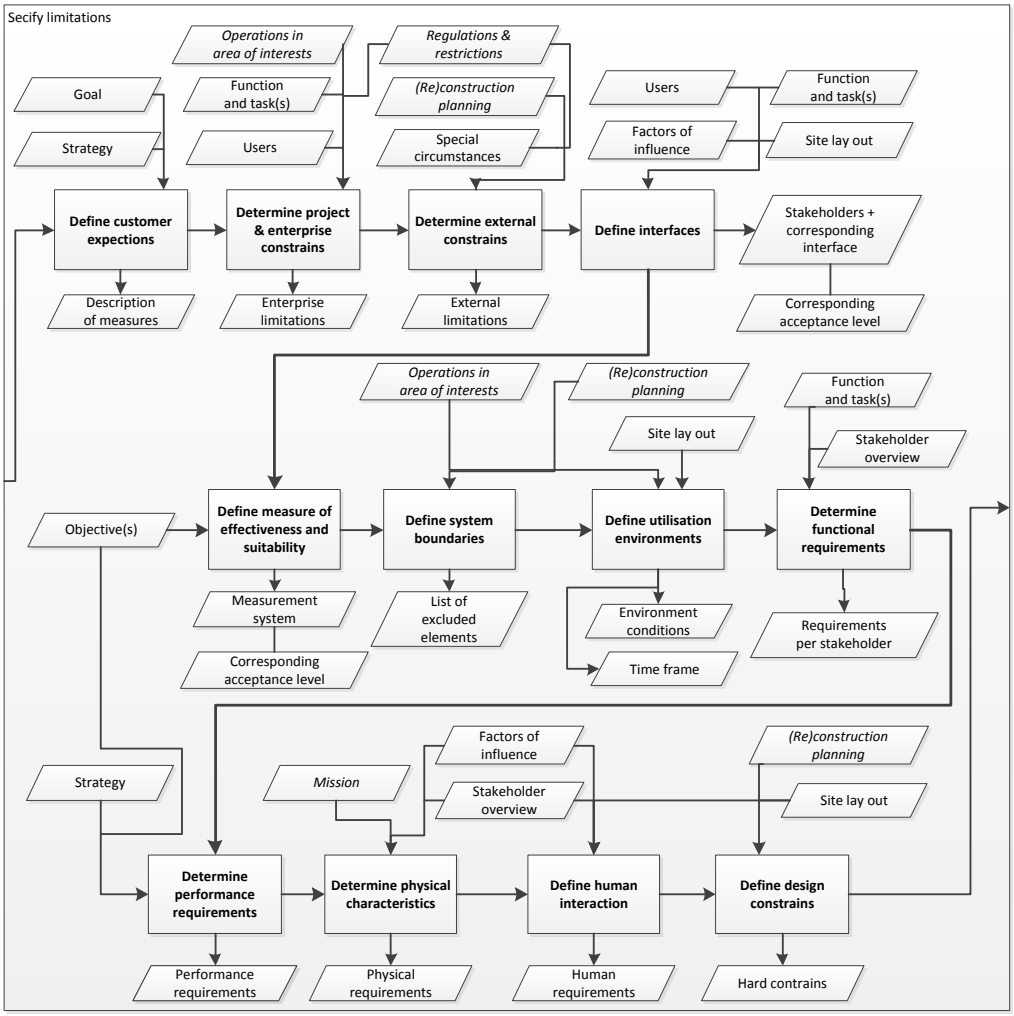

Figure 3.4: Step 2: Specification of measure limitations

Customer expectations

In this part of the specification is up to the so called customer, the problem owner, to indicate their expectations of the measures. The purpose is to determine what they expect from the measures on a crowd management perspective (Department of Defence (2001) p.42).
To do so the following questions should be asked:
What is the problem owner's expectation from the crowd management (soft and hard) measures during the (re)constructions while business is performed as usual?
A fictional example could be: *The measures should perform such that those do not hinder, operations and minimise inconveniences of passenger experiences. All should be applicable during the whole (re)construction period.* The result of this subject reflect on the hard and soft requirements. Due to possible preferences in lay out, planning and processes.

Project and enterprise constraints

The project and enterprise constraints relate to the impact of limitations in the design of measures. This include time, costs, scope (Nicholas and Nicholas (2012)) and, company structure, standards and procedures. Assuming costs and scope are part of the (re)constructions, these are left out of the specification.
In terms of time, this will cover the total length of the (re)construction period. So here the main focus lays in the company structure, standards and procedures.
To capture the content of these subjects, the following question should be asked:
What are the limitations within the company structure, standards and procedures that that will influence the crowd management measure design space? An example of a fictional airport regarding procedures could be: *Those parties that are responsible for the security of passengers should be capable of monitoring all public areas at all times - resulting in hard requirements to avoid dead corners.*
The result of this subject reflect on the hard and soft measure designs. Which is based on the areas (hard) and processes (soft) one need to perform their function and/or tasks.

External constraints

External constraints relate to the regulations and restrictions determined in the Input-step. It is here to make the constraints explicit for areas that are specifically notified by regulations and restrictions.
What are the external constraints that should be taken into account that limit the design of crowd management measures?
Suitable examples of the outcome of the design constrain step are: *The measures should comply with some specific legal documents of the Dutch law at the boarding area.*
The effect of these constrains will only reflect on the limitations on hard measures.

Interfaces

In terms of interfaces, the requirements that relate to this content are interactions between physical limitations, stakeholders, processes and users. In terms of stakeholders, processes and users, the interfaces refer to those effects that interact on the performance of measures. To determine the requirements of these interfaces, the following two questions are introduced: **Which stakeholders or processes interact with the measures?**, followed by: **What is the level of acceptance of the effect by crowd management measures?**.
A suitable example could be: *Due to the measures, the entrance of the local bookstore is narrowed. The consequence may lead to less potential buyers. So the shop demands that the measures should no lead to a decrease of 10% of shop visitors. (How this can be monitored, is left out of this methodology).*
This part of the specification reflect on the hard and soft measure designs due to the combination of physical (lay out) and process (soft) interactions.

Measure of effectiveness and suitability

This part of the requirement specification focuses on "...customer expectations and satisfaction...[]...to how well the system must perform the customer's mission..." (Department of Defence (2001) p.42). Here 'customer' is related to the user (passengers and visitors). However, as determined in the preceding sections, the mission of the problem owner is taken into account. The problem owner will be responsible for the handling of passengers and/or visitors. So therefore the content of this part of the requirement is transformed to fit the methodology. To comply with the expectations and satisfaction of the users, the problem owner should answer the following 2 questions:
What kind of measure system is preferable to determine when users comply with expectations and satisfaction of crowd management measures? followed by:

What is the minimal preferred number to comply on the introduced scale?. An example of a measurement system and preferred score could be: *The service level (measurement system) should not be lower than a 3 (preferred score) in a scale from 1 to 5.*
The result of this subject only reflects on soft measure designs due to expectations and satisfaction levels.

System boundaries

This part of the requirements relate to the boundaries that fall in or out of problem's owner activities. To capture those elements that influence the performance of measures, but do not fall in the control of the problem owner, the following question should be asked:
What elements that relate to the crowd management measures, cannot be influenced by the problem owner, but are accepted?
An example that is related to this question could be: *The variety number of departing passengers*
Same as the preceding subject, this subject only reflects on soft measure designs. However, this is referred to the content of operations.

Utilisation environments

Regarding this subject this reflects on two points: weather and time. Regarding weather, this will influence all measures that are not within the protected climate of the main area of interests (e.g.: detours that force passengers to go around the main building). So in this case a proper question is: **What are the weather conditions that should be taken into account that may affect the crowd management measures?**.
This part of utilisation reflects on the hard part of measure design.
In respect to time, the measures should be able to perform as required when the area is operated as business as usual. So the most suitable question regarding this requirement is: **What is the defined time that the crowd management measures should be operational?**
For example: *Departing operation starts at 05:00 and ends at the last departing aircraft - estimated 20:00. So the measures should be applicable within this time frame.* The last part of this subject reflects on the hard and soft design of measures, due to the combination of area usage and processes.

Functional requirements

With respect to functional requirements these relate to the requirements that are set by those stakeholders that perform mandatory operational functions or tasks. With the use of the overview of functions and tasks of the Input-step, the following questions should be answered to gain requirements for the responsible stakeholders. The question is stated as:
What are the minimal requirements needed to perform the associated mandatory function or task? (per stakeholder)
An answer of the Ground Handler at an airport could be: *At least 3 check-in desks are required to deal with the demand of an average day. Next to that, minimal 1 boarding desk should work at gates that are in use.*
The result of this requirement will reflect on the design of hard measures, due to mandatory use of facilities.

Performance requirements

The goal of this requirement is to determine performance and will used to determine the efficiency of measures. To do so the performance of the measures should be made specific. This can be achieved by clearly defining the different measurement levels of hard measures. An example of hard measures could be defined as: *The available space per person may not be lower than 0,25m^2*
To determine these, the following question should be asked, applicable both for the soft as for hard requirements: **What is the required performance the crowd management measures should comply?**
This subject only reflects on hard measure designs due to the performance of the area.

Physical characteristics

This part of the requirement specification mainly reflect on the exterior of measures. The content of this requirement is to react on the behaviour on the user of the measures. By applying certain measures this may influence the effectiveness or performance of the measures. (e.g.: due to coloured/painted wooden walls the level of experience may change). These can be captured by:
What are the exterior requirements that should be taken into account that may affect the experience?
Initially, this reflects on the hard part of requirements. However, the side effect may influence the experience of users. So therefore also on the softer side of measures.

Human interaction

This part of the requirement specification refers to those requirements that relate to the human interaction with the measures. The content of these requirements can therefore be captured with the following question: **What are the requirements/specifications that cover to the characteristics of users acting in a business as usual, that may limit the design space?**
An example could be: *An descriptions of type of users that indicate certain preferences, such as personal guidance, flexible work spaces, etc. Which can be indicated by the descriptions of e.g.: Customer Journeys*
Finally, this part of the specification reflects on the soft part of measures. This due to the experience level of users.

Design constrains

In case of the design constraints, these are different than the requirements mentioned earlier. In this case the design constraints relate to the physical lay out of the area. The goal of this particular step is to identify those limitations wherein the functional requirements should be performed. Here the input is covered by physical appearances of the area, conditions, defence of threats, contracts, and/or customer regulations/standards. The output of this step should deliver the limitations wherein the design salutations should operate and therefore only reflect on hard limitations.
To determine the suitable outcome of this step the following question should be asked:
What are the area lay-out constraints that should be taken into account that limit the design of crowd management measures?
Suitable examples of the outcome of the design constrain step are: *The measures should be performed within the area of interest, based on the current physical appearance.*

3.4.2. End of requirement specification

In this part of the specification of requirements the content of the preceding content is tested and covered. Similar to the previous section, all content should be covered to proceed to the following section/step of the methodology. If all questions are answered one may proceed. When one ore more questions are/can not be answered, it may occur that, irrespective of the missing requirement, the measure will not act as initially intended by the the problem owner or methodology user. It is here to (re)consider the effort to set the requirement, if not, the problem owner or methodology user accepts any non-expected measure behaviour or limitations. It is beyond this research to determine the consequences if one or more requirements are skipped/not filled in.

All information gained by the questions of the respectively paragraphs, will then be numbered and filled in table 3.1. By doing so, one creates a clear overview of requirements constrains and are easily tractable during the design step. In the column of requirement owner, this relate to the stakeholder that are responsible for that requirement (e.g.: *Owner: AviaPartner - Minimal 3 check-in desks opened during peak-hours*).

Table 3.1: Requirement and constrain check list for methodology user

Requirement type	Provided (YES/NO)	Requirement owner	Requirement content
1. Customer expectations			
2. Project and enterprise constraints			
3. External constraints			
4. Interfaces			
5. Measure of effectiveness and suitability			
6. System boundaries			
7. Utilisation environments			
8. Functional requirements			
9. Performance requirements			
10. Physical characteristics			
11. Human interaction			
12. Design constrains			

3.5. Methodology - Step 3: Creation of measures

This section is dedicated to the creation of measures. The main purpose of this step is to specifically steer the design process of the measures. To do so, the content of product design methodologies (discussed in section 2.3) are used as a basis; iterative build up a concept, extend, proceed with detailed design.

In figure 3.5 the creation steps of these methodologies are merged to an iterative creation process. Starting with conceptual designs, extending them with softer sides of measures and finally details may be added. In the following paragraphs the process steps of figure 3.5 will be elaborated in detail, supported by individual flow diagrams. The respectively decision processes are elaborated on at the corresponding process steps.

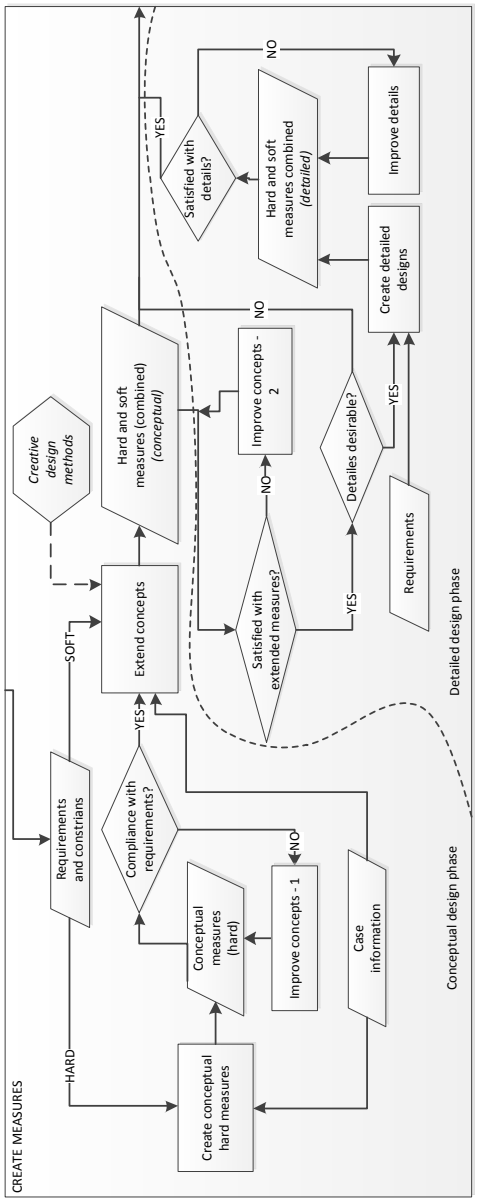

Figure 3.5: Step 3: Creation of measures

3.5.1. Conceptual design phase

This part of the creation phase exists of the creation of measures in a conceptual content. To do so, three processes take place: the creation of conceptual designs, improvement of concepts and finally the addition of softer inputs. Each of these processes are discussed regarding the input, what and why it should be performed, and what it will deliver as output.

Create conceptual hard measures

This is the first process in the design phase and focuses on determining conceptual designs of crowd management measures on hard level. The process is indicated in figure 3.6.
The first step in this process is to split the area of interest. To do so, one should consider to use (re)construction related project interfaces to respond on System Thinking or standardised areas by function from the perspective of the company. In the latter, the measures can be assigned per specific area allowing to assign measures to responsible parties for that specific areas. Which in this case is rather more focused on spatial planning perspective than passenger flows ((Nes, 2012)).
The next step is to allocate specific crowd management measures to cover the issues at specified areas. When the specific issues per area are known, the step that follows is to create the measures that can be applied on the specific issues, supported by the 4 principles of (Hoogendoorn (2011)).
To do so, one should use sketching as a suitable way of approach, which is a suggested approach by (Cross (2005) p.23-25). It should be noticed that the principles should result in measures that fit the design limitations (described using table 3.1) of the previous section. When the first measures are generated, the next step is to determine whether these are achievable with the available resources. This can be done by fitting the resources to the measures. Here it is up to the methodology user to determine which resources are required or inform the problem owner to consider extra resources.
By assigning the resources to the measures, this will result in a collection of hard conceptual measures. Whereas the content reflects on: measures at specific areas, solving specific issues that fit the design limitations.

To proceed to the next process, the decision question regarding compliance should be passed. This is performed by mirroring the requirements and constrains with the conceptual measures. If the measures comply with the analysis, one may proceed. If not, one should proceed to the improvement of concepts. To elaborate on the content of the improvement, this is discussed in the following paragraph. The paragraphs that follows is the extension of the hard measures.

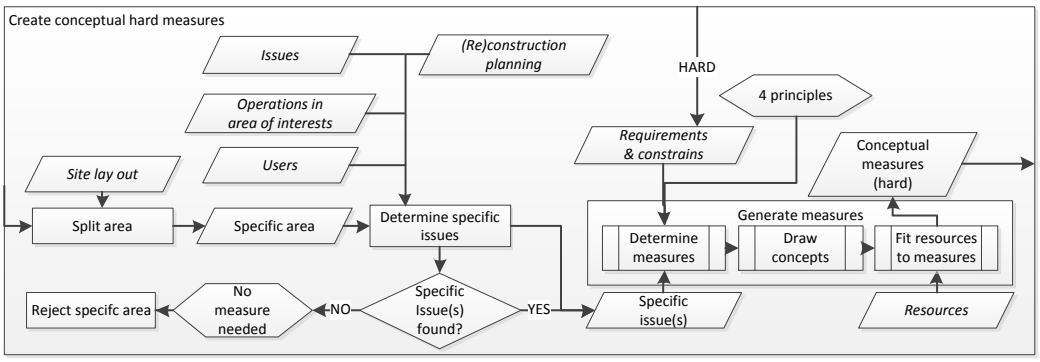

Figure 3.6: Conceptual design steps for creation of hard measures

Improvement of conceptual measures

This process is dedicated to the improvement of the initial concepts. Here the only process that is executed is that of improving the initial concepts (indicated in figure 3.7). This can be performed by adjusting the initial designed measures based on the requirements, 4 principles, specific issues and resources. The end product of this process should cover measures that fit the requirements, 4 principles, solve the specific issues and should be solvable by available resources.

Again at the end of the process, one may proceed to the decision process compliance. If agreed, one may continue.

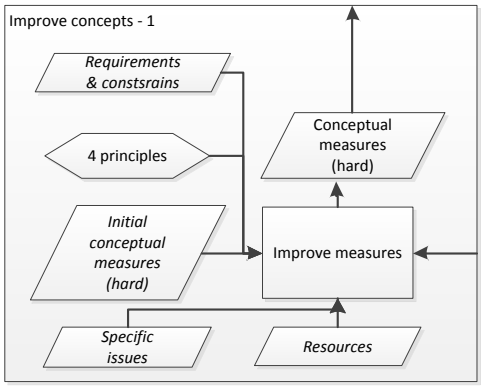

Figure 3.7: Improvement of conceptual design - iteration 1

Extending concepts

This step is dedicated to extension of concepts and addition of soft measures, indicated in figure 3.8. The goal of this step is to create soft measures that are applicable to support the hard measures or not specifically dependent on specified areas, but are generally applicable in the hub area (e.g.: a light plan for all ceilings). The content of these measures should cover a collection of soft measures, including possible resources to execute them (e.g.: Passengers should be informed about the (re)constructions beforehand to anticipate on travel experience. Applicable resources to support this: website, social media or posters). The process to come up with these ideas should be supported by the creative design methods (section 2.1.3). Whereas the purpose of these methods is to collect solutions from another perspective; enlarging the solution space for soft measures.
The selection of which creative method will be used will depend on the users preference. But should take in mind that participants of group sessions should be part of the project stakeholders and have different expertise. From the authors perspective it is advised to perform a group session over and individual process. By performing a group session the methodology user can be supplemented by ideas and resources by the different types of participants.
For the determination of soft measures, the user should think of three soft measure categories, introduced from the authors perspective: Inform & Advise before arrival at the hub, Inform & Advise during visit at the hub (irrespective of specific area) and Guide during visit at the hub (irrespective of specific area). These categories are based on the interpretation of the crowd management measure categories and location (in)dependency by (Baelde (2016) p.11-12) and feedback of B. Wiggers (appendix A.1): "What is important? When?".

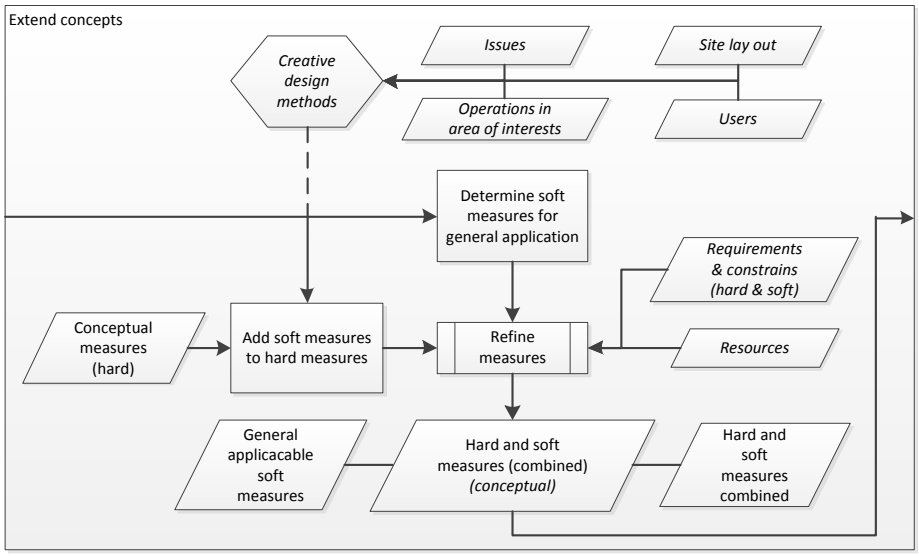

Figure 3.8: Steps to determine soft measures

To trigger the opening of solution space, the methodology user or group participants should be asked to following question:
1. What information does a visitor/traveller would like to know before arrival at the hub, to anticipate on the use of crowd management measures due to (re)constructions? 2. What information is assumed to be complementary and need to be shared, compared to earlier distributed information? 3. What resources can be used to guide visitors/travellers along (un)specified areas where (re)constructions are performed, to respond on the four principles of (Hoogendoorn (2011))?

As can be determined from the figure is that there are two different processes, addition of soft measures hard measures and determining soft measures in general (there is no priority in executing them.)
First the addition of soft to hard measures are discussed. In this process, the purpose is to find soft measures that may support the hard measures in content of informing and guidance. It is up to the creative design methods to determine what kind of resources can be used. An example to explain the way of approach could be captured as: *Due to (re)constructions at the departure corridor, a detour is necessary to avoid bottlenecks (fictional hard measure). To guide passengers, the airport suggests to deploy extra floor walkers (applicable soft measure for the detour).*
In reflection of extending the hard measures, soft measures can be applied in general as well. A suitable example of soft measures could be described as: *Enlarge the group of floor walkers that are available for questioning, information and guidance. Or: Change the lighting inside building to create a calm atmosphere. As a reaction of the (re)construction mess.*
Eventually when both processes are executed, the process of 'refine measures' can be applied. This process is added to determine whether the hard and soft measures can be applied anyway. To test whether these measures are applicable, these are tested to the requirements, constrains and resources available. It is here up to the problem owner to determine whether investment can be done on resources to avoid the rejection of some of the measures.
The final product of this total process are a collection of (combined) hard and soft measures, all in conceptual content.

At the end of the process, a decision process should be passed, regarding satisfaction. It is here up to the problem owner to argue if the measures fit the expectations and/or set up of the measures. The decision process should be based on design choice approaches: plurality, majority, weighted voting or binary comparison voting (Sage (2000)). It is up to the problem owner what kind of decision process will be used to determine those measures that are used to continue in the total process.

Improvement of conceptual measures - iteration 2

This process is similar compared to the first iteration of improvements: review the measures, improve where the measures do not meet the requirements, constrains and/or resources. The second iteration is indicated in figure 3.9. It should however, be an improvement of measures rather than the design of new ones.
If one is finished with this process, the next step is to the question regarding desired details.

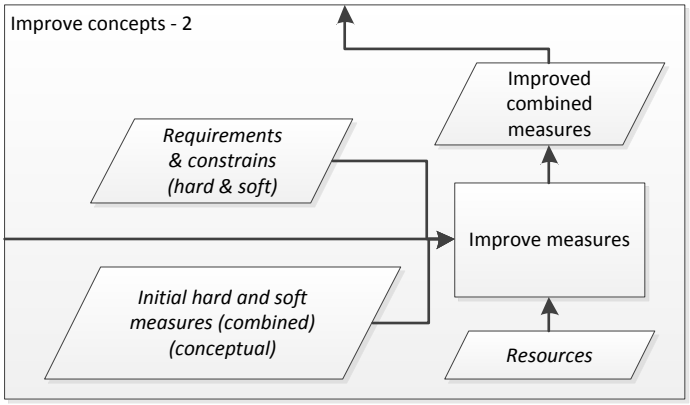

Figure 3.9: Improvement of conceptual design - iteration 2

During the question of desired details, it is up to the problem owner to determine what measures should be worked out in detail. This answer can be answered with yes or no. Independent of the answer, one may proceed. If the answer is no, the design phase is finished. If yes, one proceeds to the detailed design phase. This will be discussed in the following paragraphs.

3.5.2. Detailed measure design phase

The detailed design is focused on extending the conceptual measures on a detailed level (figure 3.10 and fig:design6). In the paragraphs that follow the content of these processes are discussed.

Create detailed design

This is the first process regarding detailed designs. It is up to this process to exploit the possibilities of detail of the already conceptual measures.
Here the detailed requirements (regarding 'types' and 'features') are of interests. It is up to the resources and the intention of the problem owner to determine the level of detail. To avoid loss of time, it is up to the problem owner to prioritise the requirements/constrains and if details to be added. When finished, one may continue to the decision question to determine if the problem owner is satisfied with the details.

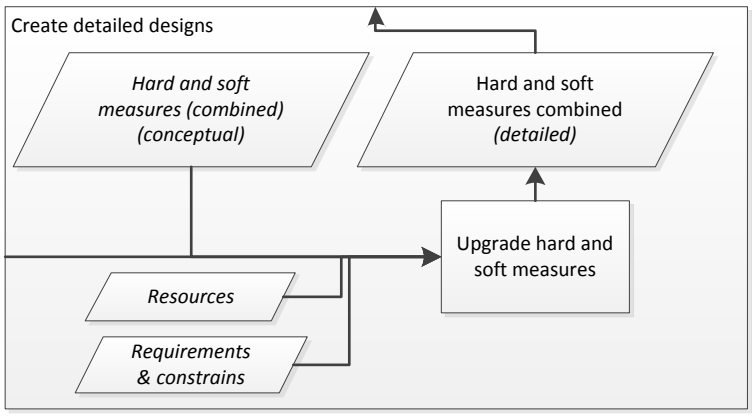

Figure 3.10: Creation of detailed design

Improve detailed design

Finally the last process in the design phase is to improve the details. This process can be exploited as long time is available. The principle of executing this step is similar as the improvements of concepts, but only focusing on details.
The end product of this step is to deliver improved details of the measures. Again one should pass the question regarding detail satisfaction. If one, agrees to continue, the design phase is finished. If not, one should redo the improvement of details.

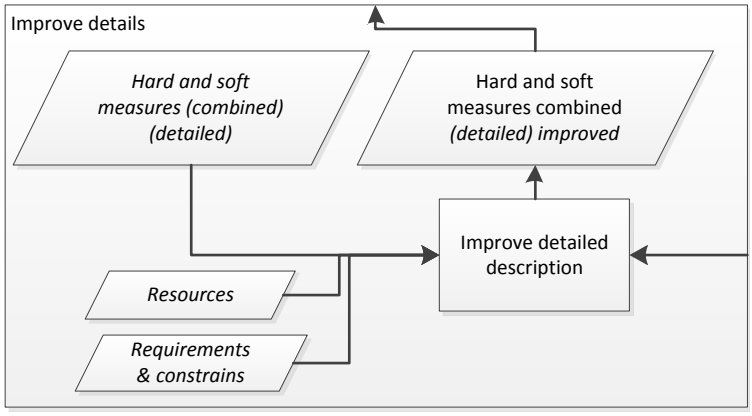

Figure 3.11: Improvement of details

3.5.3. End of Creation of measures

The end of the design phase captures the collection of hard and soft measures. All of these measures should be applicable at the specific issues at the respective areas, meet the requirements/constrains and should be executed by the available resources.
It should be notified that the numbers of measures should:
- should cover at least an issue at the specific area,
- may more than, but not less than the number of requirements and constrains,
- and should fit the problem owner's resources.

In the end all measures could be placed in table 3.2, including the issues and, requirements and constrains, covered and which resources will be used. This will create a clear overview, and therefore easy to use for the next step: Delivery of measures.

Table 3.2: Measure table - including example (*italic*)

Specific area	**Issues**	**Measure(s) (hard)**	**Measure(s) (soft)**	**Requirements and constrians covered**	**Resources**
Corridor departure area	*Blockage of aisles*	*Increase number of corridors*	*Floor walkers to inform passengers about other routes*	*Corridor capacity >300 passengers/hour*	*Temporary walls & Floor walkers*

The description about the exact content and how it is communicated is still rather vague. It is therefore that the content is captured such that is understandable for those stakeholders or parties that should execute the measures.
To do so, this is performed in the step when delivering the measures.

3.6. Methodology - Step 4: Delivery of measures

The Delivery of measures is the last part of the methodology and focuses on transforming the information of the previous step into understandable content. Different from the previous steps is that no new information or designs are added. This step only focuses on how the measures can be presented and may cover the description of realisation. In the latter case, the description covers instructions on how problem owner should exploit their resources or employees to perform the measures.

In figure 3.12 the steps within the delivery of measures process are presented.
The first procedure is to determine the preferred way of communication. From the authors perspective only two ways of communication may be chosen: verbal communication or written communication. This due to the fact that the methodology is used to determine measures and should be performed by those that who are responsible for certain measures or areas. To inform them, this can be performed by verbal conversation or presentation(s), or written documentation.
In terms of verbal communication, the measures will shared with a single contact person of stakeholder group, involved or responsible for particular areas, or specific (set of) measures, by presentation or conversation. To do so, it is up to the user of the methodology to know the intention of the stakeholder, their expertise and what information should be shared. The content should only cover main subjects (e.g.: Head of floor walkers must understand that it is up to their responsibility to spread out passengers over multiple corridors. Instead sharing information about the signs that are painted yellow due to attraction purposes). By prioritising the information of measures, it is up to the parties that are present at the conversation or presentation to determine how the measures can be executed.

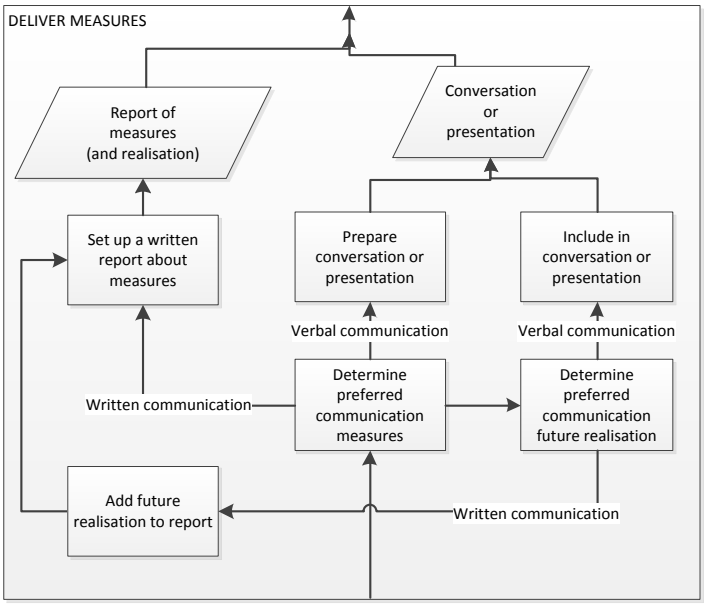

Figure 3.12: Step 4: Delivery of measures

When written communication is preferred, the measures will be written out in a report. The content of this report should at least cover descriptions and elaboration of the subjects from table 3.2 and is written by the user of the methodology. It is then up to the reader of the document to decide what information is read and taken into account.
The next step is to determine the future realisation. In this case, future realisation relates to the realisation of the measures. Again this can be communicated verbally or in a written file. It is up to the problem owner to decide who is responsible of instructing how the measures can be executed.
In terms of verbal information the measures are explained and how these can be executed. It is up to the conversation participants to discuss what is the best approach to execute the measures. Whereas in the documented file instructions are included on how the measures should be performed from the methodology user's perspective.

3.7. Methodology - End

This is the end of the methodology, in this step the measures may be communicated with the problem owner. From this moment on, there is no more process to be executed.
If there is a demand for extra or new measures, one should redo the whole chain of methodology steps. In the section that follows the sub question of section 1.2 will be answered.

3.8. Methodology structure review

In this section the methodology structure is reviewed, creating the possibility to answer the sub research question: *What are the steps that identify the structure of the methodology?*
The content of the methodology is build up from four main elements: 'Collection of information', 'specification of measure limitations', 'Creation of measures' and 'Delivery of measures'. Where the two first elements are used to identify information and, requirements and constrains necessary to limit the creation of measures. The third element is dedicated to process the information and create measures that fit the identified issues, resources and requirements. Finally, the last element is to transform the description of measures such that the problem owner understand how the measures can be implemented. This description can be delivered by verbal or written communication.

3.9. Methodology assessment indicators

In this last section, assessment indicators will be discussed that are used to determine whether the methodology performs as initially defined.
To determine whether the methodology can be used to create crowd management measures, two indicators are used: (1) the methodology ability to perform all steps and (2) qualification of practical, feasible and efficient crowd management measures.
In case of the methodology ability to perform all steps, this can be indicated by the execution of each methodology step. This is only assessed once and is only related to this particular research.
In case of the step performances, there are 3 scenarios possible: (i) methodology step can be performed, (ii) a step is not performed as initially intended but adjusted and creating the possibility to continue to the next step, or, (iii) methodology step cannot be performed, making it impossible to perform the next step. In the latter case it can be concluded that the methodology does not perform as initially intended and so the methodology is not able to deliver crowd management measures. As long as all steps are performed, the methodology is able to deliver an end product. The question is then whether this end product can be captured as practical, feasible and efficient crowd management measures.
To indicate if the methodology performed such that it delivered these type of measures, the delivered measures should match the characteristics of section 3.1.1. These should be proven by the measure references, specifically related to the case. This can be achieved by filling in table 3.3. This qualification however, should be executed every time the methodology is used. Without this qualification it is not possible to determine whether the measures can be categorised as practical, feasible and/or efficient.

Table 3.3: Assessment table to qualify the created crowd management measures as practical, feasible and efficient

Type of measure and characteristics	**Included (Yes/No)**	**Type of measure and characteristics**	**Included (Yes/No)**
Practical and feasible		Efficient	
Included elements		*Performance*	
Identified issues		*Dimensions*	
Limitation in resources		*Legislation*	
Location applicability		*Requirements*	
Factors of influence			
Communication and application			

If all characteristics within the measures are covered and references can be presented, it can be concluded that the methodology delivered practical, feasible and efficient crowd management measures. If a characteristic cannot be met, the respective measure(s) are not categorised as feasible, practical or efficient. This is assumed not be a consequence of the methodology, but rather depending on information/specifications to fulfil the measure characteristics.
When both the methodology steps are performed such that crowd management measures are presented, and match the characteristics of practical, feasible and efficient, it can be concluded that the methodology fully performs as intended. If a scenario occurs when a measure characteristics misses, which helps to identifies the crowd management measure practicability, feasibility or efficiency, it is up to the problem owners subjective view to accept or reject the measures.
What is not included is the effect of the methodology performance or outcome by different methodology users. This could be assumed to be a recommendation: perform the methodology by different users to determine the robustness and convenience for future applications/cases.

As a new methodology is presented in this chapter, the next step is to apply the methodology on a case. This is performed to determine whether the methodology actually can be executed as a whole and preferably create practical, feasible and efficient crowd management measures.
To comply with this application, the methodology will be applied on the case of Rotterdam The Hague Airport. The results are presented in the following chapter. The case study approach is performed by applying each step of the methodology in sequence and discuss the results of the case respectively. The assessment of the methodology is presented thereafter.

4

Methodology application at Rotterdam The Hague Airport

This chapter is dedicated to the application and evaluation of the methodology on a real-life case. In the first section the methodology is applied on the case of Rotterdam The Hague Airport. To elaborate on the application of the methodology, each step is discussed on two levels: the methodology feasibility on the case and case related content. The content that is related to the case is presented in boxed or contains references to the appendices D and E, due to extensive tables, maps, pictures or drawings. The second section is dedicated to the methodology application review and assessment based on the results of the application. Postponed are the the adjustments and additions found during the methodology application, these will be discussed in chapter 5.

4.1. Methodology application

This section is dedicated to the application of the methodology at Rotterdam The Hague Airport. First the choice of Rotterdam The Hague Airport is discussed, followed why this particular case is suited for the methodology application. Thereafter, the methodology steps are discussed according to the previous chapter.

4.1.1. The case of Rotterdam The Hague Airport

Rotterdam The Hague Airport, is a regional airport, serving as a hub for (mainly) passenger transport (appendix B.2), which currently faces problems regarding their floor capacity to deal with passenger handling. This capacity issue is mainly based on the level of service the airport wants to emit: IATA standard Level of Service C. However, due to the increasing passenger demand, this level of service cannot be delivered.

As a response, the airport would like to expand and adjust their terminal area, consisting of the land-side area - internally the 'Passagehal' - and the clean/departure area - called the 'Vertrekhal' (see appendix C.1 for respective floor maps). To make the transformation from the current building lay-out to the future building, the airport tend to keep the building opened for 'business as usual', while performing the mandatory work around the operations & services. This due to avoidance of monetary losses. To deal with expected inconveniences, the airport requested for measures that would be applicable on passenger handling on a crowd management level.

Due to the fact that Rotterdam The Hague Airport functions as a hub, is soon starting with (re)constructions, request for crowd management measures and close by the city of Delft (for practical travel reasons of the author), this case is used for the application of the methodology.
More information about the airport history and Rotterdam The Hague Airport as a company, can be found in appendix B.

4.1.2. Application step: Start

As the methodology introduces, first the start procedure should be executed. In the following framed texts, the procedure and corresponding answers are presented.

(Re)constructions?
Yes - (Re)constructions will start from November 2017.
Where the (re)constructions will cover the expansion and adjustment of the land-side area - internally the 'Passagehal' - and the clean/departure area.

Planning?
Yes - Conceptual plans are available.
The plans for the (re)construction existed of 4 stages (schematically presented in appendix C.2). To deal with the (re)construction, Rotterdam The Hague Airport decided to use a temporary construction (fig. C.8) to handle their passenger handling during the expansion of Phase 1.
The temporary construction will be placed on the North-East side of the airport building and will be functioning as a departure area, including several services as; kiosk, restaurant and toilets.
For the application of the case, only one particular floor map is necessary to test the methodology. For this research, figure 4.1 was used. The choice for this particular scenario had to do with the involvement of: throughput issues at the 'Passagehal', temporary security filter (regarding capacity), variable routing of departing passengers trough temporary covered corridors (combination of construction work and capacity), buffer area of the Koninklijke Marechaussee (capacity), walk-trough-shop (routing and capacity) and temporary construction (routing and capacity).
Crowd management measures?
Yes - The department of Capacity & ICT demands soft and hard requirements to deal with crowd management, due to expected inconveniences of the reconstruction for passengers.
During the (re)construction period, the airport expects that, despite precautions by separating construction work and passenger flows, most of the problems or hinder will occur in passenger flow and throughput (e.g. due to detours and/or by temporary capacity reduction by construction walls or additional nuisance from construction). These problems are not desirable but will be unavoidable. To deal with these interference's and inconveniences Rotterdam The Hague Airport therefore request for crowd management measures for these problems.

Business performed as usual?
Yes - The airport would not like to stop operations due to (re)construction work (see previous answer).
Only 72 hours the airport will be closed due to runway maintenance and therefore also operations. This occurrence is rather an incidental and will only happen once.

All answers capture the confirmation needed to proceed with the methodology, so therefore Rotterdam The Hague Airport is suited as a case for the methodology application.
In the sub sections that follow the results of the methodology application are discussed.

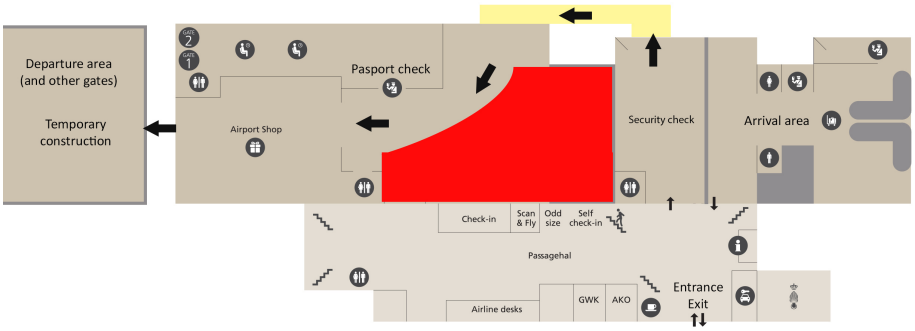

Figure 4.1: Construction step 1 - Airport layout to be used by the methodology.
Red: (re)constructions, Yellow: temporary covered corridor, Bold arrows: indicate departing passenger route

4.1.3. Application step 1: Collection of information

This section is dedicated to the application of the 'Collection of information' step of the methodology. Per subject it is discussed if the initial steps of the methodology were covered. Supplemental content that is applicable on the case of Rotterdam The Hague Airport can be found in appendix D.

Goal

As described in the description of the goal from the methodology is that it should cover some mandatory parts: drawn from the case owners mission, set for a longer period of time, be SMART and should be answered with YES or NO.

Initially there was a mission available (appendix B): "...Flying from Rotterdam The Hague Airport means ease and time savings. These are achieved by good connectivity, close parking lots and fast departure and arrival operations..."
However, in the contrary of the creation of a goal from the mission, a problem statement was used to determine the goal. Which was introduced by the problem owner:
"Construct measures regarding crowd management that deals with the stakeholder interests, activities and, people flows during the transition towards 'Phase 1 - Quick Fixes', avoiding insufficiency or failure of airport operations with respect to people flow management in the departing area, while keeping passengers satisfied, knowing that there is already a problem with capacity availability and while the airport is still opened for business as usual."

This problem description covers a Specific description of what is necessary, Measureable due to 'insufficient' and 'failure' acting as lower bounds, it is Acceptable within the resources available, it is Realistic due to the fact that operations may be executed as usual and is Time bonded: during the renovation phase.

Although the goal was set by a problem statement rather than drawn from a mission, this was found rather sufficient, suitable and acceptable for this particular case.

Objective

For determination of objective, there was no correspondence from Rotterdam The Hague Airport of this subject. So due to the lack of response, the objective had to be defined from the authors perspective, and was based on the previous introduced problem statement and the pillars of SMART.
This particular step was, although the missing validation by Rotterdam The Hague Airport, performed as the methodology states.

As a consequence of the missing objective, the following objectives were introduced:
Reduce (Acceptable & Realistic) the passenger handling inconveniences (Measurable) at mandatory processes (Specific), due to expected work from (re)constructions (Time bounded) and *Reduce inconveniences (Acceptable & Realistic) at mandatory processes (Specific) to avoid failure (Measurable) of services or process, due to expected work from (re)constructions (Time bounded).*
To measure the level of inconveniences, Rotterdam The Hague Airport uses 'Net Promoter Score' (Wiegerink and Verhoeven (n.d.)), based on the principle of (Reichheld (2003)). How these results can be collected should be performed was left out of this particular research.
For the determination of inconveniences in services and processes, failure should be avoided. This was determined by the corresponding regulations per responsible operational party.

Strategy

The strategy had been created from the objectives and was performed as the methodology states.

The strategy was created by the author as: *Create such measures that these can be combined with the (re)constructions, and minimal effort necessary to instruct the employees of the airport. Making the use of measures easy applicable and understandable for all potential stakeholders that may interact with the (re)constructions or experience any inconveniences.*

The resulted strategy was drawn from the objectives and is assumed to be applicable on both the service providers and area users. Here the methodology delivered as intended.

Operational and area tasks and functions

The execution of this step was performed according to desk research and validation by operational services.

To determine the task and function, and corresponding processes at the airport, (Belobaba, Odoni, and Barnhart (2009)) covers a description that relates to the airline industry. This states that airline business is primarily driven by the demand of air travel. In this case passengers act as demand, whereas the services and area to process passengers, are stated as the supply (Hardenbol (2014)).
Within this supply, the area is defined by the departure area and is notified in figures C.2 and C.3. For the function and task description, each mandatory process was investigated by desk research and validated with responsible service providers. The results are presented in appendix D.1.2 and can be used to allocate requirements.

As a result of this step, all tasks and functions of airport processes within the departure area are captured, so this step is passed as the methodology intended.

Area of interests analysis

As the methodology description captures is that the exploration process contains multiple sub processes; perform a site analysis, stakeholder analysis and determine factors of influence, regulation & restrictions and special circumstances.
To determine the characteristics of the area of interests, these are identified by three categories of the exploration: crowd management resources, issues, and site lay out. Whereas initially stated by the methodology, analysis of the users was performed during the stakeholder analysis.

Crowd management resources

For the determination of resources, the question of this step was used: 'What are the available crowd management resources?'. From the authors perspective, these resources only reflect on hard and soft means available within the airport. The hard resources were assumed to be categorised as tangible objects. The soft resources are found in information sharing. In respect to project related resources regarding budget, this was assumed to be a enterprise constrain.

The resources that were found by the author and assumed to acceptable and feasible for Rotterdam The Hague Airport were: temporary walls during reconstructions (quantity unknown), banking lines (see appendix D.1.3 for description) and placement of temporary operational equipment (e.g.: detection gates). In terms of softer resources the department of Marketing & Communication agreed on revision of signing. The board of Rotterdam The Hague Airport agreed that all employees should be updated and informed about the (re)construction works - making each employee available to inform or guide passengers/visitors. In the latter, this could be achieved by using a digital platform, explained in appendix D.1.3.

Assuming that the question reflects on the area of interests, the question is answered sufficient: a summation of available resources that can be used for crowd management measures. However, if the respective question is used to find resources outside the area of interests, other resources can be found as well. It is therefore suggested to adjust the question regarding resources such, that it is only reflecting on finding resources available or feasible agreed by the problem owner. This will be discussed in chapter 5.

Site analysis

The purpose of the site analysis was to determine the lay out of the area of interests. To do so the respective question of 'What is the lay out of the area of interests?' was used. However, due to the fact that the area of interest was already defined by a floor map and, tasks and functions are already captured by flow diagrams, the analysis of the site lay out would not have been performed as initially intended.

In this case, due to already determined information about the site, this analysis was performed such that it would capture the waiting areas of passengers.

To determine these, the initial question regarding the lay out was extended by: 'Which type of waiting areas are there?'. This question was found more specific and can be used to identify the different facilities/lay outs of waiting areas. The results could be used to help identify issues regarding crowd management measures.

The goal was to determine how different areas have different facilities for waiting. As was determined from the site there are three typical types of facilities available for waiting: a public area, dedicated waiting area and a hybrid waiting area (restaurant and waiting area).

Within the public area there are check-in desks and no organisational facilities for waiting. No organisation was applied due to the passenger experience stated by the department of Terminal Management.

The second is the waiting area at the security buffer. This area is structured due to the bank lining used. For this particular area Securitas and the department of Security, Safety and Support are responsible for this particular set up and processing passengers.

In the third area, seats are available to wait for the departing procedure. This area is characterised by its hybrid seats set up. Which can be determined by the mix of restaurant and airport seats. A collection of pictures are presented in appendix D.1.3.

The question respective to the site analysis was already covered but was extended to capture the areas of waiting. This is different than initially stated by the methodology, but not assumed to be a flaw. However, it could be interesting to add additional question to the site analysis to help finding issues in crowd management measures. More of this in chapter 5.

Issues

For determination of issues in the area of interests the only question that is mentioned by the methodology reflects on the 'what'. As the methodology was applied, it was found that this part of the methodology was lacking in finding suitable causes of the crowd management issues.
First the missing specific description of what to look for as causes of the crowd management issues. To compensate, from the authors perspective, new case related questions had to be introduced to find specific crowd management issues (see framed text).

Due to the fact that the planning or (re)constructions was set up as a concept - issues during the (re)constructions could not been created in detail. It was here to assume that similar issues regarding throughput may occur during the (re)constructions and would not have any effect on the methodology results.

To still perform the issue determination at the airport, the following questions were introduced:
1. What is the cause of waiting in the public area? (Subjective preferences of waiting passengers or caused by queueing (Campanella (2016)))
2. How do the passengers line-up without organisation? (Awareness and surrounding traffic (Campanella (2016)))
These two questions should reflect on the repeated waiting behaviour found in the public area. By these questions it became clear what was the cause of waiting and in which direction spill back occurs.
3. What is the cause of a pilled up group of people at the boarding pass check? (Localising the server (Campanella (2016)))
This question was used to determine an occurrence of piling up passengers at the beginning of the security buffer.
4. What kind of queuing behaviour will evolve when passengers know that they can (almost) board? (Minimal effort to pass the server (Campanella (2016)))
A typical waiting behaviour evolves in the departing area before boarding. To determine the cause of queues and how these are organised this question was used.
The results of these questions are included in appendix D.1.3.

Secondly, is the missing objective approach to detect and analyse the issues regarding crowd movement. To compensate, from the authors perspective, a photo camera was used to capture the issues and bottlenecks at the case. This was approach was rather based on so called 'common sense knowledge' (Martella et al. (2017)).
Finding issues within the site exploration was, as already mentioned, found insufficient. It is therefore that the adjustments of this step will be discussed in chapter 5.

Stakeholder analysis
For the determination of a stakeholder analysis the principle of (Bryson (2004)) was used. The results were however slightly different.

> In the contrary to the principle of (Bryson (2004)) of using a 2 by to power/interest table, Rotterdam The Hague Airport provided a 3 by 3 scale. So although the different scale, the exact same principle was used.
> The results of the stakeholder analysis is presented in appendix D.1.3. With the use of the stakeholder analysis it became clear what kind of stakeholders could influence the decisions regarding the (re)constructions and application of measures. With this overview it became more easy to approach stakeholders to discuss certain design choices and decisions.

As the methodology designed, the execution of this step was performed as intended, despite the different scale of the (Bryson (2004)) principle.

Crowd experience factors of influence
To determine the factors of influence, the principles of (Victoria et al. (2017), Nenonen et al. (2008) and NIPO (2017)) were used. In case of Rotterdam The Hague Airport they are in possession of Customer Journeys and made the study of factors of influence possible.

> The results of factors of influence reflected on the internal study of passengers at Rotterdam The Hague Airport (Wiegerink and Verhoeven (n.d.)), based on the principle of Customer Journeys (Nenonen et al. (2008), NIPO (2017) and Boeijen et al. (2013)). The content of this study was used to determine the type of passengers and their touch points. The results are presented in appendix D.1.3.

These so called touch points are used to indicate passenger interaction with the airport services/personal/processes. These can be used to create a base for the the analysis and setting of requirements interfaces.
In all, this analysis was performed as the methodology intended and no comments were found necessary.

Regulations, restrictions and special circumstances
The analysis of regulations & restrictions and special circumstances were performed at the same time. Due to the fact that this analysis was performed by desk research.

> The main regulations & restrictions of the (re)constructions of Rotterdam The Hague Airport reflect on Louwerse et al. (2013), Dutch 'Bouwbesluit' (van het Koninkrijk der Nederlanden (2011)) and special circumstances were mainly covered by the requirements of (Cloe, Hardenbol, Pronk, Schoor, and Tibboel (2017)).

For both the analysis of regulations & restrictions and special circumstances, the methodology questions provided the information that is found sufficient to test the methodology. However, a disclaimer should be notified: This step is only performed by the author with a desk research. There was no validation by responsible parties if all regulations, restrictions or special circumstances are covered. For future applications it is recommended to validate this step with responsible parties.

Lessons learned

This step was performed as initially intended, but did not provide any usable feedback for the subsequent steps. In case of the methodology it was assumed that this would not have any consequences for the up coming steps, so no action was performed to comply with the lack of lessons learned.

For the determination of lessons learned the first approach was to search for documents of previous (re)constructions at Rotterdam The Hague Airport. However, confirmed by the head of the technical department, there were no such documents available.
So it was up to the knowledge gained during the interviews from the related cases. In this case only Schiphol provided feedback, but with a rather broad message: "...there always more behind the wall or ceiling...". Meaning that there is always more work to be done than initially expected. However, this statement more reflects on the (re)constructions to be performed, instead of usable for the determination of measures for crowd management.

As the methodology description of section 3.3.7 captures, is that the step of 'Collection of information is complied when all subjects are covered. Fot this case all subjects are covered, enabling the possibility to continue to the next methodology step: 'specification of measure limitations'. This will be discussed in the following part of this section.

4.1.4. Application step 2: Specification of measure limitations

For the application of the Specification of measure limitations step, the questions of the methodology were used to determine the content of the respective subjects. The results of the specification are presented in table D.6 and table D.7, initially introduced table 3.1.
Although all subjects are at least covered by one requirements, there are three remarks that were found when performing the analysis step: Customer expectations, Physical characteristics and Human interaction.

Starting with the requirements regarding the Customer expectations. Within the methodology, the goal and strategy cover the input necessary to determine the requirement. From the authors perspective was found useful to check with the problem owner if one offers or agrees with the expectations. However, this was not the case. Therefore the customer expectations had to be defined by the author.

To comply with the hard part of the requirement a citation of the problem statement was used: '...respect to people flow management in the departing area...[]...knowing that there is already a problem with capacity availability...'. Here 'flow management' and 'capacity' are interpreted such that these refer to hard measure limitations. Therefore these are translated such that these fit the customer expectations. For the soft side of the customer expectation this was derived from '...keeping passenger satisfied...' (problem statement) and '...measures that these can be combined with the (re)constructions...[]...may interact with the (re)constructions or experience...' (strategy).

In all the combination of the goal and strategy helped with defining the customer expectations, without correspondence of the problem owner. Secondly the content of Physical characteristics, which was related to the mission, factors of influence and stakeholders.

In this case the department of Communication & Marketing suggested to use the temporary walls as a platform to share information for passengers or visitors. This would therefore could influence the experiences of any person that is at the airport. How this could be influenced was not taken into account in this requirement. It was here up to the respective department to determine what type of information was useful or demanded.

So due to the fact that the physical characteristic was used as a information platform, this was assumed to be a rather detailed description of how hard measures can applied. So the physical characteristics was assumed to be a detail requirement.
Finally the requirement content of Human interaction. This requirement was interpreted from the authors perspective.

At Rotterdam The Hague Airport they use the Customer Journey to indicate the gains and pains during a passenger trip. In this case the mandatory processes are assumed to be the pains during the visit at the airport. From conversations with the department of Communication & Marketing it became clear that Rotterdam The Hague Airport would like to keep all activities as much in the gain-zone as possible. Which also means: reduce the pains. To do so, it was assumed that during the (re)constructions that the pains should be minimised as possible. This can be achieved by making the measures easy to apply and understandable for users. Which was based on the feedback of the interview with B. Wiggers from the Utrecht Central project: '...building should be logical...[]...All sings in the building should be of one size,...[]... one style and colour. By this you create a clear distinction between signs(and its importance), calm atmosphere...'.

Despite the responses on the Customer expectations, Physical characteristics and Human interaction by the author, there were no consequences noticed for the performance of the methodology.
With all requirements and constrains noted and clarified where necessary, the next step of the methodology can be applied, which is the design phase. The results of this step will be discussed in the next part of this section.

4.1.5. Application step 3: Creation of measures

This part of the section is dedicated to the execution of the creation of measures of the methodology. In the following paragraphs the content of the design phase is discusses as the methodology initially intended. In the first paragraph the creation of conceptual hard measures are discussed, followed by the improvement of concepts. Then the extension of the concepts will be discussed. In the end a review on the design step will be given.

Creation of conceptual hard measures

The creation of conceptual hard measures is executed differently than the methodology states. How this is performed can be read in the case specific methodology application.

The first step that is indicated by the method is to split the area. This was performed using a combination of maps determined from the (re)construction planning and master plan of NACO. The result of this split led to 7 different areas. The temporary buffer (1), filter (2) and new filter (3) were included due to expected issues of blocking the arrival process, due to spillback and throughput in the 'Passagehal'. The passenger route (4) reflects on the route from the temporary

filter up to the passport check. Within this route, the (re)construction work may influence the throughput/capacity of the corridor.
The KMAR-buffer (5) refers to the waiting buffer for Non-Schengen passengers. It could occur that the demand of passengers is higher than the capacity of this dedicated area, resulting in blockage of the regular passenger throughput.
The current shop (6) is included due the shop lay-out. In this case it was assumed that some of the shelves and location of the cashier may have negative influences on the throughput of passenger flow.
Finally the lay-put of the temporary construction (7) is taken to account. It is up to this location to try out a setting of seats that will eventually be applied in the finished design. The results of the lay out may have influence on the throughput of the waiting area.

Although the methodology refers to a sequence of defining areas before determining crowd management issues, the distinction of areas was rather based on on a combination of inputs: Exploration: Site lay out and Issues. From the authors perspective this observation was assumed to be consequence of the case application. Therefore this adjustment will be rejected in terms of evaluation.
The steps that follows is the determination of measures. This is performed by matching the issues, with the principles of (Hoogendoorn (2011)). Together the use of resources, creative process (section 2.1.3) and common knowledge by the author, suitable measures for the issues were assigned. Creating table 4.1, covering the area locations, respective crowd management issues, measures and principles of traffic management All areas are captured in table 4.1, each defined with their expected issues.

The next step was to draw the concepts that correspond to the measures and principles. Together this approach it was possible to immediately take current or planned hard constrains into account. It was then up to the author to determine which areas could be used to solve the issues. This process was performed iterative until suited concepts were generated. The conceptual drawings are included in appendix E.1.3. In case of the number of concepts, the numbers varied between 2 and 5. The lower bound is set to at least provide the opportunity for the user to consider different options, whereas the upper bound is only set to limit time spent on designing of these concepts.
Different than the methodology states, is that the concepts may continue to the compliance question, but a rather additional step was applied.

Due to the fact that a collection of different options per area were designed, the departments of Terminal Management, Technical Department and, Safety, Security and Support requested only for one of the lay out per concept collection. To select one suitable lay out per concept collection, the departments preferred to choose one of the lay outs per concept based on experience and expertise. This decision process only took place for the temporary buffer and temporary filter. Other concepts were left out of this process and were assumed to be undecided due to limited assurance in planning.

The occurrence of the evaluation process was experienced as a missing feature of the methodology from the authors perspective and could have been an interesting and valuable step in the methodology. How to this decision process can be added to the methodology will be discussed in chapter 5.

Table 4.1: Allocation of hard measures per specified area - Case: extension of the departure area of Rotterdam The Hague Airport

Location	**Expected issues** ***(reference)***	**Measure** ***(suitable resources)***	**Part of traffic management**
1. Buffer temporary central security filter (B-TCSF)	Spill back of queues Blockage arrival area *Expected situation similar as figure D.21*	Creation of variable buffer that could variate in terms of supply/demand w.r.t arriving/departing passengers *Grid floor plan* *(indicated by stickers)* *Bank lines*	1. Avoid spillback of queues 2. Increase throughput
2. temporary central security filter (TCSF)	Low capacity may lead to spill back *Expected situation similar as figure D.41*	Creation of strategic lane positions for optimal use of capacity *Current equipment* *Temporary wall*	2. Increase throughput 3. Divide over network
3. Buffer new central security filter (B-CSF)	Spill back of queues Blockage arrival area *Expected situation similar as figure D.21*	Creation of variable buffer that could variate in terms of supply/demand w.r.t departing passengers and passagehal passageway *Grid floor plan* *(indicated by stickers)* *Bank lines*	1. Avoid spillback of queues 2. Increase throughput
4. Passenger route	Reduced walking speed Spill back of queues *Expected situation based on insufficient view of walking path (B. Wiggers)*	Space reservation (IATA Level: C) for passenger flow versus contractors work space *Temporary walls*	2. Increase throughput 4. Limit inflow
5. KMAR-buffer	Spill back of queues Blockage of passageway *Expected situation similar as figure D.41*	Creation of variable buffer that could variate in terms of supply/demand w.r.t departing versus passing passengers *Bank lines*	1. Avoid spillback of queues
6. Current shop	Blockage of passageway *Expected due to 'uncertain frustration zones' (J. Slingerland)* Decrease of throughput due to shoppers *Assumed by author*	Minimal space reservation (IATA Level: C) for passenger flow versus shopping area *Current shelves*	2. Increase throughput
7. Temporary construction	Blockage of passageway *Expected situation similar as figures D.27 and D.29*	Minimal space reservation for passenger flow versus waiting area *Temporary restaurant facilities* *New/current furniture*	2. Increase throughput

With the measures created, covered by the available resources, the process of generating measures is finished. The next step is to determine whether the measures comply with the collection of information and specification of requirements. This is done by the question: *Compliance with measure limitations?*. To check whether the measures comply with the limitations, all subjects of the requirements and constrains are mirrored with the measures. The results of this comparison can be found in table E.1.
In this step the methodology performed as intended, but a case related notification occurred.

> From the authors perspective it was noticed that the External Constrains (3.1, 3.2 and 3.3) of table D.6 should be checked by responsible stakeholders in a later stage. It was assumed that the problem owner would take responsibility to comply with these requirements, as the (re)construction works start and the measures are applied.

Improvement of concepts

The methodology states that the improvement of concepts is performed when the compliance is not been met. However, in this case due to an iterative approach of designing and fitting the hard measures in the respective areas, already requirements were taken into account such that this step was not necessary.
In the contrary to the purpose of this step, another action was performed. This was assumed to be an exploitation of the concepts.

> As a result of the selection process by Terminal Management and, Safety, Security and Support, about the temporary buffer, one particular concept design was preferred: 'Vrij doorloop' (fig. E.1). Within this concept, a second conceptual drawing process was performed. In this case three bank line set ups were determined. These are presented in appendix E.1.5. These options are based on the variability of the buffer according to a worst case scenario, smallest option and intermediate option. These could be used to vary between the ratio of departing/arriving passengers or other users of the 'Passagehal'.

The additional step was assumed to be complementary for the case and would not have influences on the methodology. So therefore ignored as a mandatory adjustment of the methodology.

Extension of concepts

As introduced in the methodology description of this part of the methodology, there is no priority in defining soft measures for the extension of hard measures or for general purposes. When the methodology was performed at the case, the determination of soft measures for general purposes were performed first. The cause of this sequence was based on the request of the department of Marketing & Communication.

Brainstorm session with respect to general soft measures

For the execution of the brainstorm session, it is assumed that the reader is familiar with this approach. So no extra explanation about the session itself is included in this report. More information can be found in (Cross (2005) and Boeijen et al. (2013)).

> For the determination of soft measures the creative design methods of section 2.1.3 were considered. In the case of Rotterdam The Hague Airport, the department of Marketing & Communication requested for a brainstorm session due to experience. In case of the session 6 members of the respective department were participating.

The brainstorm existed of 2 main parts: think of measures that inform &advise passengers and think measures that guide passengers along the departure processes. In case of informing and advising, two locations of passengers were considered. The decision to do so was based on the passenger journey.
As can be determined from the passenger journeys (appendix D.1.3) is that the leisure passenger get information from agencies, Facebook, LinkedIn, newsletter, Instagram and Twitter. The content of information may variate per passenger but all gained and shared during the orientation of a trip until departure of the aircraft. It is in this phase of the trip that Rotterdam The Hague Airport would like to inform and prepare passengers about certain measures or situations that are unfamiliar to passengers. It is therefore demanded by the department of Communication & Marketing to think of how passengers may be informed about the (re)construction work and respective measures.
To perform the brainstorm session such that it delivers ideas that could be used as information, advise and tools for guidance applicable for this particular case, three problem statements were used to trigger the participants:
1. Inform & Advise
1.1. What does the passenger really want to know until he arrives at the airport's door?
1.2. What does the passenger really want to know from entering the airport until (s)he passes the door, leaving the airport building?
and
2. Guide:
2.1. What means do you think you can guide passengers inside the airport building?
The results of the brainstorm session cover lists of subjects and means that could help the departing passenger to increase awareness of measures and please the experience of stay at the airport. The minutes of this brainstorm can be found appendix E.1.6.

Confirmed by the department of Marketing & Communication, is that the brainstorm session was executed sufficiently such that the feedback can be used by the respective department.

As for the execution of the brainstorm session within the methodology, there were two remarks: the problem statements and participants.
As the methodology captures is that a creative method is performed to determine the soft measures. But when the brainstorm session is performed, problem statements are necessary to trigger the actions of the participants. As a response, the author decided to include three problem statements that respond on (Victoria et al. (2017)): Communication of information. Where one statement was focused on anticipating on the experience expectation, while the other two were focused on communication at the area of interests.
The addition of these three themes were found mandatory to achieve a completion of the brainstorm session and therefore mandatory to the methodology. This will be discussed in chapter 5.
In case of the brainstorm session, the requirement is that different participants with different background/expertise should take part in the session. However, from the authors perspective a decision was made to only perform the brainstorm session with the employees of the department of Communication & Marketing. These employees have such expertise and knowledge about their passengers and are responsible for internal communication with all operational stakeholders at the airport. This particular choice of participants are assumed not to be of influence on the performance of the methodology. For future applications it is suggested that this step should be performed with a variety of stakeholders.

Extension of hard measures

For the extension of hard measures the methodology states that this also can be performed by using a creative method. This step was rather performed as the methodology states and no consequences occurred that were found mentioning. As a result of this process, table 4.2 was generated.

For the addition of soft measures to the determined hard measures, the 'creative process' was used from the authors perspective, with the support of measures by (Baelde (2016) p.11-12) and results from the brainstorm session. By focusing on the cause(s) of the issue(s) in the different areas, the intention was to create preventive soft crowd management measures to deal with these issues beforehand. The measures mentioned in table 4.2 are complementary to those mentioned in table 4.1.

Table 4.2: Additional soft measures to table 4.1

Location	Measures	Expected result	Part of traffic management
1. Buffer temporary central security filter (B-TCSF)	Perform boarding pass check before entering (T)CSF instead at buffer entrance and inform about procedure (Inform by signage or floorwalkers)	- Reduction of spill back in Passagehal - Increase of throughput of Passagehal	1. Avoid spillback of queues 2. Increase throughput
2. temporary central security filter (TCSF)	Use of an employee to assign a security filter lane (Guidance by security member)	- All security lanes are equally occupied	1. Avoid spillback of queues 3. Divide over network
3. Buffer new central security filter (B-CSF)	Perform boarding pass check before entering (T)CSF instead at buffer entrance and inform about procedure (Inform by signage or floorwalkers)	- Reduction of spill back in Passagehal - Increase of throughput of Passagehal	1. Avoid spillback of queues 2. Increase throughput
4. Passenger route	Hold passengers before entrance of Passenger route (Guidance by floor walkers)	Less crowded corridor, increasing safety and passenger experience	2. Increase throughput 4. Limit inflow
5. KMAR-buffer	Inform passengers about the buffer location and what to expect of procedure (Inform by signage or floor walkers)	- Reduction of time the passenger is at the KMAR-counter	1. Avoid spillback of queues
6. Current shop	N/A	N/A	N/A
7. Temporary construction	N/A	N/A	N/A

Improvement of conceptual measures - iteration 2

Different than 'Improvement of concept', this iteration was experienced not to be necessary. Due to already applied iterative fitting the soft measures and evaluating with responsible stakeholders.

Detailed measure design phase

For the application of this phase, it was here to exploit the conceptual measures. However, due to limited time this phase was not executed by the author but was outsourced to the Technical Department of Rotterdam The Hague Airport.
In addition to this step, a validation test was applied to determine details for the conceptual hard measures.

> In this case, the conceptual drawings of the temporary buffer options and temporary lane positions were sent to the Technical Department. They were instructed by the author, and supported by the department of Safety, Security & Support, to generate detailed plans from the conceptual hard measures for the 'Buffer temporary central security filter (B-TCSF)' and 'Temporary central security filter (TCSF)' (as suggested in appendix E.1.3). The remaining concepts were delivered to the head of the Technical Department for further evaluation.
>
> In addition of the conceptual drawings regarding the Buffer temporary central security filter, the mentioned 'grid' (explanatory information in appendix E.1.4) of table 4.1, was found useful for the Technical Department. By introducing a grid, the department could use this system for their technical plans as well. Together with the author, they used the grid as a starting point to introduce a coordination system within their technical plans.
> With this grid or coordination system, pin pointing specific location of hard measures was now more easy to understand compared to previous communication between Technical Department and operational parties of the airport building. As a result the three options of appendix E.1.7 were drawn in detail, based on the introduced grid.
> As a result of this application, this grid should be used for other projects as well. Functioning as an objective to reduce communication errors between different departments.

Next to the exploitation of the concepts, real life tests were performed (appendix E.1.8). The purpose of these tests was to validate the space available and how much time it took to set up/change different options for hard measures.

> The tests provided Terminal Management, Trigion, (head of) Technical Department and the design team of the (re)constructions, a real life experience of how two much space should be reserved by the buffer in different cases of scenarios of passenger demand. Upon that, for Trigion the time of adjusting the buffer is crucial for passenger handling. So by this tests, this gave Trigion insight how much time it takes to build up or change the banking line set up.
> How the buffer set up will be communicated with Trigion, will be performed during internal meetings.

Despite that the methodology was not fully tested and exploited in the detailed design phase, tests were found complementary to the methodology in this stage. More of the addition tests will be discussed in chapter 5.

Improvement of details

Although that the detailed design phase was not performed as intended, the improvement of details was performed as the methodology intended. However, improvement of details were not executed by the author but outsourced to the responsible department.

> In case of the detail plans of the Temporary central security filter, the Technical Department drew different lane set ups. To validate these plans, these were first discussed internal by the department of Safety, Security & Support. From the results of this discussion, a test was performed was performed by the author, using tape, rope and ribbons. The execution of this test provide real life validation for the department of Safety, Security & Support of how much space passengers would have during their security check process. The results and feedback were then again evaluated by the department of Safety, Security & Support. Finally the required adjustments and additional details were communicated with the Technical Department to create a final detailed plan of the Temporary central security filter.

Although the improvement of details were only executed once and not performed by the author, the step of improving details was assumed to be useful. It shows that an iterative process of changing or addition of details is an iterative process and depends on the decision process by that stakeholder that is responsible for a specific area. Although that the execution and addition of details was performed by another department, it is assumed that the methodology performed correctly.

End creation of measures

With all steps performed, the creation of measures was assumed to be finished. It was up to the next step to clarify how the measures should be executed and explain what the consequences are within crowd management for passengers and operational parties. The 'delivery of measures' will be discussed in the following paragraph.

4.1.6. Application step 4: Delivery of measures

The execution of delivering the measures for the problem owner depended on the preference of communication. At the case of Rotterdam The Hague Airport, both a presentation and written report were demanded. In case of the presentation, a simplified explanation was given with explanatory schematic plans about all hard and soft measures of table 4.1 and 4.2, and how they contribute to the crowd management measures.
With respect to the written report, this was a advisory report with the descriptions of: all decision processes, descriptions of hard measures, respective soft measures, expected consequences of the measures, resources needed, met requirements and additional necessities that are assumed to be useful for operational parties (from the authors perspective). In the appendices of the respective report, all conceptual drawings are added to give the problem owner insight of the iterative design process.

4.2. Methodology application review and assessment

With the total methodology applied on the Rotterdam The Hague Airport case, a review about the performance of the methodology and resulted measures will be discussed. It is not here explicit to determine the result for measures from the problem owners point of view, but rather to the performance of the methodology that was able to create practical, feasible and efficient measures. Eventually the sub question relating to this chapter will be answered:
To what extent does the potential methodology result in practical, feasible and efficient crowd management measures to keep the hub open while it is reconstructed?

First the methodology performance is reviewed, followed by evaluating the measures, based on the performance of the methodology.
In section 3.9, it is stated that the performance of the methodology can be checked by the execution of each respective step. To do so, all steps are presented in table 4.3.
From this table it can be determined that only the 'improvement of conceptual hard measures iteration - 2' and 'creation of detailed measures' were not performed.
In terms of the 'improvement of concepts iteration - 2', this was found unnecessary, because the content was already covered by the previous steps. The 'creation of detailed designs' was not performed by the author, but was outsourced to a responsible department. This created the possibility to perform tests to improve the details.
Upon that, there are 6 additions/adjustments found worthy to apply within the methodology: Exploration (resources, site analysis and issues), decision process, problem statements for brainstorm sessions and testing. All of these subjects will be discussed in chapter 5.
Despite additions/adjustments, it is was still possible to create crowd management measures, so the methodology works as intended. However, if these measures are practical, feasible and efficient, is up to measure qualification.

In section 3.9 it was stated that, if the delivered crowd management measures meet the characteristics of section 3.1.1, the measures can be categorised as practical, feasible and efficient. To do so, the characteristics and produced measure appearances are placed in table 4.4. It can be concluded from table 4.4, was that all defined characteristics of measures are met by the results of the case application. The practical and feasible characteristics can directly been determined from sections of this chapter. The efficiency of measures can be derived from case related content, presented in tables D.6 and D.7.

As a result of the validation of the methodology, supported by table 4.3, and validation of the crowd management measure characteristics, supported by table 4.4, it can be concluded that the methodology performs as initially designed and result in in practical, feasible and efficient crowd management measures, while (re)construction work is performed and business is performed as usual.

In this chapter the methodology has been applied on the case of Rotterdam The Hague Airport. The results of the methodology application led to a complete assessment of the methodology. However, found during the application where that adjustments or additions had to be inserted to fully comply the whole methodology execution. Consequently, the next chapter is dedicated to the discussion of the adjustments and additions that were found necessary to perform all steps of the methodology. Next to that a validation is presented, which is subjective substantiated from the problem owners perspective. Finally pros and cons will be presented, that are based on the case validation of this chapter as well as the adjustments and additions, and subjective validation.

Table 4.3: Methodology assessment table - including case related comments

Methodology steps	Performed?	Comment
Start procedure of the methodology	Yes	
Step 1: Collection of information		
Goals	Yes	Goal derived from problem statement
Objective	Yes	
Strategy	Yes	
Task and function	Yes	
Exploration		
Resources	Yes	Adjustments necessary
Site analysis	Yes	Adjustments necessary
Issues	Yes	Adjustments necessary
Stakeholder analysis	Yes	
Factors of influence	Yes	
Regulations, restrictions	Yes	Validation required
Special circumstances	Yes	Validation required
Lessons learned	Yes	No information was available
Step 2: Specification of measure limitations		
Limitation specification	Yes	3 limitations determined by author
Step 3: Creation of measures		
Conceptual design phase		
Creation of conceptual hard measures	Yes	Area split based on: Area Lay Out and Issues Additional step necessary: Decision process
Improvement of concepts	Yes	
Extension of concepts	Yes	Problem statement mandatory for brainstorm sessions
Improvement of concepts iteration - 2	No	Already covered by previous steps
Detailed design phase		
Create detailed design	No	Outsourced Additional step: Testing
Improvement of details	Yes	Additional step: Testing
Step 4: Delivery of measures		
Delivery of measures	Yes	

Table 4.4: Assessment table of crowd management measure qualification - case results

Type of measure and characteristics	**Included (Yes/No)**	**Type of measure and characteristics**	**Included (Yes/No)**
Practical and feasible		Efficient	
Included elements	**Yes**: 4 principles	*Performance*	**Yes**: Table D.6 Req.: 6. System boundaries 7. Utilisation environments, 9. Performance requirements
Identified issues	**Yes**: Table 4.1	*Dimensions*	**Yes**: Table D.7 Req.: 12. Design constrains
Limitation in resources	**Yes**: Section 4.1.3: Exploration: *Resources*	*Legislation*	**Yes**: Table D.6 Req.: 3. External requirements
Location applicability	**Yes**: Section 4.1.5	*Requirements*	**Yes**: Remaining content of tables D.6 and D.7
Factors of influence	**Yes**: Section 4.1.3: Exploration: *Factors of influence*		
Communication and application	**Yes**: Section 4.1.6		

5

Methodology adjustments and additions, validation, and, pros and cons

In this chapter an evaluation is performed regarding the methodology. These cover a review of the methodology additions & adjustments, which are assumed to be mandatory or complementary, a validation by the problem about the methodology and its measures, and a the presentation of the pros and cons of the new methodology.

In the first section the adjustments and additions that were found mandatory (and/or complementary) for a functioning methodology, are exploited and presented. The results of this section delivers the answer on the sub question:
What are the adjustments and improvements necessary to apply the methodology on other similar cases?
In the second section a validation of the methodology and its measures are performed, which is based on the results of a unstructured interview with S. van der Kleij (representative as problem owner of the demanded measures for crowd management issues during the (re)constructions of Rotterdam The Hague Airport). This feedback is then taken into account to consider the pros and cons, discussed in the last section.
In the third section, the methodology application of chapter 4, adjustments and validation are reviewed together to discuss and present the (dis)advantages of the methodology and its outcomes. This will provide the answer on the last sub question of this research: *What are the pros and cons of the new designed and tested methodology?*

5.1. Methodology adjustments and additions

In this section, the adjustments found in the previous chapter will be discussed in detail, which cover: Exploration (resources, site analysis and issues), evaluation process, problem statements for brainstorm sessions and testing.
From the authors perspective the adjustments of exploration (resources and site analysis) and problems statements for brainstorm sessions, were assumed to be minor changes to the methodology and can be added easily to the methodology. The adjustments of exploration (determining issues), evaluation process and testing are assumed to have more influence on the determination of measures, due to the involvement of issues, acceptations/rejection of measures and validation of measures.

5.1.1. Adjustment 1: Exploration - Resources

During the execution of the exploration regarding resources, the initial question to find available resources was defined as: 'What are the available crowd management resources?'. This question was experienced rather broad. It should therefore be adjusted that the question only reflects on the area of interest. To do so, the question should be changed to: 'What are the available and feasible crowd management resources, within the possession, budget, interests of the problem owner?'
By using this question, it is up to the problem owner to come up with a list of resources (e.g. materials, equipment, personnel) rather than collected by the methodology user, limited in knowledge of resources stock/supply possibilities.

5.1.2. Adjustment 2: Exploration - Site analysis

The site analysis step was initially performed as intended. However, as a result of available floor maps, covering the area functions, an additional question was added to this step: 'Which type of waiting areas are there?'
This question is rather case specific. If there is no dedicated waiting area, this question can be skipped, and is therefore assumed to be complementary. The results of the question can be used to help identifying waiting behaviour. Which can be supported by the next methodology step: determining issues.

5.1.3. Adjustment 3: Exploration - Determining issues

As the methodology initially describes is that issues regarding crowd management should be similar to the experiment 9 and 10 of congested conditions by (Daamen (2004)). During the execution of this step, from the authors perspective, initially described methodology step was not found sufficient, so a suitable adjustment was demanded.

To determine the crowd management issues at a specific area within the hub, it was assumed that these issues occur during peak hours of service demand. It should however be notified that the question: *What is the main cause of peak hours?* falls out of the scope of the methodology, assuming that the main cause cannot be solved (e.g.: At Rotterdam The Hague Airport the peak hours are a result of all aircraft departing within 30 minutes of each other. So if one spread the departure of aircraft over a longer time frame, it was assumed that crowd management issues occur less).
To determine when these peak hours occur, the following question was introduced to limit the time frame of the crowd management issue analysis: *1. At what time does the demand reach the peak in demand of (mandatory) services?*

To detect the crowd management issues during the methodology application, taken photographs where used afterwards to detect the issues, instead of objective analysis approaches. To detect waiting or queue forming other sensing techniques could be used as well, such as: video cameras (visual sensing), smartphones (Bluetooth/WiFi) and/or social media and microphones (Wijermans, Conrado, van Steen, and Li (2016), Versichele, Neutens, Delafontaine, and Van de Weghe (2012), Danalet, Farooq, and Bierlaire (2014) Martella et al. (2017)). For this particular research, the evaluation of sensing techniques is left out of scope due to limited time of research. This will therefore need to be investigated more during future research.

The results of the sensing techniques can be used to localise the cause(s) of queue forming and/or waiting crowds. To do so, it assumed that the behaviour of passengers or visitors act as the waiting behaviour mentioned by (Campanella (2016) p.70-71): 'H13: pedestrians prefer to stay around a chosen location in the waiting area, H14: and only move in reaction to pedestrians walking in close distances...[]...H15: When walking inside waiting areas pedestrians walk more forcefully than

in normal conditions and accept smaller distances to waiting pedestrians...', or waiting in a queue (Campanella (2016) Figure 3.12, p.72). To detect the cause of waiting or queue forming, it is here to detect whether these are caused by physical limitations of the area (experiment 9 and 10 of congested conditions by (Daamen (2004))) or are caused by mandatory services or self organisation. To do determine the cause this can be done by using '...expert knowledge based on experience...[] ...common-sense knowledge' (Martella et al. (2017)), therefore the following question was introduced: *2. What is the cause of waiting or queue forming where passengers or visitors tend to stand still?*

From the previous question, from the authors perspective, a third question formed: If there is queue forming, it is useful for the determination of suitable measures to determine the cause of why the queue is formed in such way. To question this the following question is introduced:
3. What are the interfaces that make the queue forming as it is?
Different than the questions introduced during the execution of the methodology in section 4.1.3, is that now only 3 questions are sufficient to cover the same type of feedback. In this case the question regarding 'how do the passengers line-up without organisation?' and 'what kind of queuing behaviour will evolve when passengers can (almost) board?' are captured in the newly defined 3rd question.

In all, detecting issues, as initially mentioned in the methodology was assumed too vague. With specifications of time, waiting and queuing behaviour, the intended search of crowd management issues can now be performed with the 3 new questions:
1. At what time does the demand reach the peak in demand of (mandatory) services?
2. What is the cause of waiting or queue forming where passengers or visitors tend to stand still?
3. What are the interfaces that make the queue forming as it is?

5.1.4. Adjustment 4: Concept evaluation process

Mentioned in section 4.1.5 is that from a collection of conceptual hard measures, one suited concept per specified area was chosen by the involved stakeholders. This type of evaluation making refers to an individual decision making process. Which is one of the three decision processes (Sage (2000)) introduces: individual, by a team or by a group of individuals. All of them cover the same characteristic '...there are at least seven important elements that make up the situation surrounding a evaluation situation...[]...: people, goals, constraints, values, perspective, experience, and information' (Sage (2000) p.362-363). Whereas in groups an additional form of evaluation making is applied: '...Voting is one very common form of group evaluation making...' (Sage (2000) p.424-425). Also within voting multiple approaches can be applicable, each with its own voting rules: plurality, majority, weighted voting and binary comparison voting (Sage (2000)).
From the authors perspective these evaluation approaches are assumed to be rather subjective way of choosing a suitable option of the conceptual measures. To consider a more supportive way of selecting a suitable hard measure concept, is to use a discrete method of the Multi-Criteria evaluation-Making (MCDA) (Mateo (2012)): Multi-attribute evaluation-making (MADM)
(Zanakis et al. (1998)).
The choice of using a Multi-Criteria evaluation-Making (MCDA) methods is based on the four reasons by (Mateo (2012) p.8): '...(i) It allows for investigation and integration of the interests and objectives of multiple actors...[]... - (ii) It deals with the complexity of the multi actor setting by providing output information that is easy to communicate to actors...[]... - (iii) It is well-known and applied method of alternatives' assessment that also includes different versions of the method developed and researched for specific problems and/or specific contexts...[]... - (iv) It is a method that allows for objectivity and inclusiveness of different perceptions and interests of actor without being energy

and cost intensive...'. Whereas the reason for Multi-attribute evaluation-making is based on its application characteristics of finite selection of alternatives (Mateo (2012) and Zanakis et al. (1998)). *For the execution of the Multi-attribute evaluation-making, it was assumed to the reader to be familiar with this method. So no explanation will be provided further.*

To use a the subjective or more objective way of selecting measures within the methodology, this can be performed by following the flow diagram (fig. 5.1). In all, the application of this evaluation process will support the methodology user to provide transparency in the evaluation making process. This diagram should be applied after the hard measure designs to reduce the number of possible physical set-ups, as well as the extension phase when introducing the soft measures to stay within the resources or goal of the problem owner. *Note: there is no limitation regarding the number of measures, as long as these can be feasible within the problem owner's resources and/or goal.*

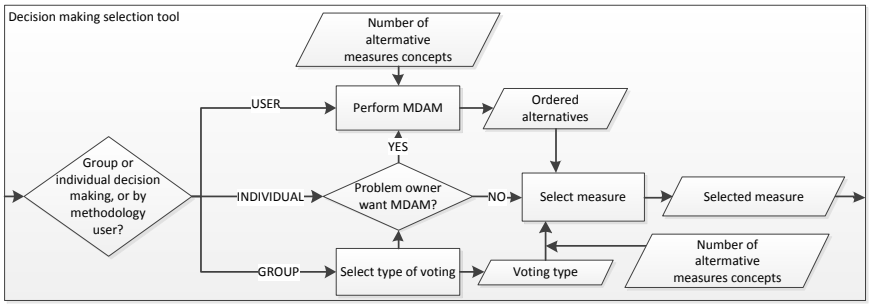

Figure 5.1: Decision tool for evaluation process

5.1.5. Adjustment 5: Problem statements for brainstorm sessions

During the execution of the brainstorm session, 3 problem statements were introduced to trigger the participants, based on (Victoria et al. (2017)): Communication of information: (1) anticipating on the experience expectation and, communication (2) and guidance (3) at the area of interest. For future applications, it is recommended to include all 3 themed problem statements in the brainstorm session. For other design methods further research will be required, to determine whether the addition of these question may affect the outcome of crowd management measures as well.

5.1.6. Adjustment 6: Testing of measures

Mentioned in the detailed design phase was that two concepts (Temporary buffer and temporary security lane setting) only the hard parts of the measure were tested. Performing the tests were possible due to the fact that these areas were (already) accessible, not involved nor changed by the (planned) (re)constructions and were not used by any operational parties or passengers.
Despite that no specific measurements were performed, fitting and practising the different set-ups (summative and comparison testing) of the Buffer at the temporary central security filter were assumed to be useful for Terminal Management, Safety, Security & Support, Trigion and Technical Department. This test was performed to visualise, compare different set ups and validate how much space would be occupied by the different buffer concepts and how much time it takes to set up and change the different concepts.
Whereas the tests of the Temporary central security filter was only complementary for validation of lane fitting. This was used as support of argumentation for the department of Safety, Security & Support and validate the possibilities of fitting for the drafters of the Technical Department.

For both tests, these complied with the initially indented to measure occupied space and set up duration. None of the results were recorded on paper but were assumed to be successful due to verbal confirmation about satisfactory by Terminal Management, Safety, Security & Support and Technical Department. However, if testing would be implemented within the methodology this should cover a specified description of how tests can be performed.

For the application of testing measures, it was assumed by the author that these tests are comparable to the tests of usability: '...a product or service is truly usable, the user can do what he or she wants to do the way he or she expects to be able to do it, without hindrance, hesitation or questions.' (Rubin and Chisnell (2008) p.4). The subscription reflects on usable products and services, where in the methodology, it was assumed that the creations of hard and soft measures are assumed to be a product. So making testing of usability a plausible way to test the measures.
Within testing of the created crowd management measures, three approaches were introduced: formative (exploratory), summative (assessment) (Barnum (2011)), validation (or verification) and comparison (Rubin and Chisnell (2008)), which all can be performed by manual testing (e.g. real-life set-ups) or by digital techniques/models (Wijermans et al. (2016)). In the latter, currently 171 models are in development regarding prediction (Wijermans et al. (2016)). Due to limited time of this research, it is out of scope of this to suggest which models could be suited for this particular addition of the new methodology. Further research will be necessary to determine modelling are of added value within the decision process of testing, compared to manual testing.

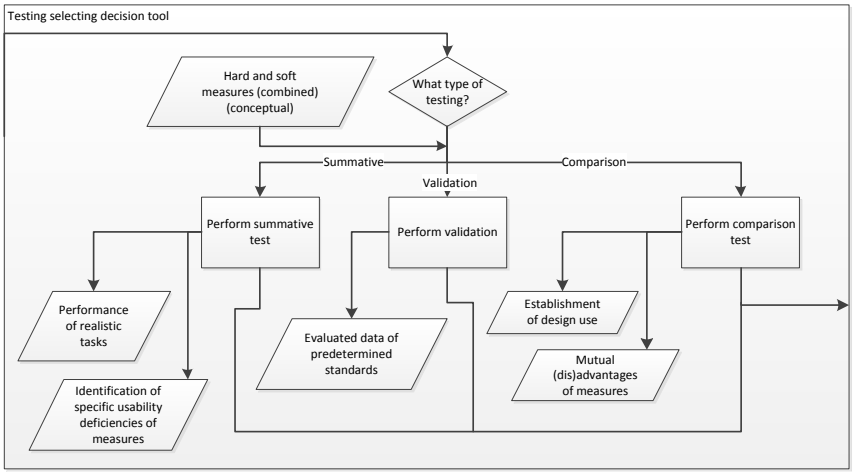

Figure 5.2: Testing type selection tool

Due to experience of the case and the satisfactory of involved parties, the author considered to provide a evaluation tool to determine the use of testing types for the methodology user. In this case the types that are considered are summative testing, validation and comparison. This evaluation tool is presented in the flow diagram, indicated in figure 5.2.
It is up then to the methodology user to determine if all requirements of these tests are met, tests are executed as initially described by literature and decide what to do with the outcomes.
As can be determined from the figure is that the test output result vary. The use of outputs can be applied to support argumentation, acceptance or rejection of certain measures. It is here up to the problem owner to determine a evaluation process, and determine whether the measures should be improved.

5.1.7. Methodology adjustment review

As a result of the methodology application and its found adjustments and additions, the suq question regarding this subject can be answered.
What are the adjustments and improvements necessary to apply the methodology on other similar cases?
The adjustments of the methodology are identified by six subjects: determining resources, exploration of the site analysis, determining crowd management issues, brainstorm session problem statements during the creative process, addition of evaluation processes and testing methods.
The adjustment in determining resources was found necessary to specifically find resources within the possession, budget and interests of the problem owner. The adjustments in site analysis was to increase the possibility to find crowd management issues, supported by an adjusted approach of three supportive questions:
1. At what time does the demand reach the peak in demand of (mandatory) services?
2. What is the cause of waiting or queue forming where passengers or visitors tend to stand still?
3. What are the interfaces that make the queue forming as it is?
The fourth adjustment covers the implementation of three themed problem statements to trigger participants during the brainstorm session: (1) anticipating on the experience expectation and, communication (2) and guidance (3) at the area of interest.
The evaluation making process should be added such that it enables the methodology user decide which evaluation making process can be executed. Where the evaluation making process consist of group evaluations based on voting, individual evaluations or methodology user evaluations, offering the possibility to be supported by a Multi-Attribute evaluation-Making method. Testing should be added the possibility to provide the methodology user to perform measure validation, summative or comparison testing. It is up the type of tests, what output can be used.
As a result of the adjustments and additions, these are added to the initially introduced methodology of chapter 3. Because the additions and adjustments are rather specific per methodology step, these are assigned to the respective flow diagrams 3.3 and 3.5. It does not change the initial lay out of diagram 3.1.

In figure 5.3 the new version of 'Step 1: Collection' of information' is presented, covering an adjustment in 'Issues' to cover the changes in determining crowd management issues. The adjustments of 'Exploration - Site analysis' and 'Exploration - Resources' are assumed to be changes in questioning, rather than changes in the flow diagram.
In figure 5.4 the new version of 'Design step' is presented. In this flow diagram, three additions are placed: (i) the placement of the evaluation tool after the creation of hard measures, (ii) the placement of the evaluation tool after the extension of concepts and (iii) addition of testing after the detailed design.

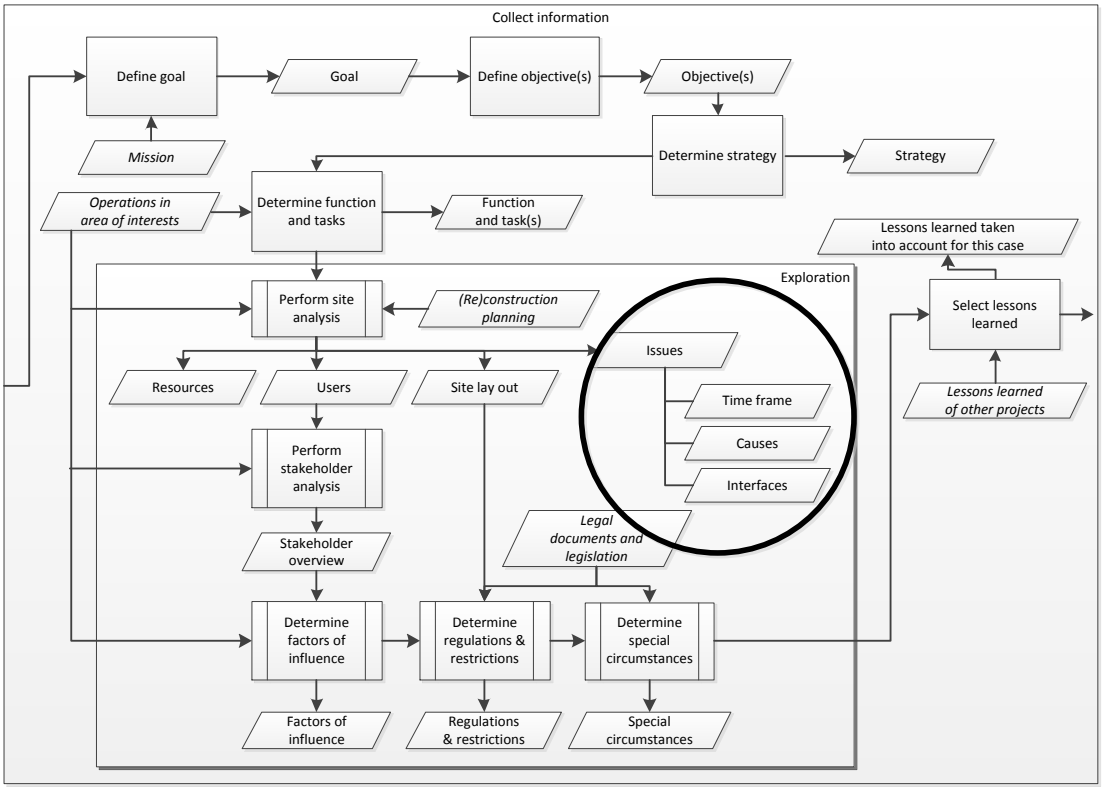

Figure 5.3: New version of 'Step 1: Collection of information' - Adjustment indicated by circle

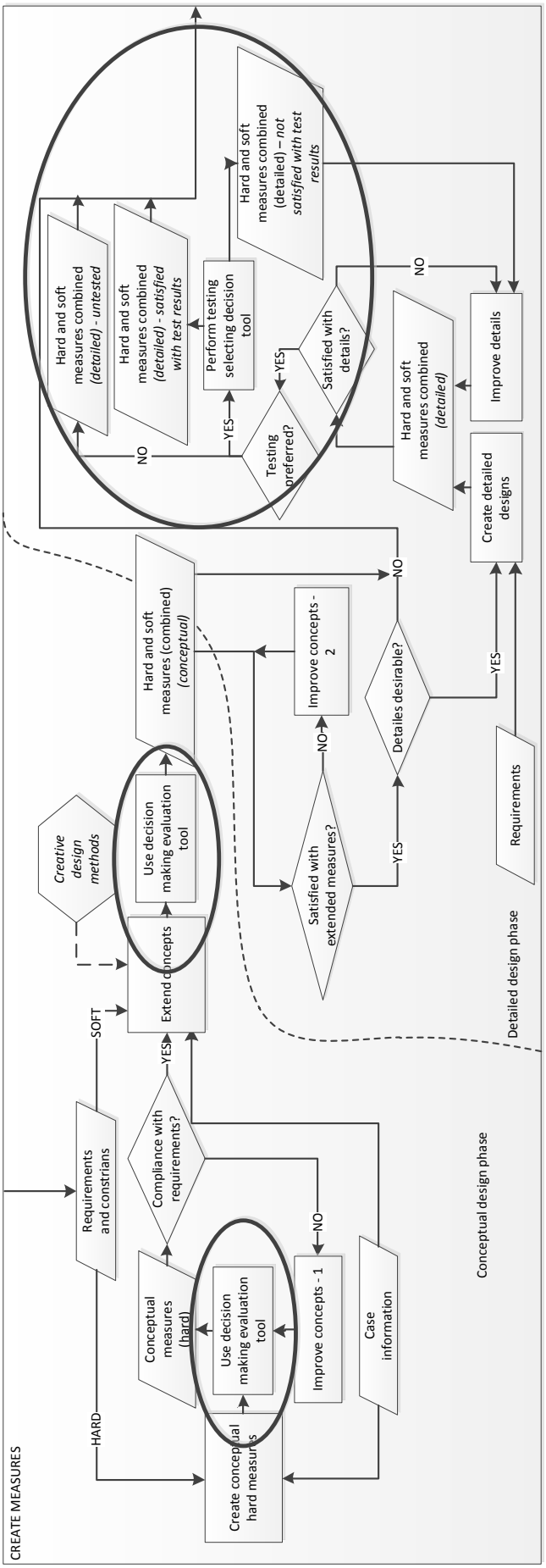

Figure 5.4: New version of 'Design step' - Adjustments indicated by circles

5.2. Measure and methodology validation by the problem owner

To validate the methodology, the application at the case of Rotterdam The Hague Airport was assumed to be a sufficient approach to determine the methodology transparency and performance. In addition to the execution of the methodology, an extra validation was performed. This was performed by a unstructured interview with S. van der Kleij. The preparation and minutes of the unstructured interview are included in appendix F. The feedback of the interview captures the a validation of measures and applied methodology at Rotterdam The Hague Airport.

The feedback of the interview provided information about two subjects: the measures itself and the methodology.
Initially during the delivery of measures verbally and written, at the end of the project in September 2017, the measures were assumed to be applicable on the (re)construction planning. However, in the first week of December 2017, the (re)constructions were not performed yet, due to changes in (re)construction planning. As a result of these changes, the measures initially presented in September do not match the planning of December 2017. Which of those measures or changes of planning were discuss were assumed to be irrelevant.
According to these changes, S. van der Kleij stated that, although the measures are outdated, the way how problems regarding crowd management issues can be solved by measures is now of more importance, instead of one-on-one measure-issue application.

Upon the validation of the measures, the content and steps of the methodology were discussed with S. van der Kleij. The remarks of the methodology cover three main notifications: 1. What to do with adjustments of planning during or after the total execution of methodology?, 2. If this planning is changed, where do you re-enter the methodology? and 3. Which steps should (not) be performed again to deal with the planning changes?
These remarks were all caused by the current state of the (re)construction work, and therefore outdated measures. Due to the changes of planning, the initial delivered measures (September 2017) were not applicable on the current (December 2017) planning of (re)constructions.

As a result of the feedback a review was performed to determine the impact of changes of planning, if this remark would be implemented. From the steps of 'Collection of information', 'Specification of measure limitations', 'Creation of measures' and 'Delivery of measures', based on the methodology steps as presented in chapter 3.1.2, it was possible to determine the influence of (re)construction planning. To do so, a summation could be presented to indicate the amount of methodology steps and outputs that are influenced by the changes in (re)construction planning.

- **Step 1: Collection of information**
  - Perform site analysis
    - Resources
    - Site lay out
    - Issues
    - (Users)
  - Determine regulations & restrictions
    - Regulations & restrictions
  - Special circumstances
    - Special circumstances
- **Step 2: Specify requirements**
  - Determine project & enterprise constrains
    - Enterprise limitations
  - Determine external constrains
    - External limitations
  - Determine interfaces (changed site lay out)
    - Stakeholders + corresponding interface
    - Corresponding acceptance level
  - Define system boundaries
    - List of excluded elements
  - Define utilisation environments
    - Environment conditions
    - Time frame
  - Define human interaction
    - Human requirements
  - Define design constrains
    - Hard constrains

- **Step 3: Creation of measures**
  - Creation of conceptual hard measures
  - Area split
  - Determination of specific issues
  - Determination of measures
  - Improvement of concepts
  - Extension of hard measures
  - Hard measures and corresponding soft measures
  - Improvement of concepts iteration - 2
  - Hard measures and corresponding soft measures
  - Detailed design of measure
- **Step 4: Delivery of measures**
  - Changes in verbal communication
  - Changes in written communication

From the summation it was determined that all 4 steps, including sub steps, of the methodology are influenced by the changes of (re)construction planning.
Because the methodology was initially intended to be a transparent and structured approach to determine crowd management measures. It was assumed that mistakes of the implementation of the (re)construction planning changes could mismatch the previous determined steps of information collection, limitations, designs or delivery of measures. It was therefore concluded and recommended to perform all methodology steps over as initially designed, to avoid this occurrence from happening.

5.3. Methodology pros and cons

In this section the pros and cons are presented, covering: the methodology structure/appearance, creation of hard and soft measures, adjustments and problem owner validation.
The first pro is the methodology structure itself. As initially introduced in section 3.1.1, the methodology has been created such to ensure understanding of why measures should (not) or can(not) be applied, what resources limit the number of measure possibilities, which constrains limit the dimension of measures, tractability of location application measures, factors of influence, measure and user interfaces, and how it should be communicated with the problem owner. From the methodology application, it can be concluded that the transparency characteristics can be met (see table 4.3), and practical, feasible and efficient crowd management measures, allowing to cover the literature gap of a missing recipe to produce a plan in crowd management.
The second and third pros are found in the ability of the methodology to create hard and soft measures independent of each other. (2) With the use of the step 'creation of conceptual hard measures', the methodology enables the possibility to deal with the physical modifications by (Baelde (2016)) to steer the traffic system (Hoogendoorn (2011)), based on resources and limitations. (3) Then creative processes are used to create soft measures as a response on the physical modifications. Where the soft measures are used to deal with crowd experiences, focusing on communication of information (Victoria et al. (2017)): (i) anticipating on the experience expectation and, communication (ii) and guidance (iii) at the area of interest.
In the contrary to these pros, there are no structural cons found that reflect on the methodology.
However, worth mentioning are the (1) the missing evaluation process, (2) the missing state of the art techniques regarding sensing and modelling and (3) the in-ability to deal with changes in (re)construction planning.
First is the missing evaluation process. During the methodology execution hard measures were chosen from a set of hard measure concepts. However, it was found difficult to determine whether these measures were chosen such that it created the possibility to continue with the subsequent steps without any required adjustments to the methodology. However, as it was already mentioned in this chapter, it is assumed that the occurrence of the missing evaluation process is rather incidental and should be added to the methodology (see section 5.1.4), making the con only one-off and be rejected.

Secondly are the missing techniques regarding sensing and modelling. As found during the methodology application in chapter 4 and the adjustments of the methodology of chapter 5, is that that the methodology did no not yet included state of the art techniques regarding sensing (e.g. video cameras, WiFi, Bluetooth, etc.) to detect crowd management issues, or techniques regarding simulation or modelling to predict crowd movement or testing of created crowd management measures. To determine the whether these techniques are complementary to the outcome to practical, feasible and efficient measures, these should be included and investigated by future research, and are therefore also assumed to be one-off.
The third point worth mentioning had been noticed by S. van der Kleij, which is the methodology inability to adjust the crowd management measures due to changes in (re)construction planning, without performing all methodology steps again. This notification aims to adjust the methodology such that less steps have to be executed to change the crowd management measures due to planning changes. However, the methodology is created to perform a structured and transparent step wise approach to determine the correct crowd management measures, which identifies its purpose. Therefore it is assumed to be more of an notification rather than a con of the methodology.
As a result, the respective question regarding pros and cons can be answered: *What are the pros and cons of the new designed and tested methodology?*
In all the cons are assumed to be absence, due to incidental and subjective perspective. This therefore results in that the methodology covers pros in the subjects of:
+ Methodology enables to determine specific measure(s) per crowd management issue
+ Methodology enables user to determine hard measures based on the resources available
+ Methodology enables user to match soft measures based on the hard measures and determine general applicable measures separately

In this chapter the adjustments and additions, external validation and, pros and cons, were discussed. As the the adjustments and additions of the methodology were assumed to be the last deliverable of the methodology application, the study of the methodology is now finished. Consequently, the next chapter is dedicated to the conclusion and recommendation of all preceding chapters.

6

Conclusion and recommendation

This chapter is dedicated to the conclusion and recommendations. To do so, the following sections will be used to support these: research findings, followed by a discussion. Then the conclusions, implications for science and practice, and recommendations for future research will be presented.

6.1. Research findings

The goal of this research was to create and test a methodology which is capable of: delivering practical, feasible and effective crowd management measures, applicable at hubs under the specific circumstances of (re)construction while business is performed as usual. A main question and six sub questions have been formulated. Starting with the sub questions and respective answers, thereafter the discussion will be presented. From this it is possible to answer the main question.
1. What methodologies, that are able to create crowd management measures applicable in circumstances of (re)construction while business is performed as usual, are found in literature?

The literature study showed that there was a lack of specific literature with respect to methodologies that are able to create crowd management measures specifically applicable at hubs that operate as business as usual, while (re)construction is performed. Therefore, a new methodology has been developed in this research. As a starting point, literature of product design methodologies (4-stage model, Main Design Core, VDI2221, System Engineering and Rational Design Process) have been analysed. The essentials of these methodologies has served as an inspiration of the new methodology.

2. What were the methodologies (that can create crowd management measure) applied at other hubs in the Netherlands, where business was performed as usual, while under (re)constructions?

Unstructured interviews had been performed along 3 related cases: (1) Utrecht Central Station, due to the hub function and construction/expansion work performed during operations while business is performed as usual, (2) Van Gogh Museum (located in Amsterdam), due to its involvement first time visitors, paying customer for services and (re)construction work performed during regular opening hours, (3) Schiphol ONE-XS: the centralisation of the security filter, due to its characteristics of being a hub and (re)construction work performed in the areas where business was performed as usual.
With the use of unstructured interviews, at each of the cases, the goal was to determine what kind of methodologies were used to determine crowd management measures applicable to the respective project. Although the responses of the interviews covered content about the project approaches

itself and which tools were used in crowd management measures at the respective cases, none of the related project used specific methodologies to create such measures. However, additional information was found which is used as an input for the new methodology: the use of a stakeholder analysis, assignment of measures to project related issues in area of interests, Objectives, Goals and Strategy description, and lessons learned from previous projects.

3. What are the steps that identify the structure of the methodology?

A new methodology was created, containing of a start procedure and four main steps: 'Collection of information', 'Specification of measure limitations', 'Creation of measures' and 'Delivery of measures'. Presented in figure 6.1 is the main structure of the methodology.

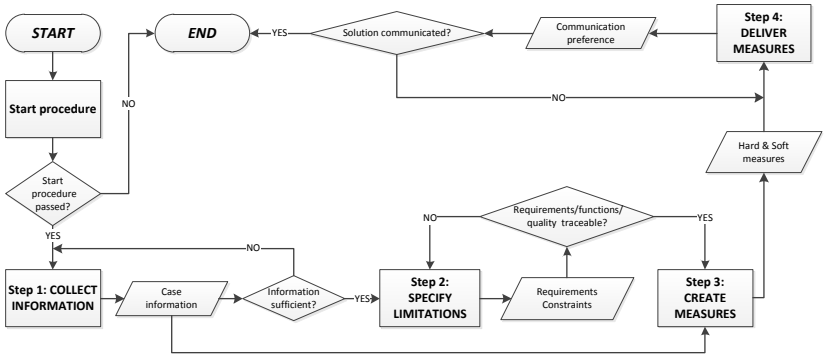

Figure 6.1: Main methodology structure

Within each of those steps, sub questions and actions are performed to provide a selection of crowd management measures.
The start procedure provides questions that assure the methodology is only applied on cases that comply to: a hub, (re)constructions, (re)construction planning is available, crowd management measures are needed and business is performed as usual.
'Collection of information' covers the actions and questions that are used to determine the crowd management measures' purpose, information, content and limitations: setting up goals, objectives, strategy, function and tasks, site analysis, stakeholder analysis, factors of influence on crowds, regulations & restrictions, special circumstances and lessons learned.
The step of 'Specification of measure limitations' is included to perform a specification on requirements and constrains. This will provide an overview of the limitations wherein the crowd management measures should be designed, containing of: customer expectations, project enterprise constrains, external constrains, interfaces, measures of effectiveness and suitability, system boundaries, utilisation environments, functional requirements, performance requirements, physical characteristics, human interaction and design constrains.
'Creation of measures' is dedicated to the creation of crowd management measures, based on the input on the preceding two steps, and exist of two main phases: a conceptual phase and a detailed design phase. Within the conceptual phase, two sub steps are leading: creation of conceptual hard measures and extending concepts. First hard measures will be created, based on selected areas and respective issues. Secondly 'extending concepts' is performed, containing of the actions performed to create soft measures applicable for general purposes at the hub and/or complementary to the already designed hard measures. Afterwards it is up to the detailed design phase to add details to the conceptual measures, consisting of hard and soft measures.

Finally, the step 'Delivery of measures' is included, which is used to assures the methodology user delivers crowd management measures understandable for the problem owner of the case. It is then up to the methodology user to decide which type of communication is preferred: verbally or written. The verbal communication consists of conversation or presentation(s) to the problem owner, containing only the main crowd management measures to avoid confusion. The written report is a detailed report, covering all crowd management measures including maps, drawings, evaluation processes and argumentation.
When all steps are performed as intended, it is assumed that the methodology is finished.

To determine the assessment of the methodology, two indicators are used: (1) the methodology ability to perform all steps and (2) qualification of practical, feasible and efficient crowd management measures. The methodology performance can be indicated by three scenarios: (i) methodology step can be performed as initially designed, (ii) methodology step is not performed as initially designed but adjusted such that it was capable to continue with the methodology, (iii) methodology cannot be performed, making it impossible to perform the next step. As long as the methodology steps can be executed until the end, it is assumed that the methodology is found capable of creating crowd management measures. This is only assessed once and is only related to this particular research. To determine whether the created crowd management measures comply to practical, feasible and efficient measures, these will be assessed on measure characteristics. These are identified by: included elements, identified issues, limitations in resources, location applicability, factors of influence, communication and application by the problem owner, performance of measures, dimensions of the location, legislation and other requirements.This qualification however, should be executed every time the methodology is used. Without this qualification it is not possible to determine whether the measures can be categorised as practical, feasible and/or efficient.

To test the methodology, the case of Rotterdam The Hague Airport was found optional for this test. Rotterdam The Hague Airport currently faces problems regarding their floor capacity to deal with passenger handling (experienced by real life experiences and master plan study by (*NACO - Airport Consulting and Engineering, a company of Royal HaskoningDHV* (2017))). As a response they start with expansion (re)constructions from November 2017. They expect that, due to the (re)construction works during their regular operations, inconveniences will occur and suitable measures are required to deal with, mainly, passenger flows, reflecting on crowd management solutions/measures.
By performing the methodology start procedure on the case, it became clear that the case of the airport was suited for this research.

4. To what extent does the potential methodology result in practical, feasible and efficient crowd management measures to keep the hub open while it is (re)constructed?

As a result of the assessed methodology on the case, only two steps could not have been performed, which are part of the third methodology step 'Creation of measures': 'improvement of concepts iteration - 2' and 'creation of detailed designs'. In case of the improvement, this step was not performed as initially designed because this was already applied iterative within the creation of conceptual measures. The step of creating detailed design was outsourced to the respective Technical Department of Rotterdam The Hague Airport. Once detailed maps were completed, these were then included in the methodology, enabling to finish the methodology. Although that only two steps were not performed by the methodology user itself, it can be concluded that the methodology performed as intended and was able to create crowd management measures.
With the use of the crowd management measure characteristics it was possible to determine whether the delivered crowd management measures, by the methodology, as practical, feasible and efficient:

included elements by the 4 traffic management principles, identified issues at the case of Rotterdam The Hague Airport covering: spill back of queues and blockage of isles, reduced walking speed and decreased throughput of isles. Limitations in resources are based on the resources available within the area of interests: grid floor plan, bank lines, current equipment, temporary walls, shelves, temporary restaurant facilities and new furniture. The location applicability was covered by 7 different locations of the case, based on the (re)construction planning and master planning by NACO. Factors of influence are covered by an internal study of Customer Journeys at Rotterdam The Hague Airport. Communication was covered by presentation of the measures and respective report, including all measures. The measure application by the problem owner depends on the effort to apply the measures, and is assumed to be covered. The performance of measures, dimensions of the location, legislation and other requirements, are covered by case dependent requirements, constrains, Dutch legislation and Rotterdam The Hague Airport regulations.
In all the characteristics of the measures are all covered by case related variables, assuring that the crowd management measures can be qualified as practical, feasible and efficient.

5. What are the adjustments and improvements necessary to apply the methodology on other similar cases?
During the execution of the methodology it became clear that six adjustments/additions were found complementary to finish the methodology and deliver practical, feasible and efficient crowd management measures: Exploration (resources, site analysis and issues), decision process, problem statements for brainstorm sessions and testing.
The exploration step to determine resources first existed of the question: 'What are the available crowd management resources?'. This question had to be adjusted to specifically determine resources available within the problems owners' possessions, budget and interests: 'What are the available and feasible crowd management resources, within the possession, budget, interests of the problem owner?'.
Within the step of site analysis, a complementary question is added to identify waiting areas to increase the possibility to find crowd management issues: 'Which type of waiting areas are there?'. From this research it was assumed to be complementary to determine the waiting areas to support the identification of crowd management issues within the area of interest. If no waiting areas are available within the area of interest, this question would not have to be answered and can be rejected.
The determination of issues had to be adjusted from one initial question: 'What are the issues regarding throughput?' to three new supportive questions to specifically determine crowd management issues:
1. At what time does the demand reach the peak in demand of (mandatory) services?
2. What is the cause of waiting or queue forming where passengers or visitors tend to stand still?
3. What are the interfaces that make the queue forming as it is?
The evaluation making process should be included to determine suitable concepts based on individual, group or user decisions, supported by a Multi-Attribute Desicion-Making and testing based on validation.
For the brainstorm session 3 supportive problem statements should be added to trigger the participants. These problem statements should are identified by (Victoria et al. (2017)): Communication of information: (1) anticipating on the experience expectation and, communication (2) and guidance (3) at the area of interest.
Finally tests should be added during the methodology execution to support argumentation, acceptance or rejection of certain measures. To do so, these can be supported by 3 different types of testing: validation (1), summative (2) or comparison (3) testing.

6. What are the pros and cons of the new designed and tested methodology?

The methodology pros are found in the transparency and, creation of hard and soft measures, whereas there are no structural cons found. However, three notifications are worth mentioning.
The first pro reflects on the structured steps of the methodology. It enables the methodology to ensure understanding of why measures should (not) or can(not) be applied, what resources limit the number of measure possibilities, which constrains limit the dimension of measures, tractability of location application measures, factors of influence, measure and user interfaces, and how it should be communicated with the problem owner. Making the transparency a pro of the methodology.
The second and third are captured by the methodology steps of 'creation of conceptual hard measures' and 'creative methods'. With the creation of conceptual hard measures it is possible to create measures that respond on the physical modifications necessary to deal with a traffic system. Complementary to those hard measures, soft measures are created separately to complement the hard measures, or are generally applicable. This as a response on the crowd experience level of communication of information by: (1) anticipating on the experience expectation and, communication (2) and guidance (3) at the area of interest.

In the contrary to these pros, there are only three notifications worth mentioning: (1) the missing evaluation process, (2) the missing state of the art techniques regarding sensing and modelling, and (3) the in-ability to deal with changes in (re)construction planning.
Regarding the missing evaluation process, the outcome of measures is assumed to be rather based on a subjective evaluation process. Making it hard to trace whether the methodology is able to deal with the determination of measures in a more objective manner. However, already notified as an adjustment of the methodology, this is therefore assumed to be incidental and rejected as a methodology con.
Secondly are the missing techniques regarding sensing and modelling. Within this research no study was performed regarding state of the art techniques regarding sensing to detect crowd management issues, or techniques regarding simulation or modelling to predict crowd movement or testing of created crowd management measures. To determine the whether these techniques are complementary to the outcome to practical, feasible and efficient measures, these should be included and investigated by future research, and are therefore also assumed to be one-off.
Finally is the notification by y S. van der Kleij, problem owner, the methodology has the inability to deal with changes in (re)construction planning. From his perspective, the methodology is rather extensive, requesting for a more accessible way of implementing changes in (re)construction planning, without performing all methodology steps again. However, from a methodology review, it was found that changes influences of planning will affect all 4 steps of the methodology. It is therefore advised to re-perform the methodology as a whole to avoid mistakes in mismatching information, limitations, created measures or communication content and exploit the transparency of the methodology.
Making the methodology only containing three pros:
+ Methodology enables to create specific measure(s) per crowd management issue
+ Methodology enables user to create hard measures based on the resources available
+ Methodology enables user to match soft measures based on the hard measures and create general applicable measures separately
With all sub question answered, the main research question can be answered as well. However, a discussion of this research will be presented first. Followed by the the discussion, the research conclusion is presented.

6.2. Discussion

This research created a methodology that should be capable of determining crowd management measures. This methodology has been applied and assessed on the case of Rotterdam The Hague Airport: expansion of the departure area 'Phase 1'.
Due to the execution of the methodology steps, it was found that it was capable of delivering feasible, applicable, and efficient crowd management measures. Based on the execution of the methodology step and its delivered measures, it can be stated that a repeat of this research could cover similar results. Whereas the content of measures may differ, due to different (case dependent) variables.
An explanation for the performance of the methodology lays within the relation to prescriptive product design methodologies. These methodologies use an analytically way of determining solutions (Cross (2005)), whereas the measures are assumed to be solutions to crowd management issues (Baelde (2016)). This is why the designed measures of this research could be captured as a product of an analytically prescriptive methodology, specifically applicable within crowd management.
The created methodology and its capability to deliver practical, feasible and efficient crowd management measures by a analytically prescriptive approach are assumed to be complementary to the missing literature as (Martella et al. (2017)) states. It is therefore suggested that other cases need to consider the use of the methodology, when traceability and transparency in the creation and decision processes are demanded.
However, it should be discussed that the newly designed methodology of this research is only applied on a single case at Rotterdam The Hague Airport and therefore validated and adjusted to the characteristics of the case. In this particular discussion, this reflects to the passenger flows to be the departing passenger following the sequence of all (mandatory) processes from arrival in the airport building until departure, therefore captured as one directional flow traffic (Daamen (2004)), without considering two-directional or crossing traffic.
By increasing the amount of cases where the new methodology is applied, it is possible to include bi-directional or cross traffic, as well validation of each step and substantive process. To do so, this can be performed by a comparative case study, with the hierarchic method (Verschuren and Doorewaard (1999)) allowing to find and explain similarities and differences of the methodology application, steps and delivered crowd management measures. Therefore more research is recommended to determine the feasibility of methodology application at hubs that are under (re)constructions and business is performed as usual.

6.3. Conclusions

The goal of this research was to find an answer on the the main research question: *What is a suitable and applicable methodology to create practical, feasible and efficient crowd management measures to deal with passenger flows that could be used during (re)construction work at a hub, while business is performed as usual?*. To do so, a literature study, interviews and single case study were used to examine current methodologies and, define and assess a new methodology which is capable of creating such specific crowd management measures.

From results of literature study and interviews no specific methodologies or general recipe was found that could be used to create such specific crowd management measures in a structured way. However, the theory and respective essentials of product design were assumed to be suitable in defining a new methodology. This new methodology would consist of a start procedure and four main steps: 'Collection of information', 'Specification of measure limitations', 'Creation of measures' and 'Delivery of measures'.
The start procedure ensures that methodology is only applied on hubs that need to deal with

(re)constructions, have a planning available, crowd management measures are necessary and business should be performed as usual. The first main step 'Collection of information', is the analytic step of the methodology. Which is executed by collecting case related information about crowd management measures' purpose (goals, objectives and strategy), content (function and tasks, site analysis, stakeholder analysis, factors of influence on crowds), limitations (regulations & restrictions, special circumstances) and lessons learned.
'Specification of measure limitations' is used to specify the limitations of the design space of measures, based on structured identification of requirements and constrains. 'Creation of measures' is dedicated to the creation and location assignment of hard and soft crowd management measures within the area of interests. Finally the step of 'Delivery of measures' is used to deliver the crowd management measures by verbal and/or written communication.

With the use of a single case study, the newly designed methodology was applied and assessed on the expansion of the departure area of Rotterdam The Hague Airport. From this application it occurred that only two sub-steps were not performed within the application. The 'improvement of concepts iteration - 2' step was already covered in preceding sub-steps and the 'creation of details' was outsourced to the technical department of Rotterdam The Hague Airport. These missing steps did not influence the subsequent steps of the methodology, allowing to perform all remaining methodology steps successfully.

As a result of a successfully methodology application, the delivered crowd management measures had to be assessed on their qualification as practical, feasible and efficient. From the assessment it was found that all created crowd management measures complied to the qualification. Consequently, the delivered crowd management measures for the case of Rotterdam The Hague Airport were therefore accepted as practical, feasible and efficient.

This research has shown that a new methodology, based on the principles of product design, is capable of creating crowd management measures suitable for hubs under (re)constructions while business is performed as usual. Where the structured approach and its transparency in processes, allow the methodology user to trace inputs, decisions and actions to be performed and eventually create hard and/or soft practical, feasible and efficient crowd management measures.

6.4. Implications for practice

The implications in practice concern the application of the methodology and the introduction of a grid coordination pattern. With respect to the methodology, it allows the methodology user to make use of a transparent analytically prescriptive approach to create crowd management measures. The transparency offers the opportunity to trace information, limitations, decisions and qualification to deliver practical, feasible and efficient measures.
As for the implications in practice for Rotterdam The Hague Airport, and generally applicable, is the use of a gird coordination pattern. By introducing a coordination grid on technical drawings and/or with stickers on the floor, it could help the communication between different parties with respect to pinpointing or localising exact location of certain physical adjustments of construction sites and/or crowd management measures.

6.5. Recommendations for practice and future research

This section is dedicated to the recommendations that should be taken into account for practical applications and future research.

6.5.1. Recommendations for Rotterdam The Hague Airport

For the case of Rotterdam The Hague Airport, two specific recommendations are discussed, which are the result of the methodology application. But first a notification.
As a product of this research, a written advisory report was presented and delivered at Rotterdam The Hague Airport, containing all outputs regarding the determined crowd management measures of the applied methodology within this research. In the advisory report it is suggested to apply these measures during their (re)construction period, because these are after all, the product of the methodology suited for their case specifically.
Although the advisory report contains all crowd management measures, in this part of the thesis two crowd management measures are worth mentioning: (1) relocation of the boarding pass check and, (2) lane route of fast-lane users and crew members at the new security filter.
Upon that two additional recommendations are presented that are generally applicable and could have been discovered without this particular research: (3) an evaluation report and (4) collaboration between large passenger/visitor hubs/destinations.

The first recommendation reflects on the relocation of the boarding pass check, mentioned in table 4.1 as part of the hard crowd management measures at the temporary buffer. As found in the 'Collection of information' methodology step, is that the queue forming of this boarding pass check covers 3 drawbacks: (i) the boarding pass check queue merges with the queues of the check-in counters, (ii) the boarding pass check queue forms a blockade of the entrance/exit and (iii) the boarding pass queue blocks the passageway to the toilets. By relocating the boarding pass check, these three issues can be avoided. Secondly an additional effect is that passengers start to get used to the boarding pass check just before entering the security filter, which will be situation in the future. Although not mentioned in this thesis, this type of boarding pass will be installed in the departure area.
The second recommendation is found in the conceptual hard measures of the new security filter. In figure 6.2 the concept drawing is presented. As indicated, the 'Fast Lane?' and 'Crew' are suggested on the respective right side of the security lanes. By locating these security lanes on this position, 3 advantages arise: (i) the location of the crew lane enables crew or employees enables the security lane entry directly from the elevator and with the shortest path to the Koninklijke Marechaussee office, (ii) the fast lane can be used for passengers categorised as People Reduced Mobility, and is easily accessible by avoiding possible spill back of the buffer and (iii) the buffer lane of the fast lane creates a distance between buffered passengers and relatives, which is considered to be a pro (confirmed by Safety, Security and Support).

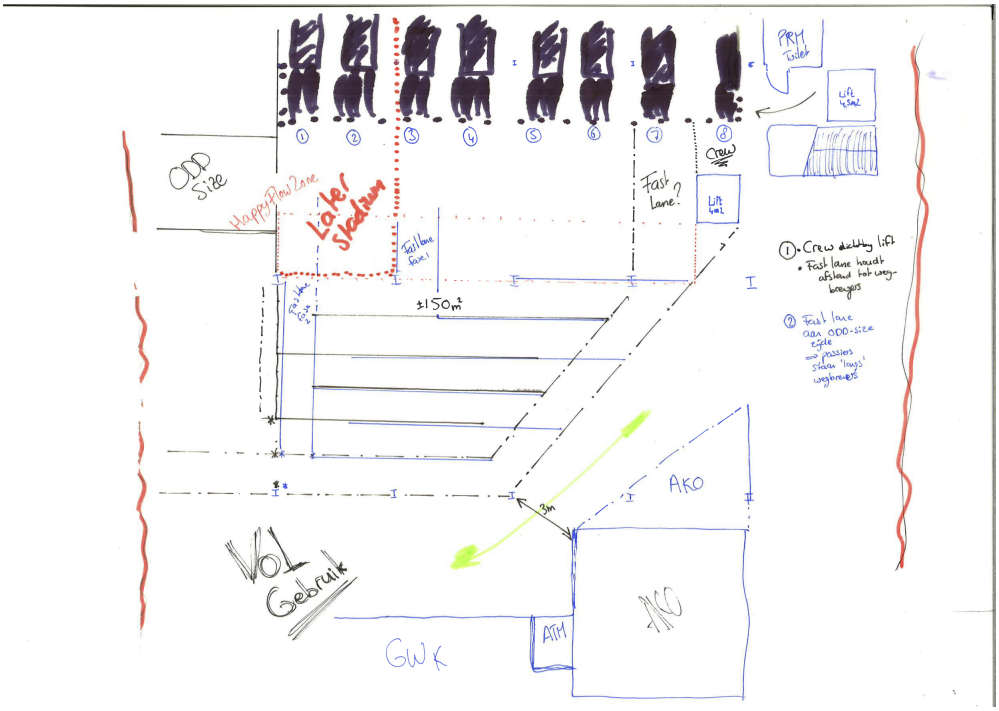

Figure 6.2: Conceptual buffer lay out new security filter

The first additional recommendation is the use of an evaluation report. Upon the advisory report, from this research it occurred that Rotterdam The Hague Airport is not in the possession of a (transfer) report with respect to lessons learned of previous (re)constructions. It is therefore recommended that during and/or after finishing the (re)constructions an evaluation report should be written up, covering unfamiliar occurrences with respect to (re)constructions and passenger handling (e.g. Despite the precautions to keep the noises at low as possible, no passengers took place at the waiting area nearby), asbestos findings/locations and worth noticing lessons learned that mistakes in assumptions for next projects can be avoided. This evaluation should be hosted by the design team of the (re)constructions and participated by the stakeholders that were directly involved with the (re)constructions.
Finally is the additional recommendation regarding collaboration between
large passenger/visitor hubs/destinations. As this research used unstructured interviews to determine methodologies to create crowd management measures at different cases, a visit to a train station, museum and other airports was experienced as an enrichment of knowledge of how these locations deal with passenger/visitor handling/flows. It is therefore recommended to Rotterdam The Hague Airport to keep in contact or visit different train station, museum and other airports to learn from each others crowd management (issues and /or measures).

6.5.2. Recommendations for further research

In case of future research, there are four recommendations to be considered when this research will be performed again or the methodology will be applied to other cases: (i) execution of creative methods, (ii) the noticed adjustments/additions to the methodology, (iii) influence of the methodology of measure creation with respect to social consequences on crowds and (iv) validation of the methodology by other cases.

The first recommendation refers to the execution of the creative methods. During the extension of the hard measures, the user has the opportunity to select between different creative design methods to come up with soft measures. During this research only 2 out of 4 creative methods were performed. However, there was not specific evaluation process included to determine one specific method. At this phase it should be useful to introduce a decision tool to help the user to determine the preferred method. Irrespective of the use of methods, the measures should be within the category of soft measures and generally applicable, or complementary to the hard measures.
The second recommendation reflects on the adjustments/additions. Future research and consequently the methodology application should include: an adjusted exploration regarding crowd management resources, site analysis, issue detection (including state of the art techniques), the concept of a evaluation process, brainstorm problem statements and execution of testing (including prediction or modelling techniques). To determine the complementary value of these adjustments, it is recommended to perform the full methodology on a different case parallel by two executioners, one with, and the other without the adjustments. It is only then possible to determine whether the obtained adjustments are complementary or mandatory to the methodology.
Thirdly, it is recommended for further research to determine whether the use of the new methodology could have positive influences on social consequences on crowds. As (Martella et al. (2017)) states is that 'Understanding the visitors' is part of the preparation phase, but few models are focused on 'conformity' within prediction models (Wijermans et al. (2016)), while crowd management measures may influence crowd experience (Victoria et al. (2017)), it is therefore recommended to determine whether with a structured approach within the preparation phase/creation of measures, affect loyalty and post-behaviour of passengers or visitors (Chen and Chen (2010)) in a positive way. Where an increase in loyalty and post-behaviour is assumed to be positive for the hub operator.
Finally, the methodology was only tested and validated on a single case study and was not validated on all methodology steps. It is therefore recommended to execute the methodology on other cases as well. This execution should be performed at a different hub, and covers the circumstances of business as usual and performed (re)constructions. To goal of this application is to apply and validate the new methodology, include variables regarding crowd flows (speed, direction and/or flow composition), determine its robustness, while still delivering crowd management measures that are characterised as practical, feasible and efficient.

A

Interviews

A.1. Case: Expansion and renovation Utrecht Central Station - B. Wiggers

Mr. Wiggers, Rail System Engineer at ProRail, was responsible for pedestrian movement during the renovation period at Utrecht Central station. The goal of this interview was to determine the measures they applied and method or approach that was used to create measures, able to deal with the renovations in and around the stations. The choice of this particular case is due to the common factor of passengers using a service building (station or airport) to gain access to a certain type of transport (bus, tram, light-rail, train or aircraft) and construction work performed during regular operations when business is performed as usual.
The most important points of the interview are summarised, including a small explanation why this is relevant for this research.

Measure related feedback

- Way finding (signs) - Although way finding should be indicated for those passengers who need it, a building should be logical. The perfect condition is a logical building that way finding indicators (signs) are not even necessary. If not, a way finding or sings should be of main priority over other sings such as temporarily or commercial purposes. According to Wiggers: "All sings in the building should be of one size, or should have a limitation in size. Additionally, the signs should be of one style and colour. By this you create a clear distinction between signs (and its importance), calm atmosphere and you do not surpass important sings, such as those of platforms, information or ticket machines, etc. Next to that, direct view is of importance. A person would like to see what is coming. So by even adjusting 90 degree walls in to two 45 angled walls (cutting a corner), will improve the way finding of passengers." Way finding is of importance in this project, due to the fact that the renovation will cover multiple adjustments in usable paths to certain services at the airport.

- Stickers - Although it is nice to present future plans on temporarily walls, or ground stickers for the use of way finding, these are neglected in a wide range of passing passengers. B. Wiggers stated: "As mentioned before, way finding is important for passengers. By placing information that is not directly necessary, such as future plan images, way finding is suppressed. Resulting in confused passengers. Secondly, with respect to ground way finding or sings, passengers only use them when it is 'medium' crowded. When there is minimal use of the station, people ignore them, and when it is overcrowded, passengers don't even see them.". The relevance for this subject relate to the resources that Rotterdam The Hague Airport should apply during the renovation.

- Do's and don'ts - From the knowledge perspective and practical experiences of Utrecht Central, there two do's and don'ts that are applicable in way finding and measures during construction work.
  DO: The area should have a logical lay out. As long as the area or paths to certain locations (e.g.: platforms, exits, shops, etc), are clear and logical to reach from a user perspective, there is no need to implement lots of signing. In addition to that, movement will go with less/without hesitation because the user know where they are heading.
  DONT: To suppress the in-logical area use overcompensated signing. Keep the same size and consistency in signing. This will create recognition for the user and will suppress any stress or feeling that one is lost. Two examples on how it should be done are: Utrecht Central station and the station of Luik (Liege).

Methodology related feedback

- Stakeholder analysis - "Communication is key" as declared by B. Wiggers. By clearly knowing and communicating with each of the stakeholders, each party in the process will create an empathy for each others view point on the renovation. Due to the mission of Rotterdam The Hague Airport, by highly valuing their passengers, it could be a good approach to create the empathy for the work to be done during construction and why some measures are applied. By informing a passenger in proper way, they could understand that the construction work is performed for a limited time, and in the end will result in better circumstances compared to the current situation. Whereas the other stakeholders should be informed how to avoid a decrease in positive passenger experience or expectations during the renovations. By determining the preferences of each stakeholder, one could make the mandatory measures for each stakeholder more acceptable.

- Project approach: "no explicitly use of System Engineering" - '...The work performed existed of multiple projects, performed by Prorail, as well as the municipality...'. As B. Wiggers stated is that the project existed of different levels of performed work. By making mutual appointments about project scopes and boundaries (and later monitoring), clear 'building blocks' were created; covering multiple (complex) interfaces, but sometimes led to lots of discussion. But still, these building blocks and interfaces are kept manageable.
  "Upon these building blocks and interfaces, aspect-systems were used (transfers), which were dependable per building block to maintain the performance of the transfers, integral coherency was necessary. With integral application, municipality projects were easy to couple, and therefore creating the possibility to highlight details. With this application one was able to succeed to determine the effect of specific construction inconveniences in the whole station area, and so determining applicable measures (e.g. de-tours, signing, emergency exits and service access, etc.)"
  "In practice this type of approach is not always successful. It seemed hard to introduce the 'you are part of a aspect-system' to all executive parties. Especially smaller contractors just started with their work without correspondence."
  "Typical examples of not communicating, is that external contractors blocked important pedestrian aisles, which could have led dangerous situations such as injuries during evacuation."

A.2. Notes appointment - ProRail, B. Wiggers

Kernpunten/conclusie gesprek:
- Stakeholder analyse
- Volgorde aanpak: SE
- Bestickering
- Bewegwijzing

- Do's en don'ts

Notulen gesprek
Bart Wiggers:
- Achtergrond: Logistiek en Technische Bedrijfskunde.
- ProRial:
– ingezet bij Project planning analyse
– functies: logistiek omtrent reizigers

Aanpak en problematiek omtrent Utrecht Centraal:
- Combinatie van logistieke (passagiers) problemen als technisch (pilaren/ondersteuning etc.)
- Piekmomenten en kritische factoren zijn cruciaal
- Stakeholder analyse is key!
– Elke stakeholder heeft zijn eigen mening: "Ik vind van niet"
– Data omtrent input en output is erg bruikbaar om deze 'meningen' te ondervangen
- Loopstromen van verschillende piekmomenten samenvoegen (bijv. Aankomst trein om perron 1, daarna op 5 etc.)
- Gedragsbepaling van het logistieke proces is erg handig

Volgorde van aanpak
1. Inventariseer de ruimte (capaciteiten en aantallen)
2. Bepaal seizoen fluctuatie
3. Bepaal passagierstypen
4. Kijk naar gedrag
a. Oermens
i. kijk naar vuur – rood en geel zijn 'alertmakers'
ii. men heeft behoeft aan natuurlijke kleuren – blauw en groen
5. Kijk naar signalering
Signalering
- Overschreeuwen helpt niet
- Zorg voor kalmte en eenduidigheid
– Absoluut geen verwijzingen met verbouwing, bewegwijzing én iets ervoor

Grondbestikkering
- Uitgevoerd tijdens de OS in Londen op UC. Was een succes in:
Rustige situatie –> Geen volgens van het pad
Medium –>Mensen volgen lijnen, "Als ik mijn pad aanhoud, jij ook?" (wel minder wachtenden in loopzone)
Drukte –> Belijning niet meer te volgen
- Indien er lijnen zijn, moet dit wel duidelijkheid hebben wat dit precies doet!
- Gradatie is belangrijk
– Belijning kan handig zijn, indien het nodig is. Als een gebouw logisch is, dan is er geen behoefte aan een extra route aanduiding. Dit geeft alleen maar verwarring.
- Als je belijning of stickers nodig hebt, heb je je ontwerp niet goed gedaan.
- Vraag jezelf altijd: "Hoe zou ik het ervaren?"

Zichtlijnen
- Belijning helpt niet zozeer, zichtlijnen helpt!
- Station Luik is een goed voorbeeld:

– ‘Less is more’
Typische momenten
- Koningsdag
- Weekend
- Doordeweekse dag

Methodiek
- Quick wins zijn meestal al toegepast
- Gebruik vooral System Engineering als methode
– Verzamel input
— Stakeholders
— Infra etc.
— Data
— Etc.
– Verwerk
– Ontwerp
– Etc.
- Prioriteer: “Wat is belangrijk? Wanneer? Waarom?”
- Zorg voor onderling empathie voor bepaalde situaties. Wanneer heeft welke stakeholder bepaalde eisen, en wanneer wegen deze op tegen anderen?
- Kies voor gesprekken met 1 op 1 met stakeholders:
– Succesfactoren
– KPI
– Tussenstappen
– Interne organisatie
- Betrek elke partij
- Zorg voor empathie - Brainstorm sessies. Let op: geen dominantie toelaten! - Benoem knelpunten/overlappingen in proces

Overig
- Customer Journey gebruikt om cruciale punten in reis te vinden
- Voldoende data beschikbaar voor betrouwbare analyses, alleen niet toepasbaar op de airport. - Analyseer (mogelijke) knelpunten
- Tellen kan wel een goede analyse zijn – geeft vooral orde grootte
- BIM niet toegepast op UC – wel op station Assen
- Kijk naar evenementen en crowd-control

Conclusie
- Communicatie is key – tussen stakeholders en naar gebruikers
- Less is more
- VWB signing en objecten

Voorbereiding - Gesprekspunten
1. Introductie
a. B. Wiggers
b. B. Leutscher
c. Afstuderen

2. Publicaties beschikbaar

i. 2011: Case study ‘Perron 5’
1. Knelpunten & Kansen; Passenger Journey
2. Incidentiele reis
3. Frequente reis
4. Communicatie en comfort
5. Obstakels
6. Dynamische aanduiding
7. Wijzigingen dienstregeling
8. Markeringen
9. Succesfactoren

ii. Nov. 2013: ‘Brein achter looplijn’
1. Loopstromen in de hal en omgeving
2. Zichtlijnen
3. Oriëntatie
4. Elke bouwstap voldoende ruimte bieden
5. Snappen
6. Goed, veilig en aangenaam

iii. Dec. 2013: ‘Looplijnen-specialist leidt reizigers door station Utrecht CS’
1. Systemen op elkaar afstellen
2. Piekmomenten
3. Zichtverbreding
4. Glas

iv. Nov. 2015: ‘Het dak gaat eraf in Utrecht: nieuwe looproutes’
1. Goede informatie
2. Verkeersregelaars
3. ‘Interwijkverbinding’

Conclusie publicaties
i. Aanpak: Service design project
ii. Onderzoek: ‘Participatory observation’
iii. Passenger Journey
iv. Zichtlijnen
v. Oriëntatie
vi. Goede informatie – tactisch en operationeel?

3. Methodiek
a. System Engineer?
b. Service design – in ‘Perron5’?
c. Optionele methodieken?
i. Process management
ii. System Engineering
iii. BIM – Building Information Technique
iv. Project management?
v. Design thinking?
d. Wat is de meest relevante methode geweest?

4. Kennis/data
a. Kwalitatief onderzoek
b. Kwantitatief onderzoek
c. Enquêtes?
d. Mogelijke conclusies van dit onderzoek?

5. De Case: Rotterdam The Hague Airport
a. Volle terminal
b. Plannen toekomst
c. Verbouwing – 6 fasen – 1.5 jaar
d. Communicatie en aansturen passagiers focus onderzoek

A.3. Case: Expansion and renovation of the Van Gogh Museum - J. Slingerland

Mr. Slingerland, Head of visitor service at Van Gogh Museum, is responsible for the visitor service at the van Gogh Musuem Amsterdam and took part in two major (re)constructions of the museum. Same as the interview as the previous interview, but at a different location and setting, was to determine the method that was used to create measures, able to deal with renovations at a museum. The common factors of those of the museum and that of Rotterdam The Hague Airport are first time visitors, paying customer for service at that particular location, construction work performed during 'operations' and almost similar annual visitor counts 2 versus 1,7 million, van Gogh Musuem and Rotterdam The Hague Airport respectively.

The most important points of the interview are summarised in the following list, including explanation why these particular points are relevant for this project.

Measure related feedback

- Ask people to come on time - When visitors are asked to be on time, as indicated on your ticket, the operating party knows exactly how, where and what time to apply their resources. Although it seems convenient to ask visitors to arrive earlier, to deal with peak-periods from operational perspective, this works contradictory for both the service provider as the visitor. In case of the service provider, the arrival pattern of the visitors is than more random (some people can see 'earlier' as 15 minutes before the indicated ticket time, while others see it is an hour earlier), making prediction regarding the use, place and time of resources more difficult. As for the visitors, those who are on time, now mix with visitors that were initially planned on later time slot. This could lead to increased waiting times and even to a reduction in visit appreciation. In this case this could be rather interesting for the case of Rotterdam The Hague Airport, due to the fact that they expect to have an even lower capacity due to measures they need to apply, and need to make some strategic decisions regarding resources for passenger handing (occupation rates for certain services).

- Corporate identity - As soon a visitors come in contact with their planned activity, the identity of the company should be unique and being recognisable along the whole process. If the style of signs are not identical, visitors may not identify them as part of the company and neglect important possible information. For the case of Rotterdam The Hague Airport this could be relevant due to its, currently, different identity than that of other airports. It could be an option to make the corporate identify so that it has some similarities with other airports. In this case you create recognition and perception of familiarity for passengers who departed from other airports before. As well as new passengers are introduced in a 'new' airport type of signing.

- Uncertain frustration zones - When visitors arrive at a new location and are nervous in a certain manner, provided information could stay unnoticed. Resulting in questions where to find the wardrobe or toilets for instance. Addressing this problem is to make a differentiation between the provided information, and postpone the locations of signs. This statement is relevant to the case of Rotterdam The Hague Airport due to the fact that passengers tend to be nervous at the mandatory processes (check-in, security and boarding), and not paying attention to their surroundings. So it could be useful to identify these areas and respond to passengers with personal attention.

- Lighting plan - For identifying routes in the building, lighting is important for way finding. Differences in lighting will create different attraction levels in perception and assumptions regarding routing. For example: higher flux levels will create the perception of routing or important locations, whereas lower flux lighted areas will indicate secondary locations.

Because of the different areas that will be passed (old baggage handling area, current departure area, shop, hall-way, etc.) from a passenger process view, it is useful to use lighting to unconsciously guide passengers to the right direction, reducing the use of sings.

- Route dominance - If a building is logical, sufficient line of sight and lighting is placed on a proper way, signing could then only be used to confirm assumption of the visitor, instead of steering the visitor in a the right direction. The location of sings could therefore be determined by an identified dominant route. Identifying such a route can be determined by a 'stress test' (a test where fire fighters, police men, colleagues, professionals and laymen need to continue trough a process, without any personal help of employees - feedback will be collected via a survey). At the airport it could be useful to apply this as well. With a goal to place sings in such a position that, the earlier mentioned uncertain passenger, can be informed properly.

- (Re)construction and expansion - During the building of the new entrance, there where 3 focus points: 1. Minimise nuisance, 2. Shielding the construction site and 3. Reroute visitors, also those of the neighbouring museums. Use of modelling was applied to indicate possible bottlenecks. For this case it is rather useful to keep these points in mind, due to the fact of the similarity in the characteristics of the users. Upon that it could be very useful to model the construction phase in case of hazardous situations (terrorist threats).

Methodology related feedback

- Project approach - The project approach was performed using the tactical planning process of OGSM (Objective, Goal, Strategy and Measures) and was divided over five work packages, whereas the objective was based on the museum mission: "To inspire and enriching the knowledge about van Gogh", translated to "To enrich and inspire" for the entrance build. Regarding the work packages, each contained the responsibilities and activities for a particular action (e.g.: 'The opening and start of the new entrance' - covering operations on what to perform to open the new entrance, but also what happens to the old entrance?). Upon on that the main project driver of the project was time, where money was a tool to create the possibility to meet the deadline. In general System Engineering was not used as a method for this particular project.
  In case of Rotterdam The Hague Airport, it could be useful to let the (re)construction period be led by a certain vision, compared to that of the Van Gogh Museum. By doing the airport is able to profile itself as an airport that is there for the passenger, creating more empathy of the passenger during the construction period.

A.4. Notes appointment - Van Gogh Museum, J. Slingerland

Kernpunten gesprek voor project:
1. Vraag mensen om op tijd te komen en niet te vroeg
2. Huisstijl
3. Lichtplan
4. Onzekere frustratie-zones
5. Route dominantie

Notulen gesprek Gesprekspunten
1. Introductie
a. J. Slingerland
Betrokken geweest bij 2 verbouwingen:
i. Aug '12 – mei '13 – groot onderhoud
- Hermitage gehuurd voor 7 maanden
ii. April '14 – 5 sept 2015 – uitbreiding
b. B. Leutscher & case RTHA
2. Van Gogh museum:
a. 2,045mln bezoekers per jaar
b. Customer Journey én Life time cycle wordt meegenomen
c. NPS-scores wordt ook meegewerkt
d. De verbouwing
- 'Nooit een dag gesloten geweest' (wel voor Obama bezoek en transport van grote kunstwerken)
- 3 focusputen: 1. Overlast beperken voor bezoeker, 2. Bouwlocatie afschermen, 3. Bezoekers omleiden, óók voor naastliggende musea.
- Hier is gebruik gemaakt van modellen (Theater Advies BV en DGMR)
i. Beide bedrijven waren al betrokken vanaf de start
ii. Gekenen naar 'What if…' scenarios' (Evenement op het plein, OV, uitloop Schiphol, etc.)
- Meer lucht, licht en ruimte – het helpt niet echt, maar het geeft mensen wel het idee 'dat ze ergens naartoe kunnen'
- De 'veehallen' (Efteling-opstelling) helpt als het gaat om rechtvaardig wachten
e. Algemeen
- Bezoekers worden geanalyseerd mede door V-Sense en EasyCount
- Erasmus helpt bij het stellen van bezoekersprognose (tot op 3 maanden)
- 'Éigenlijk wil je weten wat mensen gaan doen' – dit geeft inzicht in patronen
- Er wordt ook gekeken naar meta-data. Zo is er ook te zien dat weertype ook degelijk invloed heeft op de bezoekers
- Dynamische bezetting is belangrijk, zodoende kan je inspelen op drukte op bepaalde plekken -> alle productiesnelheid moet wel op de zelfde hoogte zijn, want anders ontstaan er 'bottlenecks'
- Tijdens daluren wordt er 'gestunt' met daltijd-marketing
- Indien er een prognose is over drukte verzoeken wij:
i. NIET om eerder te komen, maar om OPTIJD te komen. Als mensen te vroeg komen neemt wellicht de waardering af…?
- Zorg dat je weet waar je aan toe bent als je staat te wachten, of ergens naartoe wilt zorg voor overzicht Mixed zones helpen niet altijd, helemaal niet als het gaat om overzicht (bijvoorbeeld walk-trough-shop)
f. Bewegwijzing in van Gogh
i. Animatie van entree wordt getoond aan bezoekers
ii. Huisstijl is ontzettend belangrijk – andere stijlen worden niet opgemerkt
- Kijk naar locaties – A, B, C locaties

- Hóe kunnen we zo subtiel mogelijk herhalen? – let op zichtlijnen en contrastwerking
iii. Bij ontwerpproces (Bourne Design, huisstijl en EuroRouting voor way-finding)
- Kijk naar de logica van het gebouw
- Bordjes staan uiteindelijk voor bevestiging
iv. Kijk naar de dominante route – wat is logisch?
v. Gebruik een lichtplan (Hans Wolff)
- Donkere locaties nodigen minder snel uit
vi. Voer een 'stresstest' uit, zo min mogelijk personeel – zodoende wordt de dominante route uitgetest – gebruik gemaakt van 'dichtbij-schil' (hulpdiensten, hulpdiensten en buren musea — directe feedback) en ATP-proefpersonen — wat wordt er precies bedoeld met deze feedback?
vii. In onzekere frustratie zone, hoe nemen mensen informatie op – boodschappen komen (bijna) niet binnen —- hoe wordt informatie geïnterpreteerd.
g. Omleidingen tijdens de verbouwing
i. Echt in geïnvesteerd, 40 doeken van 2x3m
ii. Ieder doek ook zijn eigen doel
iii. Gezorgd voor hosting
iv. Vertel wat er nu aan de hand is – niet hoe het gaat worden (kan wel, maar dan niet te groot in beeld)
h. Methodiek voor verbouwing
i. Meerdere 'pakketten' gemaakt, zodoende elke partij verantwoordelijk voor zijn pakket – bijvoorbeeld: 'In gebruik nemen' ("Wat gebeurd er met de oude ingang als de nieuwe wordt gebruikt?")
ii. OGSM – methode — doelstelling was gefilterd uit het museum: - "Het verrijken en inspireren"
iii. Tijd was de belangrijkste driver voor dit project – budget minder

Gesprekspunten
3. Introductie
a. J. Slingerland
b. B. Leutscher & case RTHA
4. Rede en aanpak verbouwing Van Gogh museum
a. Focus op glas/transparantie – uitnodigend/nieuwsgierig maken
b. Entree-proces – efficiëntere rijen. Waar hebben toen naar gekeken?
c. Groeiend aantal bezoekers (>1,6mln? ± RTHA zelfde aantallen)
i. Waar halen jullie de data vandaan? Eigen data? Toekomstige planning?
ii. Ook terugkomende bezoekers?
d. Hoe hebben jullie de verbouwing aangepakt?
i. Bepaalde methode in Project Management/Ontwerpen of toepassen van maatregelen?
ii. Volgorde van aanpak
iii. Gemodelleerd vóór verbouwing omtrent bezoekers/logistiek?
iv. Tijdens de verbouwing, verschillende faseringen?
- Bezoekersomleidingen? Was dit nodig? Bewegwijzing?
- Aanvoer van logistiek?

A.5. Case: ONE-XS at Schiphol - Zwart, B. De

Mr. B. De Zwart, Head of project ONE-XS, was responsible for the transition of the security filter system at Schiphol Airport. Here the security lanes were reduced from 130 to 50, centralising the security filters at 3 locations. The goal of this interview was to determine their project approach and how they came up with applicable measures during construction.
As previous, first the measures applied at their case are discussed, followed by the methodology they used.

Measure related feedback

- 'Prioritse points of attention' - by prioritising one is able to determine the minimum requirements for certain measures to be applied. The following points were mentioned:

  'Fire safety' - this is the most important point of attention. When applying detours or construction, note that some fire detection (zones) are no operational. Meaning that these areas are not covered in case of fire.

  'Operational requirements' - when applying measures due to construction inconveniences, know that there is a variation in demand of a specific area. Especially at Schiphol, certain areas are used at transits. So plan wisely.

  'Quality of handling inconveniences' - Schiphol is aiming for a service level B. So maintaining this level meant to keep corridors open, as well as passage ways along shops, was of high priority. Upon that focus on cleanliness of the temporally placed walls and perform work in the same direction of passenger flows.

  People Reduced Mobility (PRM) - when applying a level of service B. This is not even covering the area needed for a PRM. At Schiphol these passengers are driven by golf kart type vehicles trough the departing area. However, at Rotterdam The Hague Airport, that is not the case. Upon that, there is a saying, that could be applicable for Rotterdam The Hague Airport; "One elevator is no elevator".

- To determine the locations of bottlenecks, a simulation model was used.

- 'Communication' - although communication is of importance's in a project, one major lesson-learned was gained from the 'Noord-Zuid-lijn' (an underground metro project in Amsterdam); Avoid making excuses. By doing so, one avoid the subject of mentioning that there is an issue/problem. This is how propaganda works; don't say that there is an issue, people won't create a problem of it.

Methodology related feedback

The method that was applied during the execution of ONE-XS was the Schiphol approach of Structure of PRINCE2 by AXELOS (AXELOS (2017)). This method is not explicitly used to determine measures, but was mainly focused on keeping the project manageable.
For the case of ONE-XS lessons learned referred to 'This is how we gonna do it, but there always more interfaces that you encounter that thought of in the first place.' Secondly, there is always a surprise what you encounter when performing construction work, such as non-documented cables, fixes or short comings.

A.6. Notes appointment - Schiphol ONE-XS, B. De Zwart

Kernpunten gesprek:
- Prioriseren van maatregelen
- Let op PRM's
- Communicatie is key
- Altijd meer raakvlakken van maatregelen dan gedacht

Notulen gesprek
- Zwart, B. de: Projectdirecteur ONE-XS
- ONE-XS:
– Verkleinen van aantal security lanes van 130 naar 50
– Bij het verbouwen en prios van bepaalde punten:
1. Brandveiligheid staat voorop – let op dat sommige brandmeldposities zijn uitgeschakeld
2. Operationele voorwaarden; let op tijdskader. (Schiphol heeft veel transits)
3. Servicelevel; (op Schiphol level B)
- let wel dat voor zowel gebruiker als exploitant artikelen wil (ver)kopen
- Stofschotten zodanig netjes dat dit niet eens opviel
- Werk in uitvoering moet worden gedaan in de lengte
4. People Reduced Mobility (PRM) – eigenlijk meer bepalender voor LOS
- "Één lift is géén lift"
– Passagiersstromen zijn met name gemodelleerd op knelpunten
– Communicatie zeer bijzondere zet
1. Gekeken naar Noord-Zuidlijn als voorbeeld
2. Niet doen: "Excuus maken" dit trekt het onderwerp naar zich toe (zo werkt propaganda niet)
- Er is nooit wat gezegd over overlast en is daarom minimaal opgemerkt
- Houd stofschotten up-to-date
- Human interest (echte gezichten erbij) "Houd authentiek"
– Minimale/geen daling in waardering
3. 'Jij bepaalt het onderwerp': - Schipholkanaal, youtube,
- Onderwerpen: bijv.: techniek, duurzaamheid
- Lessons-learned ONE-XS
– Blijvend vallen zaken tegen. "Dit gaan we doen" uiteindelijk altijd meer vlakken die je raakt dan je in eerste instantie raakte. . . - Te veel raak raakvlakken
– "Je schrikt wat je tegenkomt wat erachter zit"

Introductie
a. B. Leutscher - Afstuderen
b. B. De Zwart
2. Punten
a. Aanpak/Optionele methodieken
i. Procesmanagement
ii. System Engineering
iii. BIM – Building Information Technique
iv. Projectmanagement
v. Design thinking
vi. Etc.?
b. Passagiersstromen
i. Level of service? A, B?
ii. Data? Kwalitatief of kwantitatief

iii. Aansturen van passagiers? Hoe?
iv. Informatievoorzieningen – live of van tevoren?
v. Omleidingen?
vi. Inzet van personeel – meer hulp voor omleiding? Extra info etc.?
vii. Passagiersbeleving? (Customer journey?)
c. Valkuilen? Tips voor andere projecten?

3. De Case: Rotterdam The Hague Airport
a. Volle terminal
b. Plannen toekomst
c. Verbouwing – 6 fasen – 1.5 jaar
d. Communicatie en aansturen passagiers focus onderzoek

B

Rotterdam The Hague Airport as a company

This appendix covers information about the airport history and company structure.

B.1. History

The history of the airport goes back to the 18th century, when balloon flihgts took place over the city of Rotterdam. In 1920 the airport at Waalhaven (figure B.1) in Rotterdam opened, just 2 months after the opening of airport Schiphol.

In the '20s and 30's of the previous century, aviation was characterised by adventure. In these years the aviation 'fever' got to the Rotterdam municipality, and quickly turned the airport of Waalhaven to a success. The young airline Koninklijke Luchtvaart Maatschappij - KLM, currently the oldest carrier airline of the world (Corperate (2013)), operated from and to the Waalhaven, and even considered locating the headquarters in Rotterdam. However, the municipality management soon saw the potential of the airport and started looking for a new airport location outside of the city centre of Rotterdam. The area they found suitable for this new location was the polder areas of Laag Zestienhoeven and Schieveen.

In 1938 the Rotterdam municipality got the agreement by the Dutch government to built a new airport in the area of Zestienhoven, followed by a closure of the Waalhaven for civil aviation and would continue to operate as a military airport.

During the first year (1940) of the Second World War, heavy battles were fought at the airport of Waalhaven. As a result the Dutch forces decided to destroy the airport and aircraft factories to prevent the German forces to obtain the facilities. After the war it became clear that the airport of Waalhaven could not be rebuilt so the plans of builting a new airport (based on those of 1934) in the North of Rotterdam were revisited.

Despite the fact that the municipality of The Hague agreed upon the plans of a new airport in the 1930s, the point of view of the cabinet was different in 1945. After 3 years the Dutch government agreed for a new airport, but until 1952 nothing happened, followed by a cancellation by one of the ministers - resulting in a disappointment of Rotterdam, seeing its potential in business and economic benefits. In 1955, thanks to the chairman of the chamber of commerce, mr. K.P. van der Mandele, permission was given for the built of a new airport at the Rotterdam polder: Zestienhoven. However, under all circumstances, the airport of Rotterdam may not overgrow Schiphol airport. Within 14 months the Regional Airport of Rotterdam was built, existing of 1 runway, a few wooden builtings and 2 British airlines (figure B.2 and B.3). The airport was officially opened in 1956 by the mayor of Rotterdam, G.E. van Walsum.

Due to success, business grew in and around the airport which led to expansion of the facilities and

Figure B.1: Airport Waalhaven (*Rotterdam The Hague Airport - Onderneming (Geschiedenis)* (2017))

extended runway.

Figure B.2: Terminal and platform in early years of the airport Zestienhoven

Figure B.3: Early years of the new airport of Zestienhoven

Air travel became more and more attractive, not only for business travellers, but also for leisure passengers. Soon important European airlines, such as SwissAir, Lufthansa and Air France, made Rotterdam part of their network, resulting in a passenger movement to 500,000 passengers in 1971. Whereas in 1970 a new terminal was opened, due to growing success of the airport (figure B.4).

In the late 80s the economic importance of the airport were no longer in dispute. Therefore Schiphol (owner of Rottedam Airport BV since 1-1-1990) and Rotterdam decided to make appointments about the use of the airport, shape and size. In the 90s the airport profile was recorded as: an airport mainly focusing on business operations to the European business centre, while keeping space for private and leisure flights.
The economic growth in the 90s was a boost for the activities in and around the airport. The structural losses since the 70s were translated to limited profit due to increasing flight operations and growing passenger numbers. Next to the business traveller, the leisure traveller discovered the com-

Figure B.4: 'Passagehal' in the 70's (*Rotterdam The Hague Airport - Onderneming (Geschiedenis)* (2017))

fort of Rotterdam Airport, resulting in a new passenger record in 2000 of 750,000 passengers per year. Followed by a second year of 825,000 passengers in 2001.
Next to the growing passenger numbers, other success were achieved. As a result of tight environmental agreements the number of complaints decreased. At the end of 2001 a new agreement was formed relating to the operating licence of the airport. Upon that the city council of Rotterdam agreed to maintain the current location of the airport for the upcoming 100 years. Due to its international character in aviation and international position in the Metropolian region, one decided to change the name of Den Haag to The Hague, to use these as a new name for the airport: 'Rotterdam The Hague Airport'.
Upon the name of The Hague, the location of the airport lays nearby the centre of the Dutch government. As a result of the closure of the marine airbase Valkenburg at 1 January 2005, Rotterdam The Hague Airport also functions as a governmental airport since. *The history of Rotterdam The Hague Airport was provided by the website of the airport,* Rotterdam The Hague Airport - Onderneming (Geschiedenis) *(2017)*

B.2. The company

In this section the management of Rotterdam The Hague Airport is introduced, covering the tasks, mission and organisation. The reason why the organisational structure is already introduced in this part of the report instead of the stakeholder analysis, is that this chapter introduces the whole concept of Rotterdam The Hague Airport; where it comes from, what it is, where it stands for and what it conquers.

Task and mission

Tasks of Rotterdam The Hague Airport:
"Rotterdam The Hague Airport offers facilities and services related to the handling of aircraft. In this content, the handling of passengers and cargo, where passengers are of main priority. Next to the facility services, Rotterdam The Hague Airport has to perform the legal task to supervise and maintain order and safety, in and around the airport.".
Secondly stated in the document of Hardenbol (2014), is the mission of Rotterdam The Hague Airport:
"Rotterdam The Hague Airport strives to be the front door for the Randstad area of Rotterdam and The Hague. Flying from Rotterdam The Hague Airport means ease and time savings. These are achieved by good connectivity, close parking lots and fast departure and arrival operations."
With the use of the task and mission of Rotterdam The Hague Airport, one is able to keep in mind that the airport should focus on its reputation, especially during construction works.

Organisation

By understanding the hierarchy within the company, decisions with respect to the expansion, renovation or change of plans, are traceable. The organisation of Rotterdam The Hague Airport; 'Rotterdam Airport Holding BV', operates 100% as a subsidiary of Schiphol Group. The holding of this organisation exists of: 'Rotterdam Airport Vastgoed BV' (Real-Estate), 'Rottedam Airport BV' and 'Rotterdam Airport Supplies and Services BV'.

C

Case results: Start procedure

This appendix covers the master planning and (re)construction planning for the case of Rotterdam The Hague Airport.

C.1. Master plan floor maps

The following two points presents the information delivered by the NACO study, relating to the figures C.2, C.3 respectively and legend in figure C.1.

0 - 'Current situation' (fig. C.2)
In this figure the areas are coloured which are reserved for the indicated function, as indicated in the colours by the legend of figure C.1.

1 - 'Quick fixes' (fig. 5.3)
The first expansion of the airport building reflects on main changes, based on the the NACO master plan. First: out placing of the baggage handling system. Now situated centrally in the airport building, will be placed out side the current airport building. Secondly, as part of the out placing of the baggage handling system, this creates a new location for the Central Security Filter. This will then be located at the old baggage handling system. The reason why is not mentioned. It could be assumed that the left entrance of the building will be used as main access for departing passengers, and so the passed processes of a departing flight are in logical sequence. Upon to the location changes of services, the departing area is expanded, including the number of gates.

Figure C.1: Legend for figures C.2 and C.3

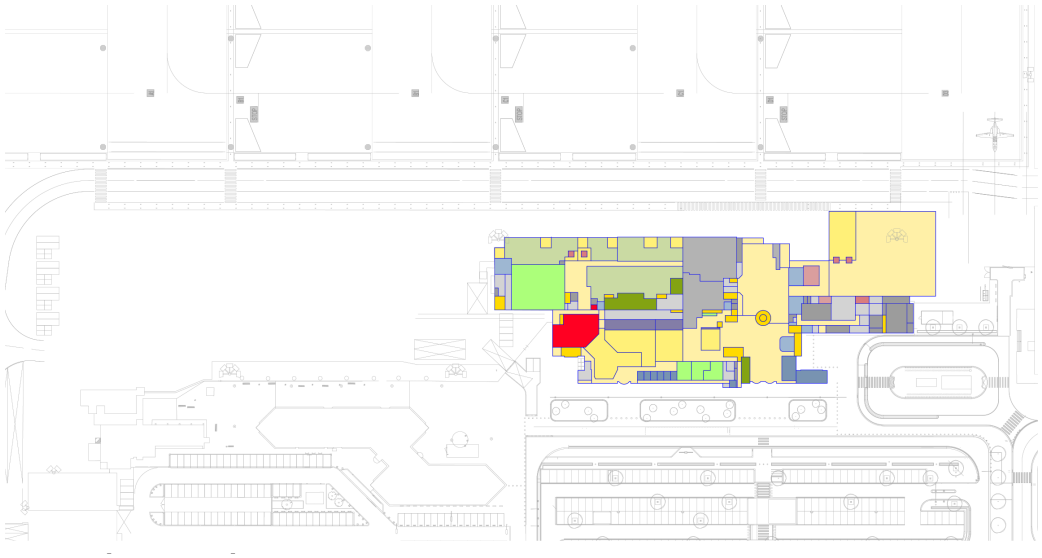

Figure C.2: Current floor plan of the airport - by NACO

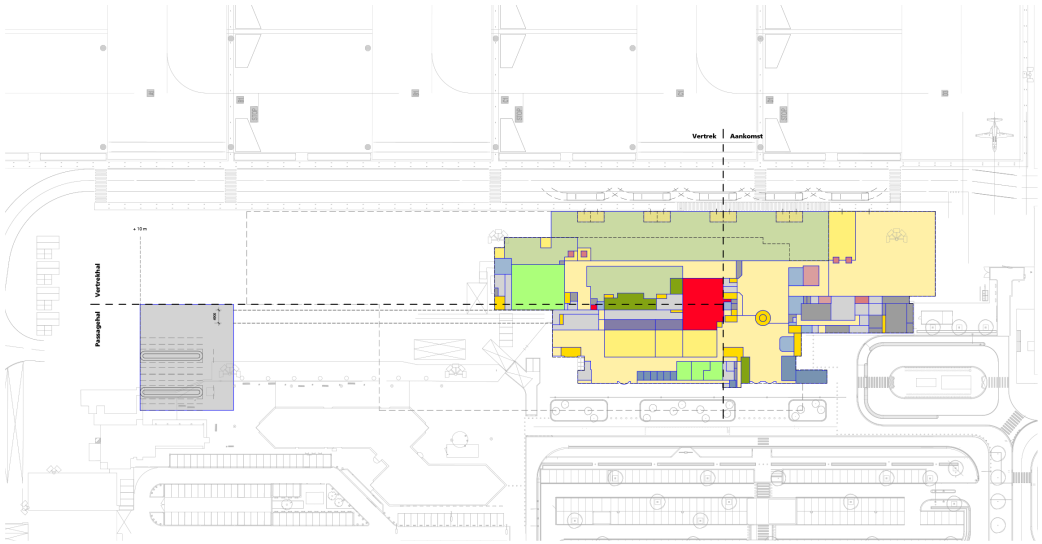

Figure C.3: Floor plan 'Phase 1: Quick fixes' - by NACO

C.2. Construction planning

In figures C.4, C.5, C.6 and C.7 the steps of the construction towards the delivery of 'Phase 1: Quick fixes' are schematically presented.

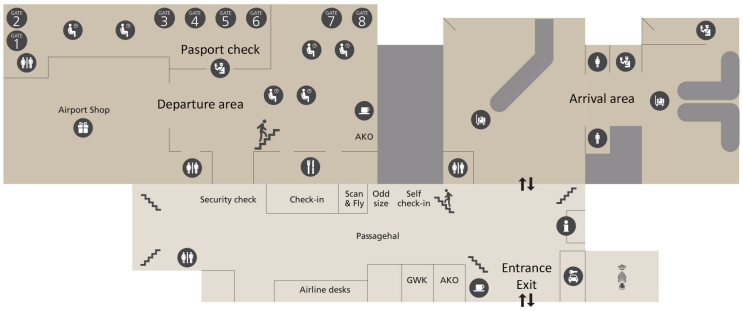

Figure C.4: Current floor plan

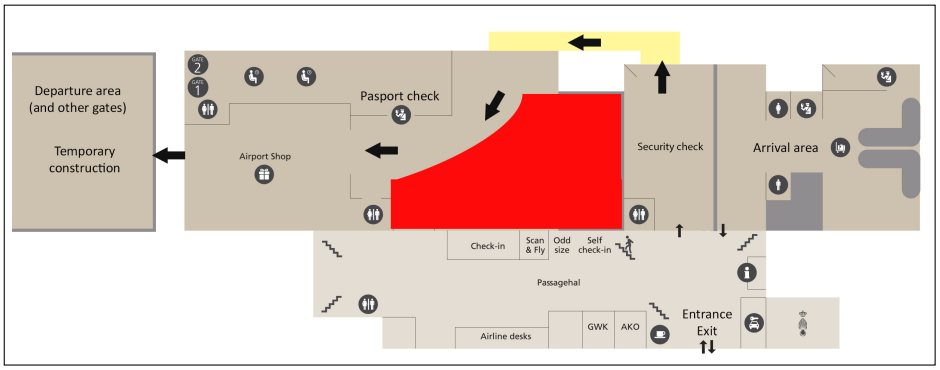

Figure C.5: Construction step 1 -
This layout will be used to test the methodology

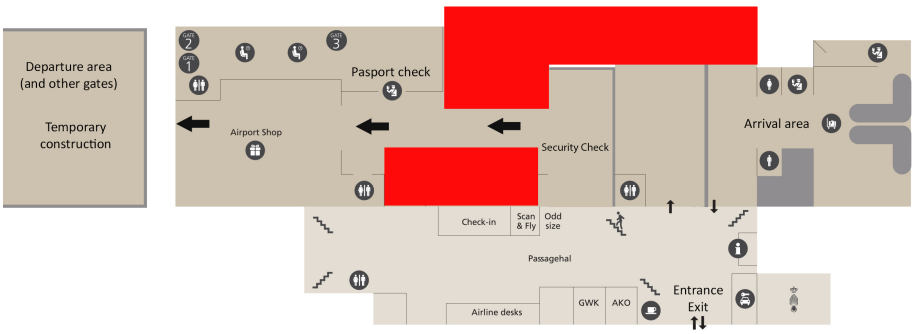

Figure C.6: Construction step 2

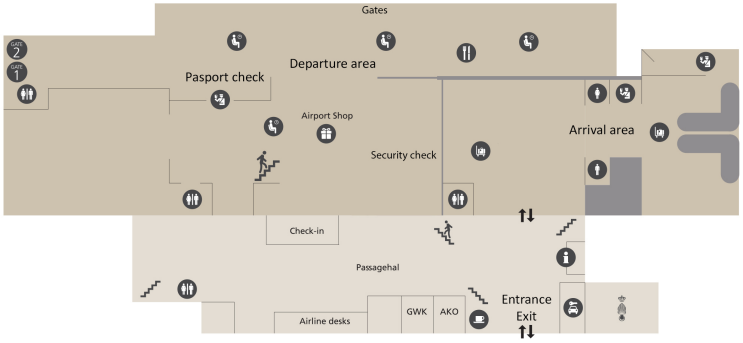

Figure C.7: Construction finished - delivery of new floor plan 'Quick fixes'

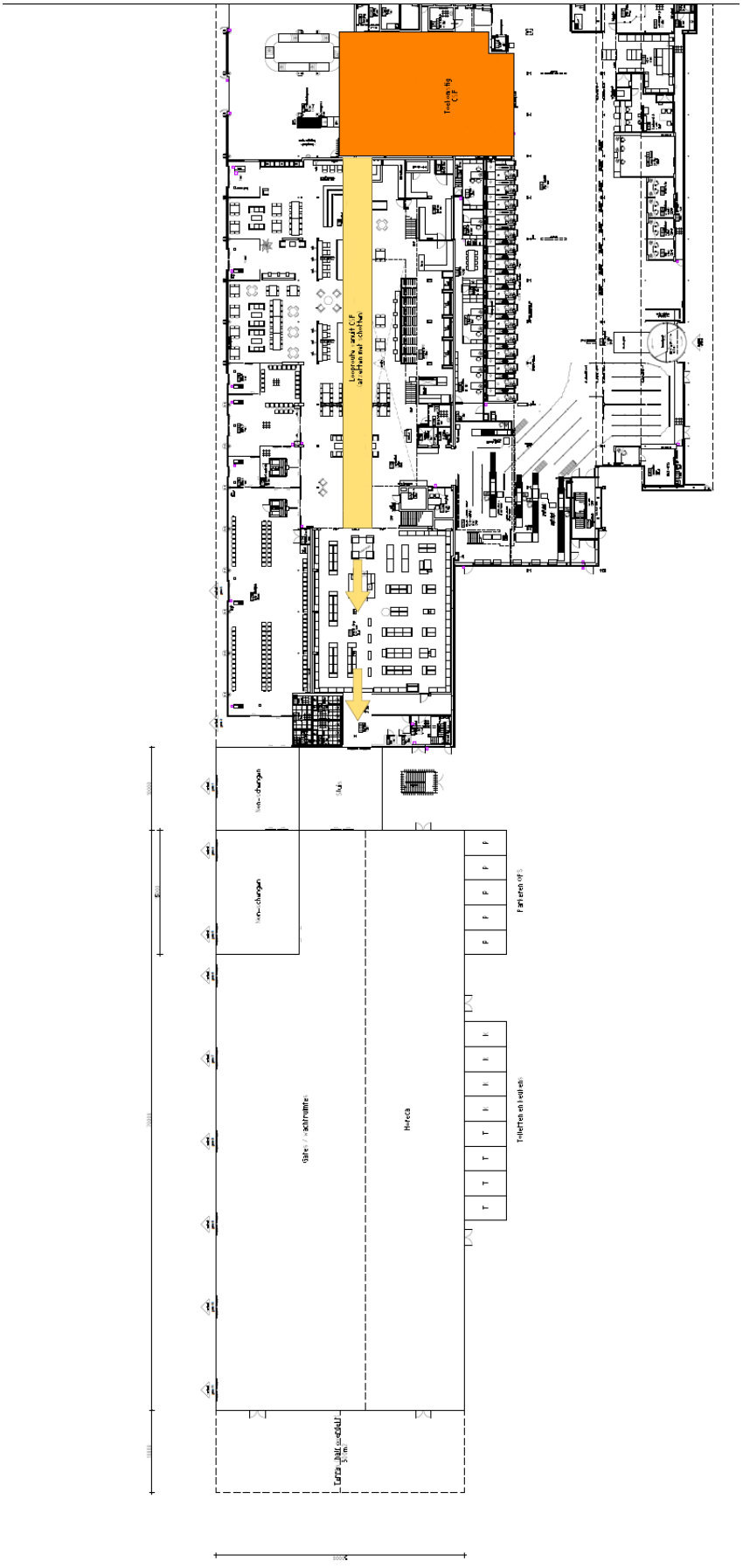

Figure C.8: Temporarily construction location (indicated on the left of the airport building. Indicated in yellow and by arrows; assumed corridors for passenger and logistical flow

D

Case results: Collection of information and Specification of requirements

This appendix is dedicated to the deliverables of the methodology application at Rotterdam The Hague Airport with respect to the collection of information and specification of requirements. The sequence of subjects is based on the methodology.

D.1. Methodology - Step 1: Collection of information

In all sections the results, clarifying information and figures are presented that were found at the case of Rotterdam The Hague Airport. In each section, extra information is presented to elaborate on any figures.

D.1.1. Objective

The aim is to to increase or keep these scores of 'Net Promoter Score' (Wiegerink and Verhoeven (n.d.)), based on the principle of (Reichheld (2003)) at a level of 51 (in a scale from 0 to 100%), which is the lower bound. The results of this scale provide insight whether passengers are satisfied, therefore would recommend the airport as a preferred departure for their trip. This principle is used to determine the satisfactory level and incidentally is used to determine any inconveniences.

D.1.2. Operational and area tasks and functions

For the analysis or tasks and functions at the airport, the demand and supply are captured in a schematic representation in figure D.1. The overall process of departing passengers are presented in D.2.
From figure D.3 to figure D.7 all mandatory processes at the airport are represented.

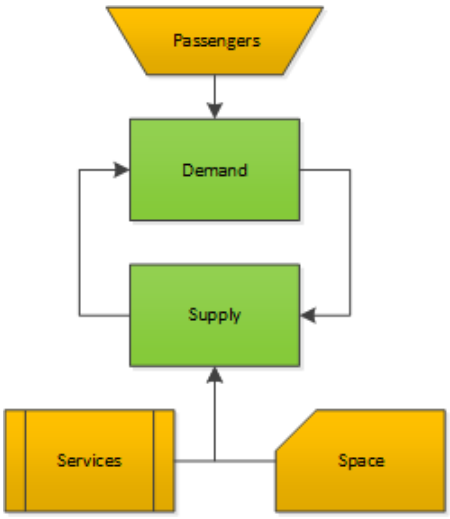

Figure D.1: Demand versus supply schematically presented

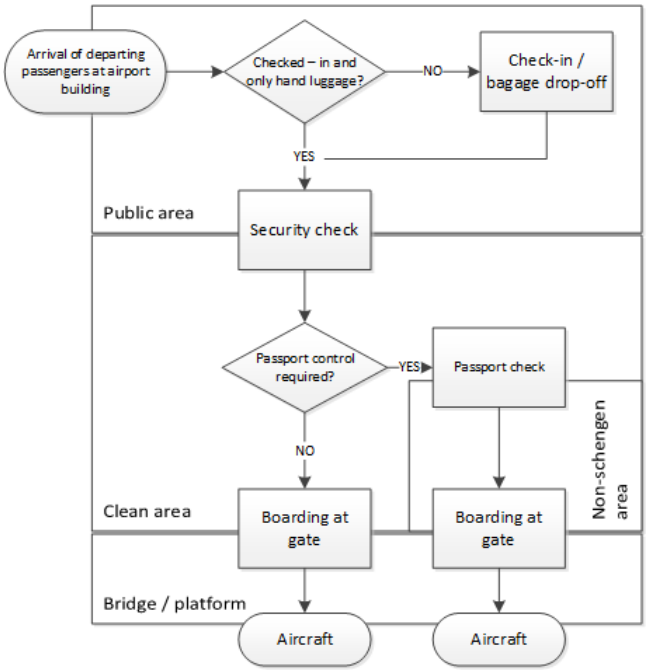

Figure D.2: The overall process of a departing passenger

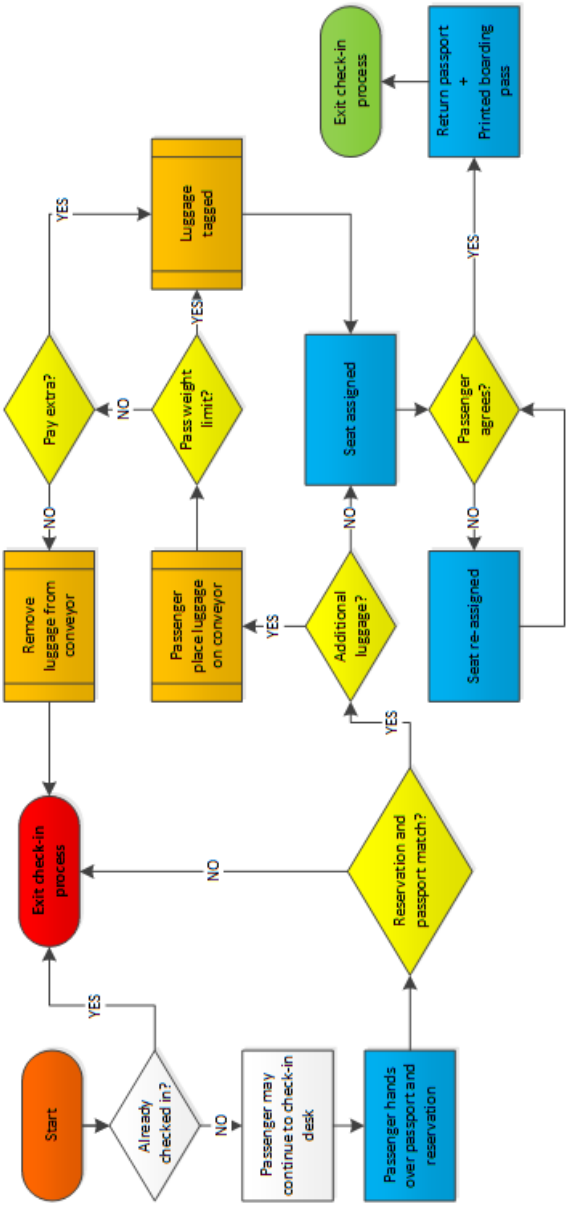

Figure D.3: The departing passenger process at check-in counter

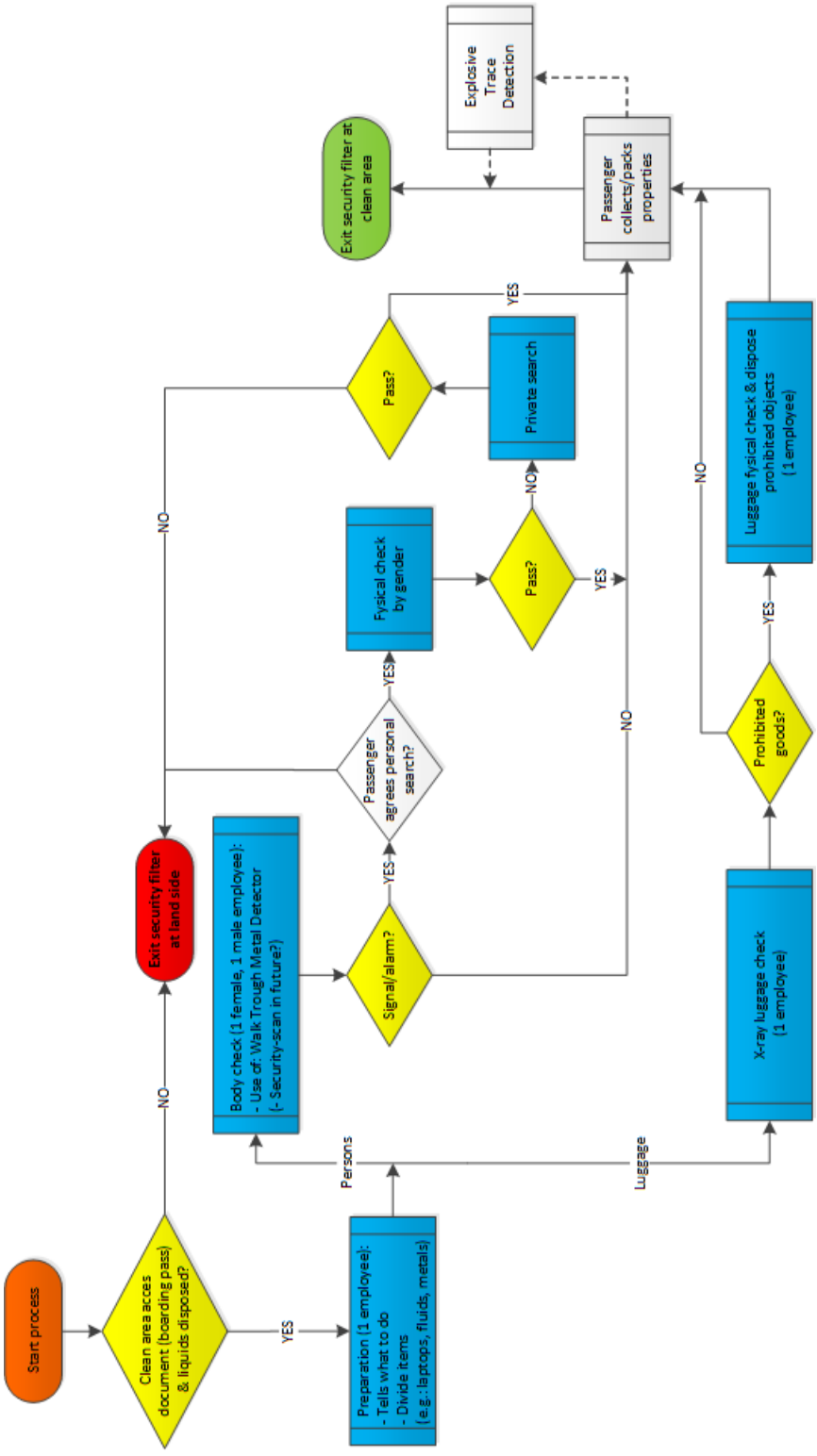

Figure D.4: Security check for passengers

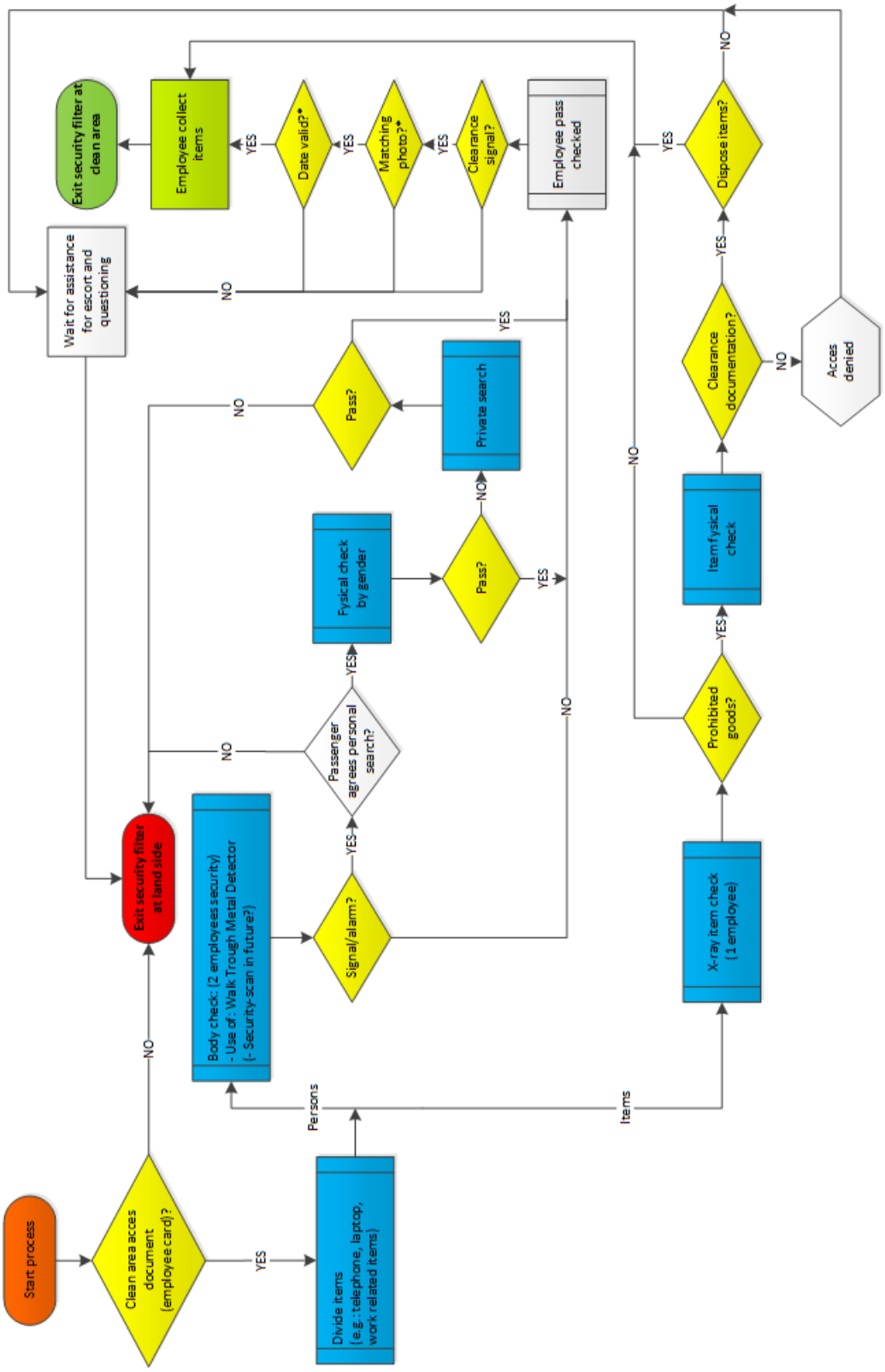

Figure D.5: Security check for employees

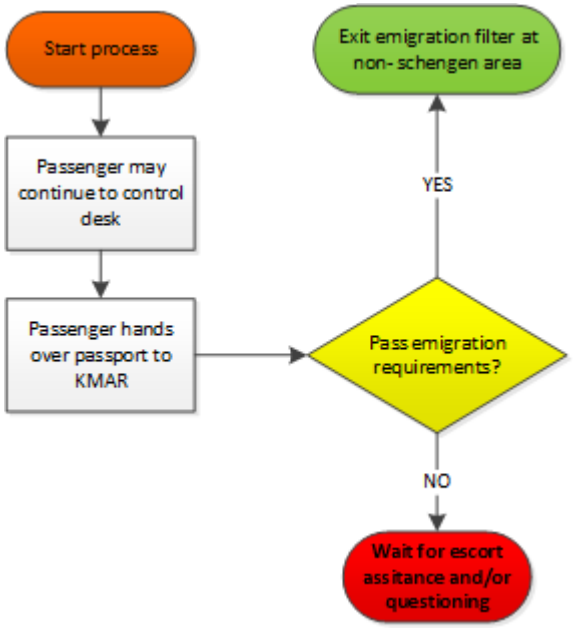

Figure D.6: Emigration process - mandatory when flying to Non-Schengen destinations

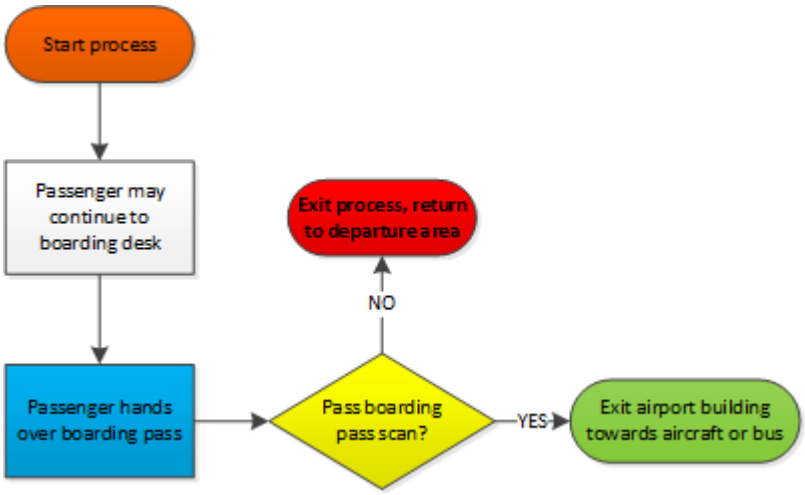

Figure D.7: Boarding process

D.1.3. Exploration

In the content of exploration, the paragraphs cover information about: resources, the results of area of interests and issues regarding throughput.

Resources

The resources that will be available at the airport and are indicated by figures are captured here. In figures D.8 and D.8 examples are shown regarding wickets and solid bars, serving as banking lines.

Information sharing platform

. To inform employees a plan of approach was introduced by the author. With the use of feedback of the interview in appendix A.1, the idea arise to introduce a digital platform that contain an overview of all (re)construction work. The main purpose is to inform all employees by a simple manner. When more information is demanded, one may continue to a more detailed platform. An example of how this platform may look like is presented in figure D.10.
Despite that this way of information sharing was not available at the airport intranet, it is assumed that this platform will be used as a new resource to keep employees updated and/or informed.
As for the subject of users in this part of exploration, this was extended to the stakeholder analysis.

Figure D.8: Wickets - similar types are used at Rotterdam The Hague Airport
Design (n.d.)

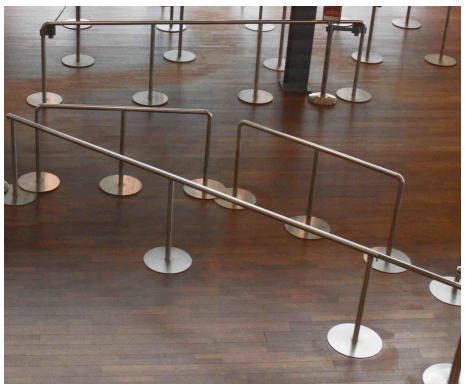

Figure D.9: Solid bars with a variate of lengths available at Rotterdam The Hague Airport

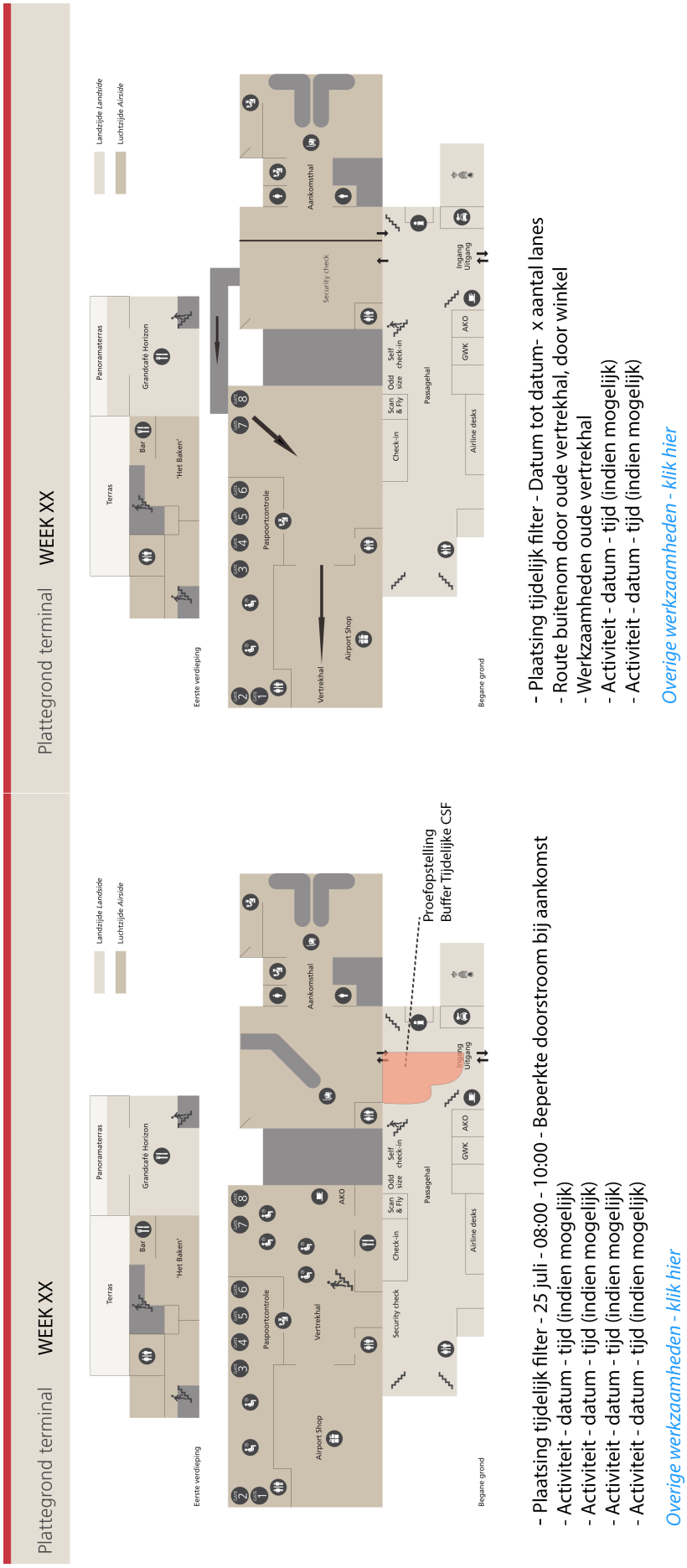

Figure D.10: Example of digital information platform for employees

The area of interest

To gain understanding about the area of interests, this paragraph covers the visualisation of the area.
Pictures are taken from a perspective indicated in figure D.11. The choice of these locations are used to generate understanding about the surroundings and perception passengers may encounter at these particular locations. Upon that, these are the locations that are highly occupied by passengers during peak-hours.
(Elaborated on in the paragraph of: Peak hour analysis)

Fig. D.12 - This picture indicates the total public area of the airport building 'passagehal', framed on the area for departing passengers.
Fig. D.13 - This picture is taken from the opposite site of the 'passagehal', with in the left side the check-in counters. This area will be (highly) occupied by passengers during peak-hours
Fig. D.14 - Taken from above, is the entrance for the buffer waiting area of the Central Security Filter. This area will be (highly) occupied by passengers during peak-hours
Fig. D.15 - Indicates the departing area as seen when exiting the Central Security Filter. The choice of this location is that this is the first point where passengers orientate themselves
Fig. D.16 - This waiting area can be used as a Schengen/Non-Schengen waiting area. It should be notified that to access this area when it is reserved for Non-Schengen departures, only accessible by passport control.
Fig. D.17 - This picture shows the aisles, perpendicular to the gate entrances, providing seats and tables for waiting.
Fig. D.18 - This image captures the whole aisle (left side) that is connected to all 8 gates.

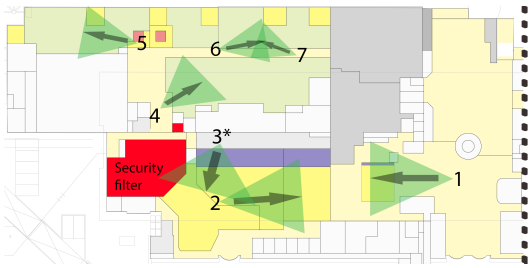

Figure D.11: Locations of pictures: D.12, D.13, D.14, D.15, D.16, D.17 and D.18

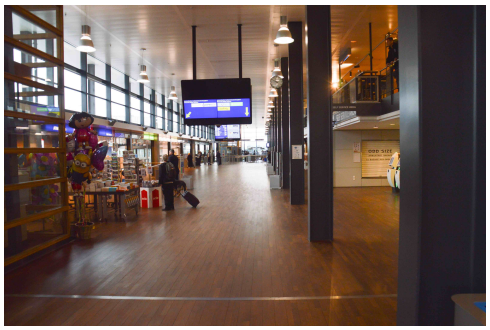

Figure D.12: Picture of location 1: 'Passagehal'

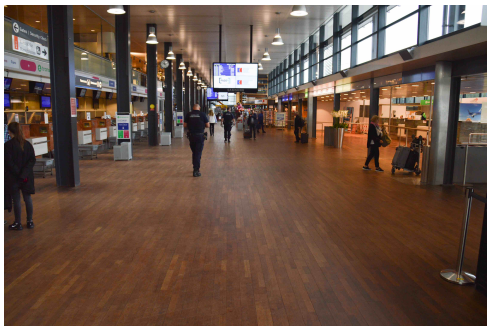

Figure D.13: Picture of location 2: 'Passagehal'

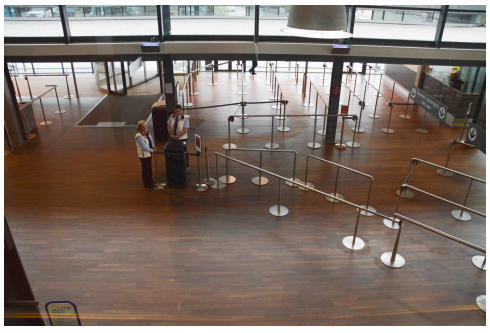

Figure D.14: Picture of location 3 (taken from the balcony of the 'Baken') - waiting area for the security filter

Figure D.15: Picture of location 4: Hybrid departure waiting area, as seen from exit security filter

Figure D.16: Picture of location 5: Waiting area usable for Non-Schengen flights

Figure D.17: Picture of location 6: Hybrid waiting area close by gate 6, 7 and 8

Figure D.18: Picture of location 7: Hybrid waiting
area close by gate 6, 7 and 8 - different angle

Issues and peak period analysis

This part of the section gives answers of the questions: *1. What is the cause of waiting in the public area?*
2. How do the passengers line-up without organisation?
3. What is the cause of a pilled up group of people at the boarding pass check?
4. What kind of queuing behaviour will evolve when passengers know that they can (almost) board?
based on the analysis performed during peak periods at Rotterdam The Hague Airport.

For the first question, the explanation relates to the the following behaviour. As passengers arrive at the airport and immediately would like to check-in, but the counter is not opened yet, they tend to line up in a random line. This type of behaviour occurred during Monday April 24. Passengers lined up in a queue, all piling up towards the arrival area. In this case the direction of the queue formed by self organisation of passengers. They choose where to line up, because any guidance was not facilitated. This explanation also gives answer on the second question.
For the clarification of question three, the occurrence of a queue in front of the buffer is related to passengers are not prepared to show their boarding pass. Upon that, there is no organisation at this area. Resulting in mixes of queues for those passengers that are in line at check-in counter 1 to 4 and waiting to enter the security check buffer.
The answer of question four can is related to unorganised queuing system. As the point of boarding almost starts, passengers will line up at the gate. However, due to fact that there is no clear path towards the gate, passengers line up in random directions. As long there is space available, passenger will make a line, even when they block aisles. This type of behaviour mainly based on the missing guidance for queuing directions.

The peak period analysis was performed during four periods of the Mei-vakantie:
Friday 21-04-2017 - ±11:00-12:30
Sunday 23-04-2017 - ±06:30-07:00
Monday 24-04-2017 - ±10:15-13:00
Tuesday 25-04-2017 - ±05:15-07:00
Note 1: *Although a few periods are analysed, quantitative analysis was not necessary considered due returning patterns in queuing. Upon that the occurrence of queuing in the 'Passagehal' and departing area did not happened at the exact same time, but occurred within the indicated time frame.*
Note 2: *Operations of airports operate according* ***indicated times****, due to the randomness of aircraft operations. As a result no exact time frame can be labelled to a certain event*
The results of these passenger analysis per dates are indicated in floor maps. Each with passenger queues (indicated in blue) and bottlenecks (pink).
For determining if passengers are in a queue, it is assumed that the wait in line and move slower/do not move, compared to freely moving people.

Table D.1: Passenger number prognosis and captured, in time frame respectively

Date	Passenger prognosis	departed during analysis
Friday 21-04-2017 - ±11:00-12:30	890	850
Sunday 23-04-2017 - ±06:30-07:00	882	926
Monday 24-04-2017 - ±10:15-13:00	901	1015
Tuesday 25-04-2017 - ±05:15-07:00	961	855

Friday 21-04-2017 - ±11:00-12:30

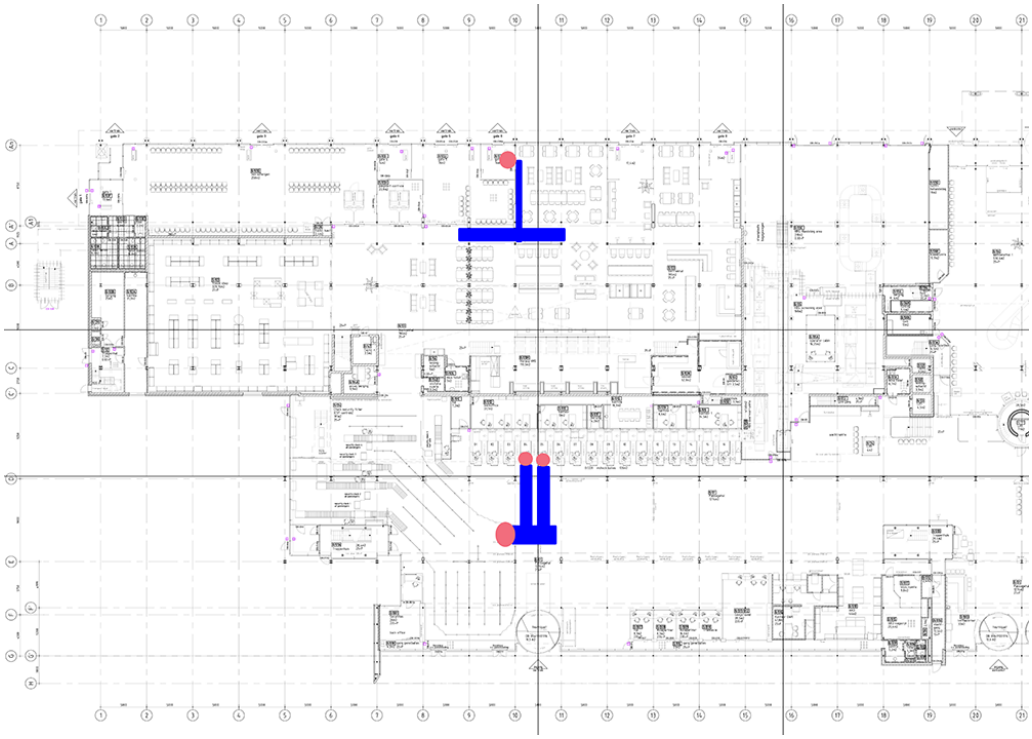

Figure D.19: Queues (blue lines) and bottlenecks (pink dots) 21-4-2017

It can be determined from figure D.19, that there are two areas that contain queue forming. Starting with the area of the check-in ('Passagehal'). Here two lines form a queue to the check-in desks 4 and 5 (vertically indicated), and a queue (horizontally indicated) that is forming for entering the security filter. In this case the pink dot indicates the bottleneck that is critical in this particular case.
During the analysis the queues of check-in desk 4 & 5 (vertically indicated) mix with the queue that is waiting to enter the security filter (horizontally indicated). This could led to confusion for waiting passengers - not knowing if they are in the right queue. The reason why this happens is the spill back of the bottlenecks (check-in counters 4 or 5) indicated in pink or the spill-back of the boarding pass check queue.
It occurred that some passengers tend to be surprised to show their boarding pass. Those who were surprised had to open their hand luggage and search for their boarding pass or people had to get out their phone and look up the file on their email/data storage. While the passenger is searching for the boarding pass, he/she holds up the line that is also waiting, creating spill back - creating a queue that eventually could mix with waiting passengers for the check-in desk.

Secondly indicated in this map is the queue forming towards gate 6 (indicated at the pink dot). Experience learns that passengers tend to sit and wait as close as possible to their departing aircraft or gate. However, at Rotterdam The Hague Airport, and especially during peak hour departures, there are not enough seats for each gate. It happens that passengers, that do not have a seat for waiting, starting a queue in front of their gate, even when the gate will not open for a unknown period of time (>10 minutes). This type of behaviour would not be an issue if there is space available to form this queue. However, as indicated in figure D.19, the queue forms up to the pathway of the terminal area, where the queue is split up into two directions - blocking the way for passengers who are tend to go other gates.

Additional pictures of Friday 21-04-2017 - ±11:00-12:30

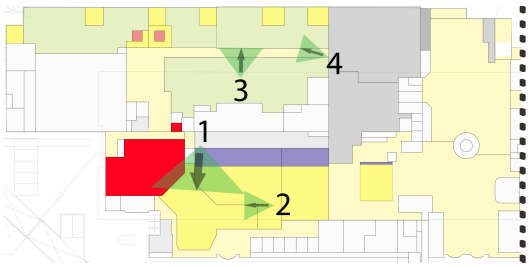

Figure D.20: Locations of Meivakantie 21-04-2017

Figure D.21: Picture of location 1 - 21-04-2017

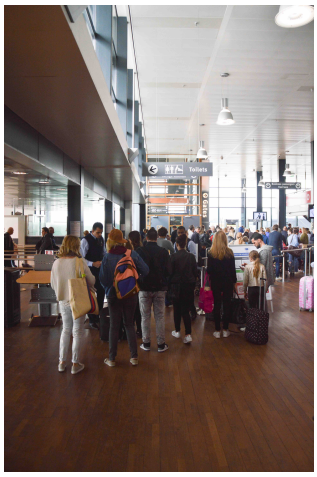

Figure D.22: Picture of location 2 - 21-04-2017

Figure D.23: Picture of location 3 - 21-04-2017

Figure D.24: Picture of location 4 - 21-04-2017

Sunday 23-04-2017 - ±06:30-07:00

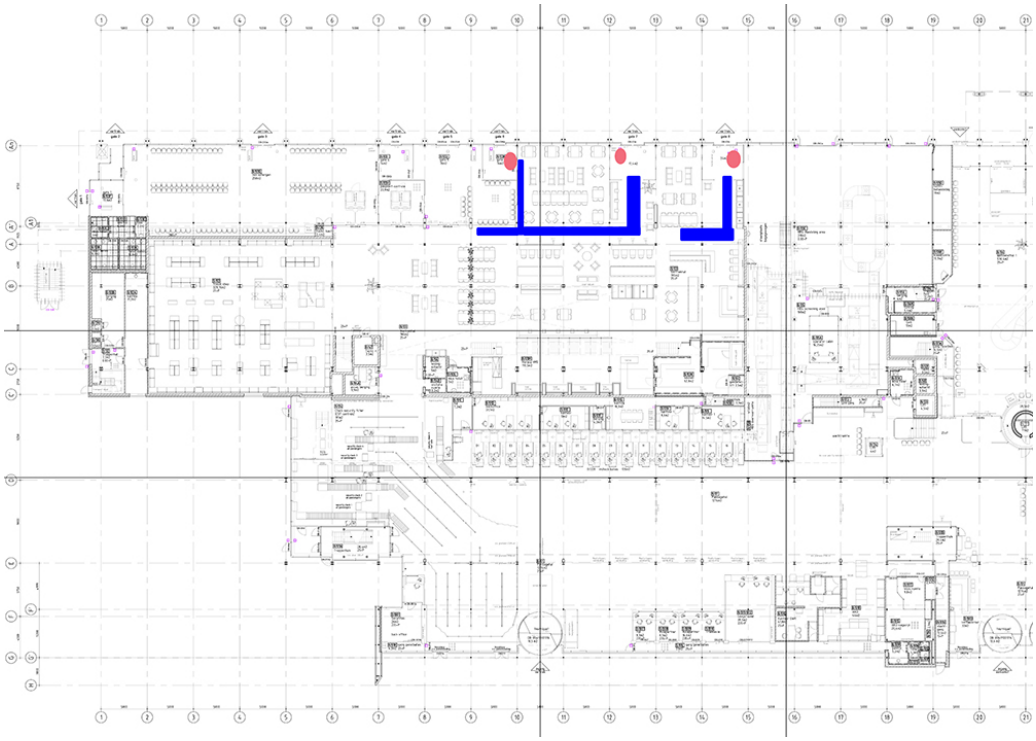

Figure D.25: Queues (blue lines) and bottlenecks (pink dots) 23-4-2017

As can be seen from figure D.25, the main queues and bottlenecks are formed in the departing area of gate 6, 7 and 8. The problem that occurs here, is quite similar of that mentioned in the previous analysis: passengers tend to wait in a queue that is already formed before the gate is opened.
During this analysis, it occurred that the queues of gate 6 and 7 merged halfway the aisle. The queue of gate 6 is split up, in left and right, seen from above. Whereas the queue of gate 7 is formed to the left. Due to this type of queuing the aisle even become more crowded, also confusing passengers - asking themselves if they were in the right queue.
It even happened that, when the first people lined up for the gate, passengers of the same flight waiting seated, left their seat and joined the queue standing.

Additional pictures of Sunday 23-04-2017 - ±06:30-07:00

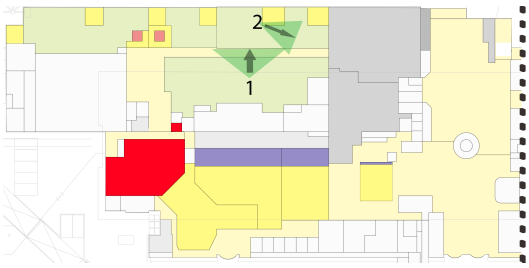

Figure D.26: Locations of Meivakantie - 23-04-2017

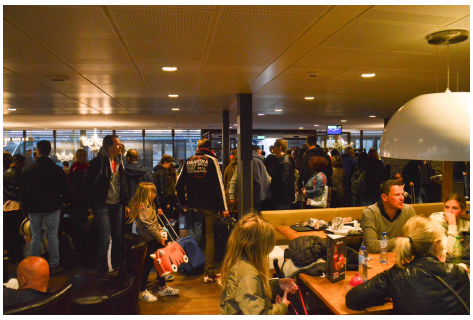

Figure D.27: First picture of location 1 - 23-04-2017

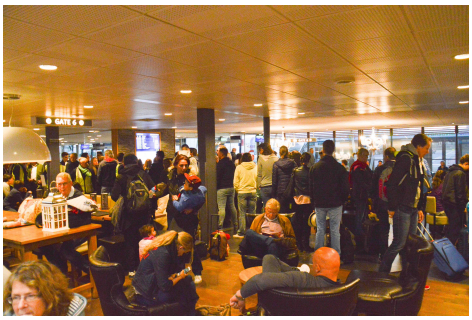

Figure D.28: Second picture of location 1 - 23-04-2017

Figure D.29: Third picture of location 1 - 23-04-2017

Figure D.30: Picture of location 2 - 23-04-2017

Monday 24-04-2017 - ±10:15-13:00

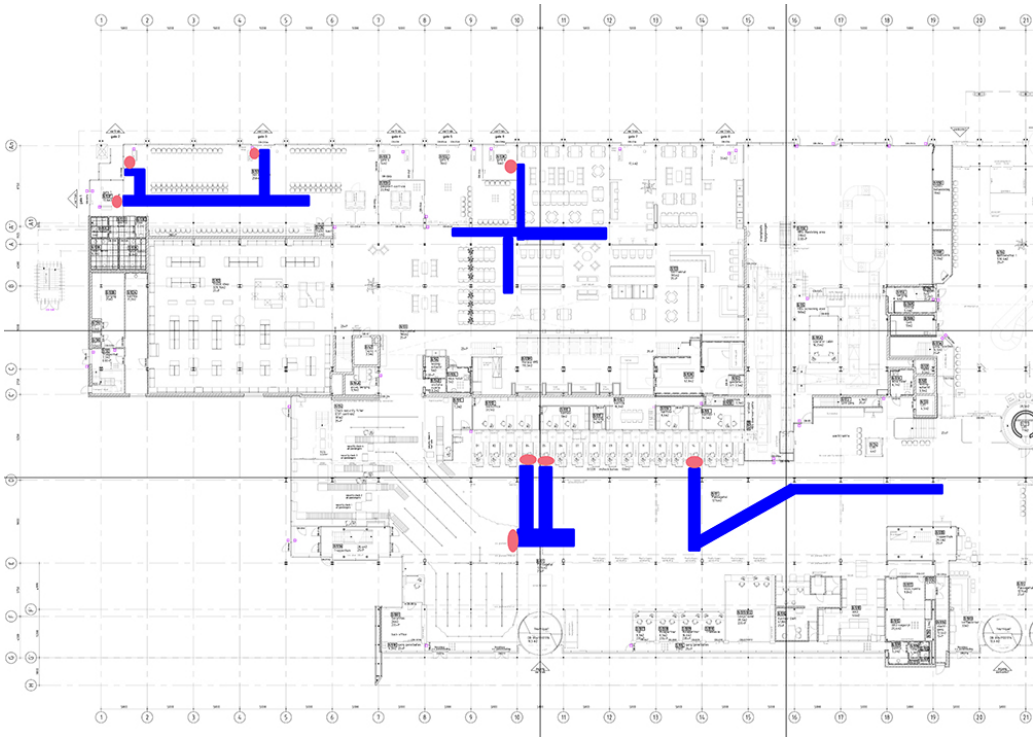

Figure D.31: Queues (blue lines) and bottlenecks (pink dots) 24-4-2017

During the morning of Monday April 24, there were 4 different notable points of interests (fig. D.31). Starting with the queue occurring in the 'Passagehal' (most right in the figure).
This queue is formed by passengers that are waiting for a check-in counter to open for a specific flight. Due to the fact that only one information screen was indicating the check-in desk assigned for that particular flight, all passengers lined up in this only queue. In this case, those passenger have chosen to form a queue towards the space that is available, in this case, towards the arrival area.
Secondly is the same issue that occurred in during the same analysis time frame as Friday 21-4; a mix of queues that of the check-in and the entrance of the buffer of the security filter. Resulting to confusion of waiting passengers.
Thirdly is the queuing that is happening at gate 6. Different than previous time, is the extra queue lane that is forming trough the waiting area in the direction of the food corner. This occurrence lead to a reduction of level of service to those passengers that are not waiting for this flight, but are seated in the area, waiting for their own flight. The problem here is that passengers are looking for space to line up for their queue, but not having space available, not even in the aisle.
Finally the queues that are formed in the waiting area of gate 1, 2 and 3 are highlighted. In this case spill back of these queues, led to a mixture of different queues of different flights respectively. In this area there is no specific distinction between queuing, and lead to confusion of passengers. However, although the crowded waiting area, passengers find their way within time. If a passenger is just willing to wait in another area, he/she had enough time to board the aircraft, even when all other passengers left the departing area.

Additional pictures of Monday 24-04-2017 - ±10:15-13:00

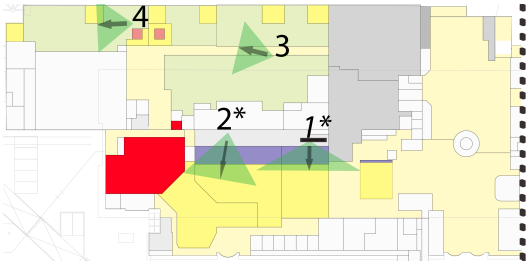

Figure D.32: Photograph locations of Meivakantie (location 1 was captured early in the time frame, while others half way or to the end)

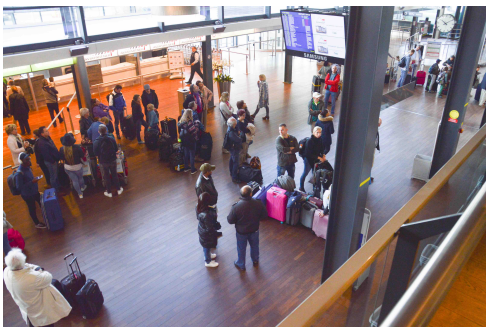

Figure D.33: Picture of location 1

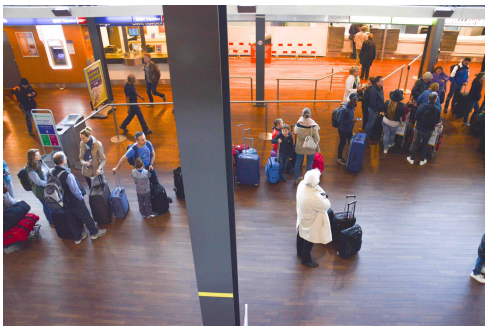

Figure D.34: First picture of location 1 - 24-04-2017

Figure D.35: Second picture of location 1 - 24-04-2017

Figure D.36: Picture of location 2 - 24-04-2017

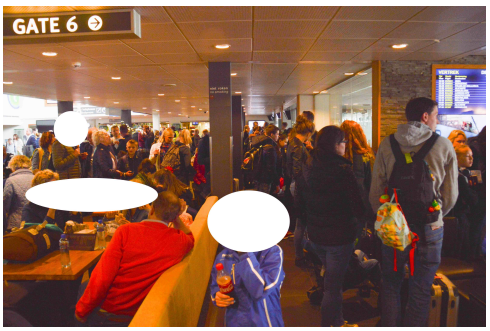

Figure D.37: Picture of location 3 - 24-04-2017

Figure D.38: Picture of location 4 - 24-04-2017

Tuesday 25-04-2017 - ±05:15-07:00

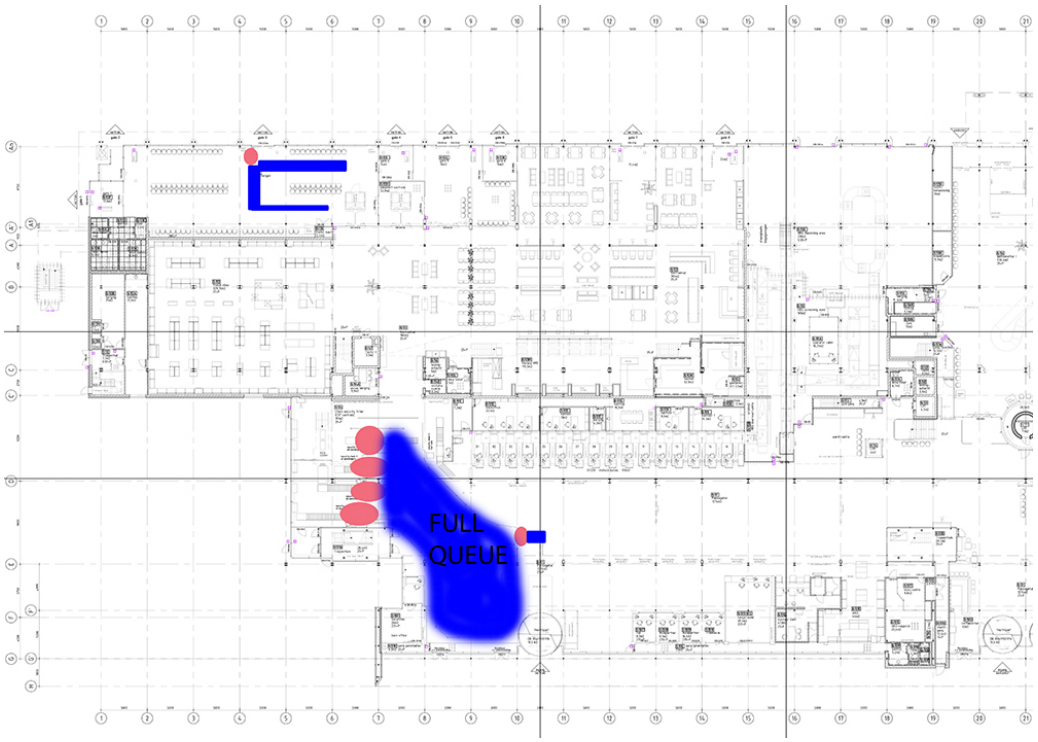

Figure D.39: Queues (blue lines) and bottlenecks (pink dots) 25-4-2017

The last analysis was conducted during the morning peak of 25-4. Starting with the 'Passagehal'. Indicated in figure D.39 is "Full queue", meaning that the total buffer in front of the security filter (and behind the boarding pass check), was occupied. Due to the full buffer, spill back grow in respect to the queue that was aligned in front of the boarding pass control. However, it should be noticed that this event occurred with approximately 15 passengers waiting in front of the boarding pass control, and does not happen occasionally (based on feedback of DMS).
The second event that is noticed during the analysis are the queues formed in the waiting area nearby at gate 3. During certain boarding procedures the queue was served by two stewards. During these events there was only one line, and only the person in front was server first by one of the two handlers. However, in the case of the boarding procedure of gate 3, 2 queues formed instead of one, leading to a overall shorter queue. In this case some of the passengers were confused if they were in the right queue.

Additional pictures of Tuesday 25-04-2017 - ±05:15-07:00

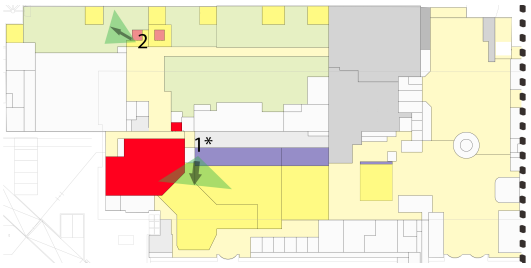

Figure D.40: Locations of Meivakantie

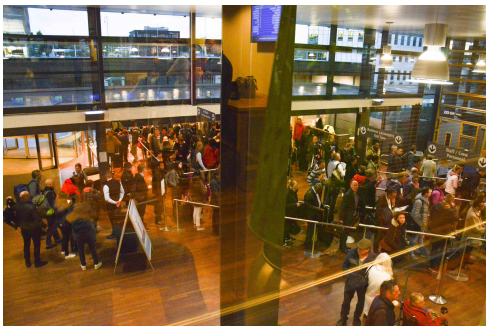

Figure D.41: Picture of location 1 - 25-04-2017

Figure D.42: Picture of location 2 - 25-04-2017

Airport stakeholders

Table D.2: Stakeholders that relate to the airport expansion Phase 1 - 'Quick fixes', between brackets (duration of visit to area of interests)

People / users	**Activities/Interests**
Passengers (max. 4 hours)	Hello-goodbye, performing activities to proceed to departing paid transfer (see passenger journey)
Dropping off passengers / collectors (max. of 1 hour)	Hello-goodbye relatives, friends, family
(Day) Visitors (max. of 2 hour)	Visiting the airport (e.g. Platform viewing, drinking coffee)
Pilots / cabin crew (max. 30 minutes)	Use the terminal to continue to the aircraft
Employees / lessees in terminal (always)	Perform job related tasks
Business in terminal	
Airlines (during office hours)	Providing information and help for passengers
Handler(s) (first to last departure)	AviaPartner, provider of handling services w.r.t. Informing, check-in, boarding,
Shops (09:00 - 19:00	Selling articles, providing information
Catering (first to last departure)	Serving and selling of food and beverages, providing information
Lessors advertising space (contract based	Selling products by advertising
Security (24/7)	Trigion
Cleaning (office hours)	Services regarding cleaning of airport building and its facilities
Tour operators (manned: office hours)	Providing travel information and selling tours
Telecom providers (permanent)	Providers of digital connections (e.g. WiFi routers)
KMAR (24/7)	Checking of passports and assure safety
Customs (first departing - last arrival)	Checking on prohibited goods for export
Regulatory/licensing authorities/government	
KMAR (security, police, BBLV (see above))	Providing supervision on: safety, order and law enforcement
Rotterdam Rijnmond Safety Region (not present)	Emergency Rotterdam is responsible for the airport building
Intern RTHA	
Security (24/7)	Responsible for security operations, functional management, policy, development, contract management and process owner screening, asset owner security agents.
Information counter (07:00 - 23:00)	Providing passenger information and reception of guests
IT (Office hours)	Responsible for the IT network
Marketing & Communication (Office hours)	Information suppliers for internal and external information
Involved stakeholders in airport extension	
Technical department (Office hours)	Responsible for the management and maintenance of buildings and installations at the airport.
Schiphol Real-Estate (Office hours)	Project developer and owner of land side development of Rotterdam The Hague Airport
PLUS (on appointments)	Project manager
Procurement (on appointments)	Selection and procurement of consultant services and contract implementation
Design team (on appointments)	Covered by NACO, architect, engineer(s), installation consultant, fee expert
Architectural supervisor (on appointments)	(PaulWintermans) and municipality quality team

The airport stakeholders are be combined into one overview. The goal of this overview is to see the internal relation between stakeholders and what the interest/power difference is per mutual stakeholder. By combining the power/interests of the stakeholder list of Lonis and Perdon (2017)), a stakeholder overview is created (fig.D.43).
In this case the power and interests per stakeholder were already provided by Rotterdam The Hague

Airport. In this case the levels were indicated from 1 to 3, whereas 1 indicates a low power/interest and 3 high power/ interest. These levels were also used to place the stakeholder in the correct power to interest cell.

In this case the blue line indicate relation originate from a passenger point of view (based on the customer journey and quantity), while the black line refers to the mutual stakeholder relations, which originate from the design team point of view. The choice of reasoning from the design perspective is that the plans and/or measures will be discussed by this group first, then will be passed to the other stakeholders.

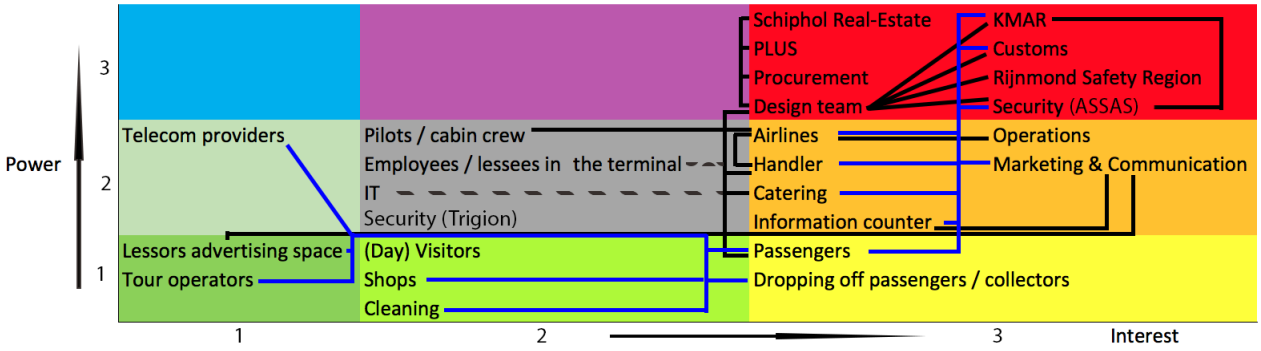

Figure D.43: Stakeholder analysis, placed on their power and interests

The relation between the stakeholders can be used in the requirement and functional analysis to trace and support why certain decisions or restrictions have priority over the other.

Passenger Journeys and Characteristics (of Rotterdam The Hague Airport)

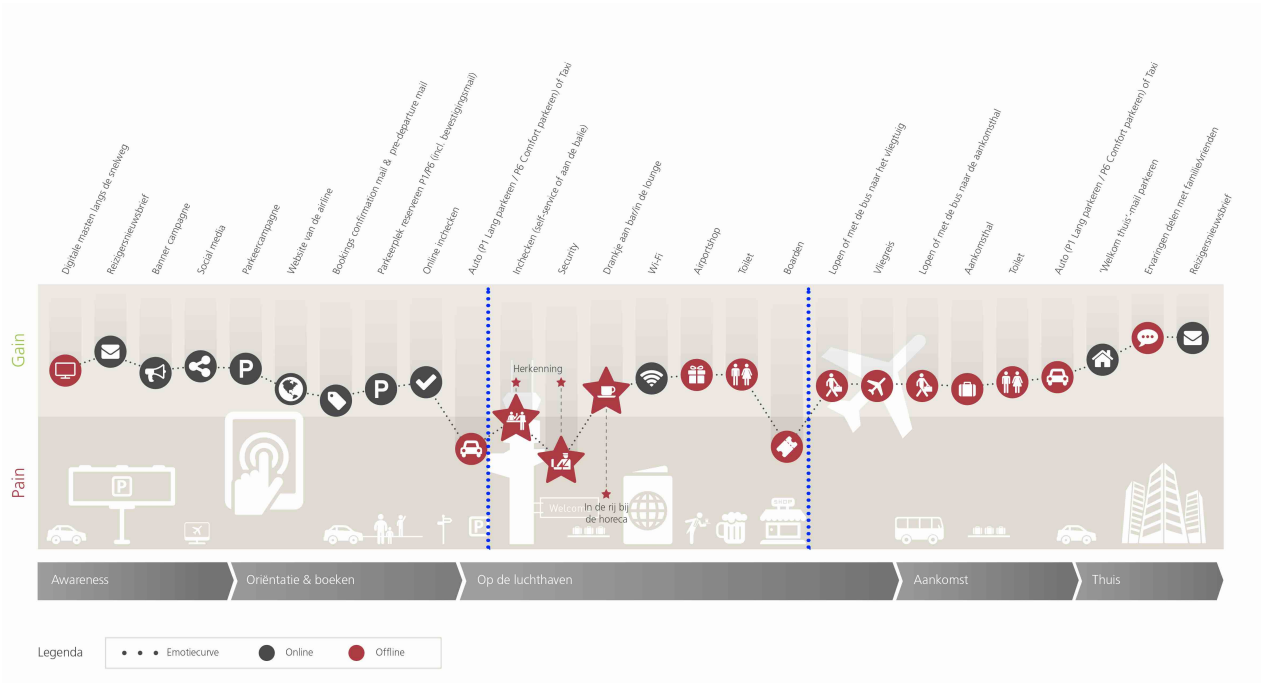

Figure D.44: Passenger journey of the luxury passenger (Wiegerink and Verhoeven (n.d.))

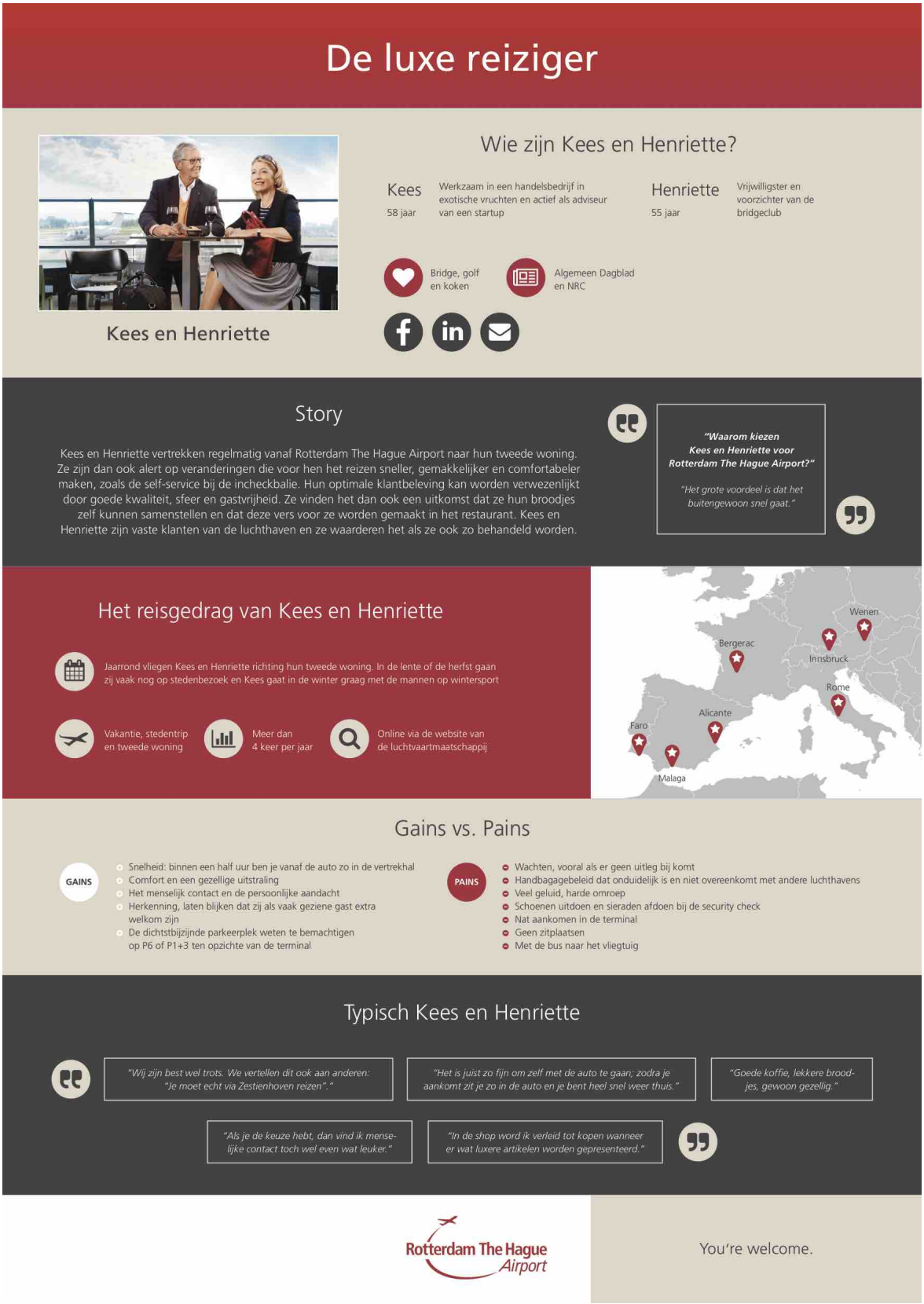

Figure D.45: Passenger profile of the luxury passenger (Wiegerink and Verhoeven (n.d.))

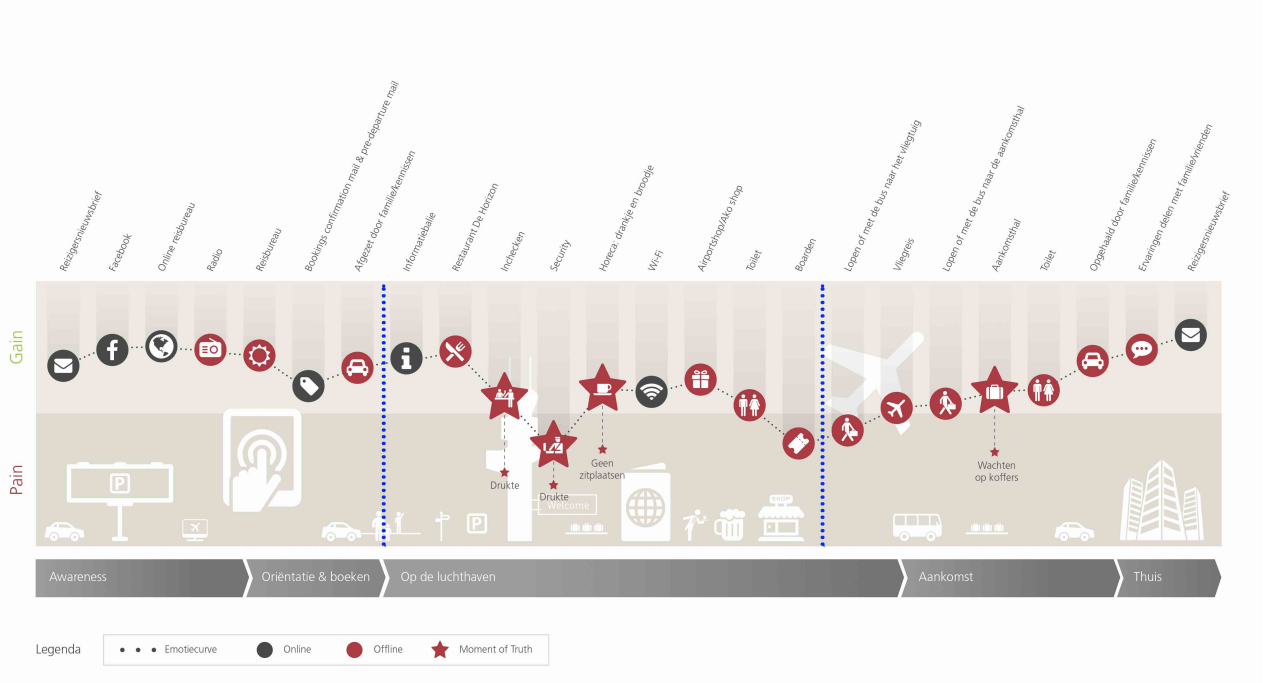

Figure D.46: Passenger journey of the elderly passenger (Wiegerink and Verhoeven (n.d.))

Figure D.47: Passenger profile of the elderly passenger (Wiegerink and Verhoeven (n.d.))

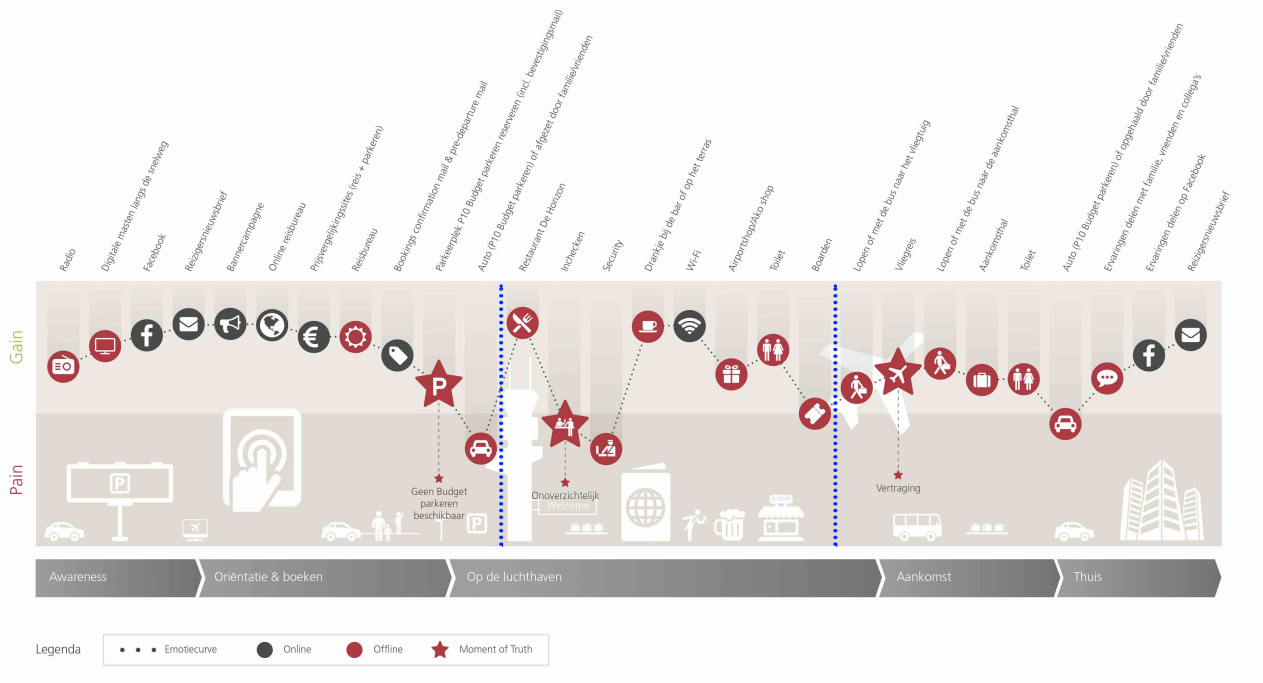

Figure D.48: Passenger journey of the holiday passenger (Wiegerink and Verhoeven (n.d.))

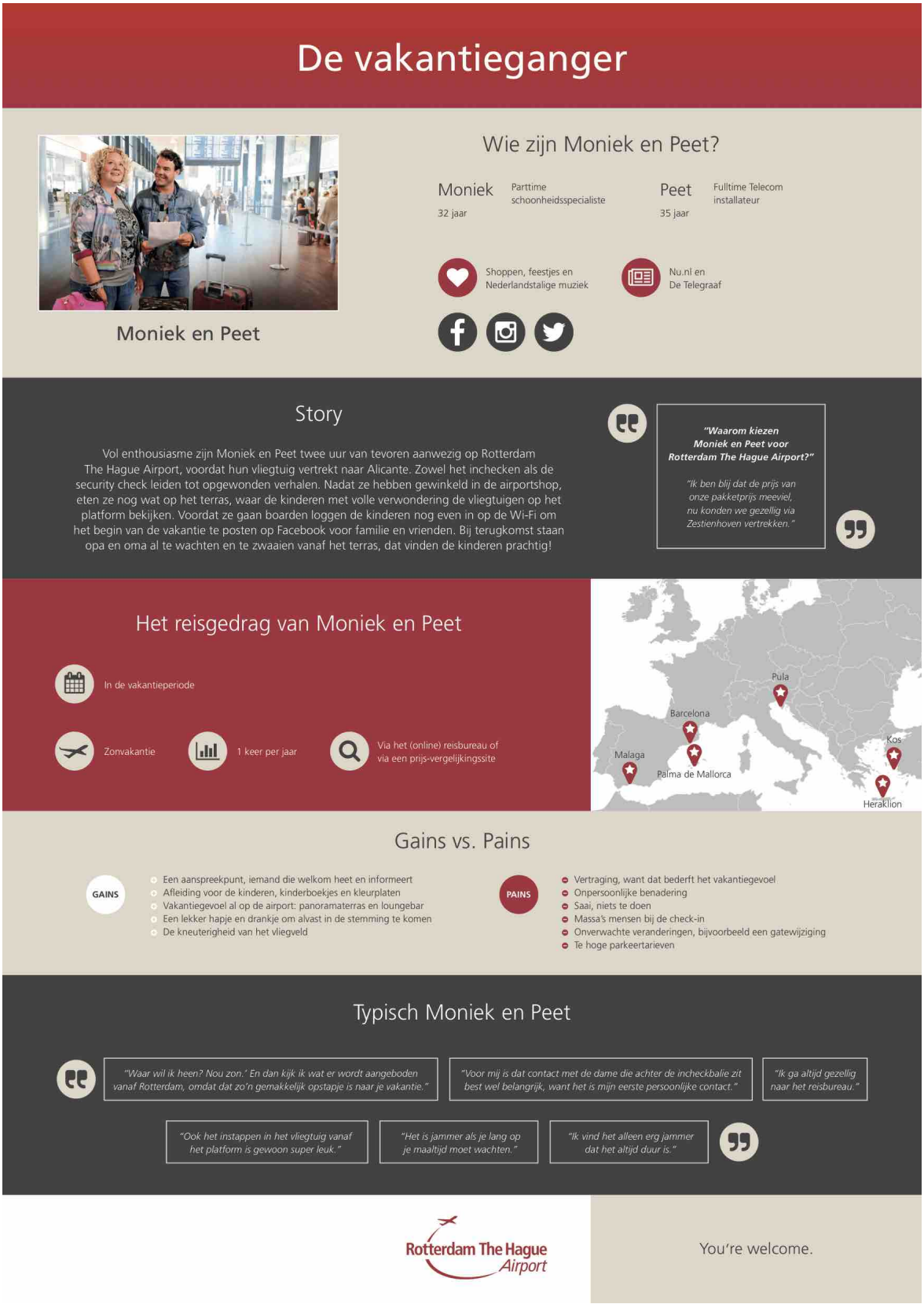

Figure D.49: Passenger profile of the holiday passenger (Wiegerink and Verhoeven (n.d.))

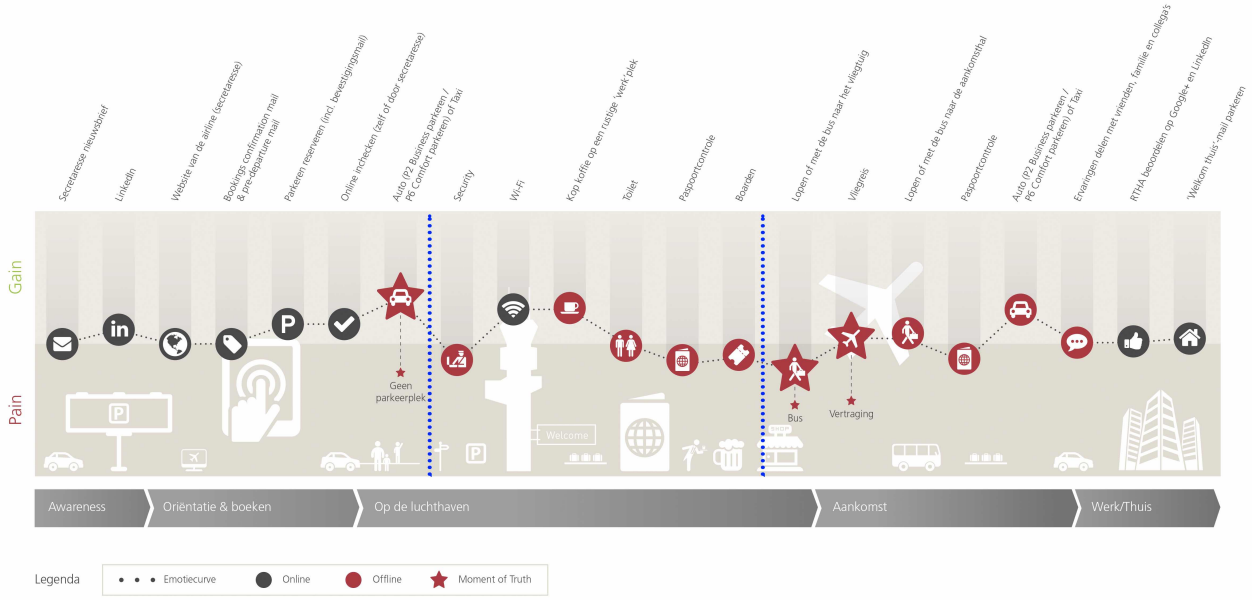

Figure D.50: Passenger journey of the business passenger (Wiegerink and Verhoeven (n.d.))

Figure D.51: Passenger journey of the business passenger (Wiegerink and Verhoeven (n.d.))

D.2. Methodology - Step 2: Specification of requirements

This part of the appendix is dedicated to documents that were used during the analysis. In table D.6 and D.7 on may find the results of a filled in 'Requirement list', originated from section 3.4.2.
In the subsections of external constrains and level of service additional information is presented that may help understand the references of the requirement checklist.
Those Yesses that are indicated with an Yes*, are defined from the authors perspective.

D.2.1. External constrains

In table D.3 the specific articles of the "Calamiteitenplan" are included.

Table D.3: Regulations by Rotterdam The Hague Airport Louwerse et al. (2013)

Chapters of regulation manual	**Articles within scope**	**Articles out of scope**
Definitions	1 - Definitions	
Scope and effect	2 - Applicability regulations 3 - Supervision 4 - Sanctions 5 - order and security requirements	
General rules of conduct	6 - Mandatory notifications 7 - Prohibited at airport 8 - Parts of airport 10 - Environment 11 - Found objects	9
Further regulations Terminal	12 - Prohibited in terminal	
Detailed rules Airside		15 - 30
Fuel and refuelling		31 - 39
Terms with respect to the airport traffic		40 - 43
Final provisions	44 - Liability 45 - Privacy and Confidentiality 46 - Modifications	

D.2.2. Level of service

Table D.4: Level of service - space provided for passengers in different situations (Kazda and Caves (2007))

Activity	**Situation**	**Level of service standard (LOS) [m^2/passenger]**					
		A	B	C	D	E	F
Waiting and circulating	Moving about freely	2.7	2.3	1.9	1.5	1.0	Less
Bag claim area (outside claim devices)	Moving with bags	2.0	1.8	1.6	1.4	1.2	Less
Check-in queues	Queued, with bags	1.8	1.6	1.4	1.2	1.0	Less
Hold room; government inspection area	Queued, without bags	1.4	1.2	1.0	0.8	0.6	Less

Table D.5: Level of Service Standards for Passageways in terms of (passengers/meter of effective width/minute) Neufville and Odoni (2013)

Type of passageway	**Speed of walking**	**Level of service**					
		A	B	C	D	E	F
Corridor	Regular	10	12.5	20	28	37	More
Stairs	Slower	8	10	12.5	20	28	More

To determine the effective width, Neufville and Odoni (2013) gives the following formulas: (4.1 and 4.2).
(The formulas for waiting areas are left out scope)

$$Corridor\ capacity\ per\ hour = (effective\ width) \cdot (level\ of\ service\ standard) \cdot (60) \tag{D.1}$$

$$Effective\ width\ needed,\ meters = \frac{(design\ flow/h)}{(level\ of\ service\ standard) \cdot (60)} = \frac{design\ flow/min}{level\ of\ service\ standard} \tag{D.2}$$

It should be notified, that designers often corridors plan wider than necessary, resulting in unnecessary construction and therefore wasted money, as stated by Neufville and Odoni (2013). However, it should be mentioned that the effective corridor not directly is referred to the distance of the walls, as indicated in figure D.52.

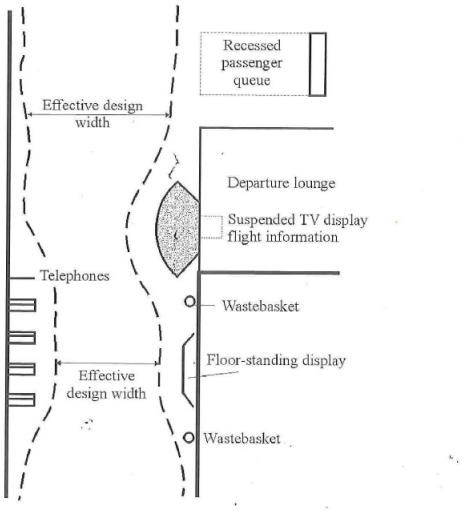

Figure D.52: Public corridor effective width (Kazda and Caves (2007))

Table D.6: Requirement checklist applicable for the case

Type	Covered (YES/NO)	Requirement owner	Requirement content
1. Customer expectations	Yes*	Problem owner (RTHA)	1.1. The hard measures should steer/guide passengers/visitors unconsciously trough the different areas. 1.2 For the soft measures these should help (service providers) to inform and guide users.
2. Project and enterprise constraints	Yes	Securitas	2.1 All persons should proceed trough security - except employees of Marechaussee (Airport regulations)
	Yes	KMAR	2.2 All departing Non-Schengen passengers should pass passport control
	Yes	AviaPartner	2.3 All departing passengers should pass boarding pass control
3. External constraints	Yes	Dutch government	3.1 Bouwbesluit (bv (n.d.))
	Yes	Problem owner (RTHA)	3.2 Calamiteitenplan (see table D.3 for detailed list)
	Yes	KMAR	3.3. Hoofdstuk 2. De uitvoering van de politietaak - § 2.1 (Opstelten and Hillen (2012)) and 'Hoofdstuk 2 Politie - § 1 (Hirsch Ballin and Bijleveld-Schouten (2017)).
4. Interfaces	Yes	Problem owner (RTHA)	4.1 All stakeholders have to comply with the (re)construction work to be performed. However all staircases/services/doors should be accessible at all times.
	Yes	GOM (Cleaning)	4.2 Cleaning equipment storage should be accessible
5. Measure of effectiveness and suitability	Yes	Problem owner (RTHA)	5.1 Net Promotor Score system - No reduction of current score (51 in a scale of 0 to 100) is allowed
6. System boundaries	Yes	Problem owner (RTHA)	6.1 Number of passengers or visitors irrespective of day or hour of departure (part of the demand)
	Yes	Problem owner (RTHA)	6.2 All measures should be adjustable to comply with the mandatory work performed by contractors

Table D.7: Requirement checklist applicable for the case - continued

Type	Covered (YES/NO)	Requirement owner	Requirement content
7. Utilisation environments	Yes	Problem owner (RTHA)	7.1 All measures should perform such that these should not fail despite any Dutch weather condition, irrespective of season
		Problem owner (RTHA)	7.2 All measures should at least be applicable between 05:00 and the last departing passenger aircraft
8. Functional requirements	Yes	AviaPartner (H. Hoevink)	8.1 Use 2 or 3 check-in counters per departing flight
	Yes	AviaPartner (H. Hoevink)	8.2 Use minimal 1 boarding counter per flight
	Yes	Security, Safety and Support (F. Tammes)	8.3 Use 3 security lanes (minimum)
	Yes	S.Janssen (Janssen PhD Candidate - Air transport and operations - Technical UniversityDelft).	8.4 Buffer at security filter should be able to 'store' between 43 and 83 passengers
		Marrechaussee	8.5 1 passport check counter for Non-Schengen flights (minimum)
9. Performance requirements	Yes	Problem owner (RTHA)	9.1 IATA Standard: Level C (details in appendix D.2.2)
10. Physical characteristics	Yes*	Problem owner (RTHA)	10.1 Temporary walls should be decorated such that these indicate improvement of the airport instead of making appologies
11. Human interaction	Yes*	Problem owner (RTHA)	11.1 The experiences of mandatory processes should not be influenced such that the 'pain' in passenger journeys increase even more
12. Design constrains (section 3.4.1)	Yes	Problem owner (RTHA)	12.1 Current lay-out and floor maps, conceptual (re)construction maps

E

Case results: Creation of measures and delivery of measures

This appendix is dedicated to the deliverables of the methodology with respect to the Creation of measures and delivery of measures at Rotterdam The Hague Airport.

E.1. Creation of measures

The following section covers documentation and drawings gained during the case.

E.1.1. Area split

Area split led to 7 different areas:
1. Buffer temporary central security filter (B-TCSF)
2. Temporary central security filter (TCSF)
3. Buffer new central security filter (B-CSF)
4. Passenger route
5. KMAR-Buffer
6. Current Shop
7. Temporarily construction

E.1.2. Hard measures

All areas are captured in table 4.1, each defined with their expected issues, measures to deal with them and corresponding principles of traffic management.

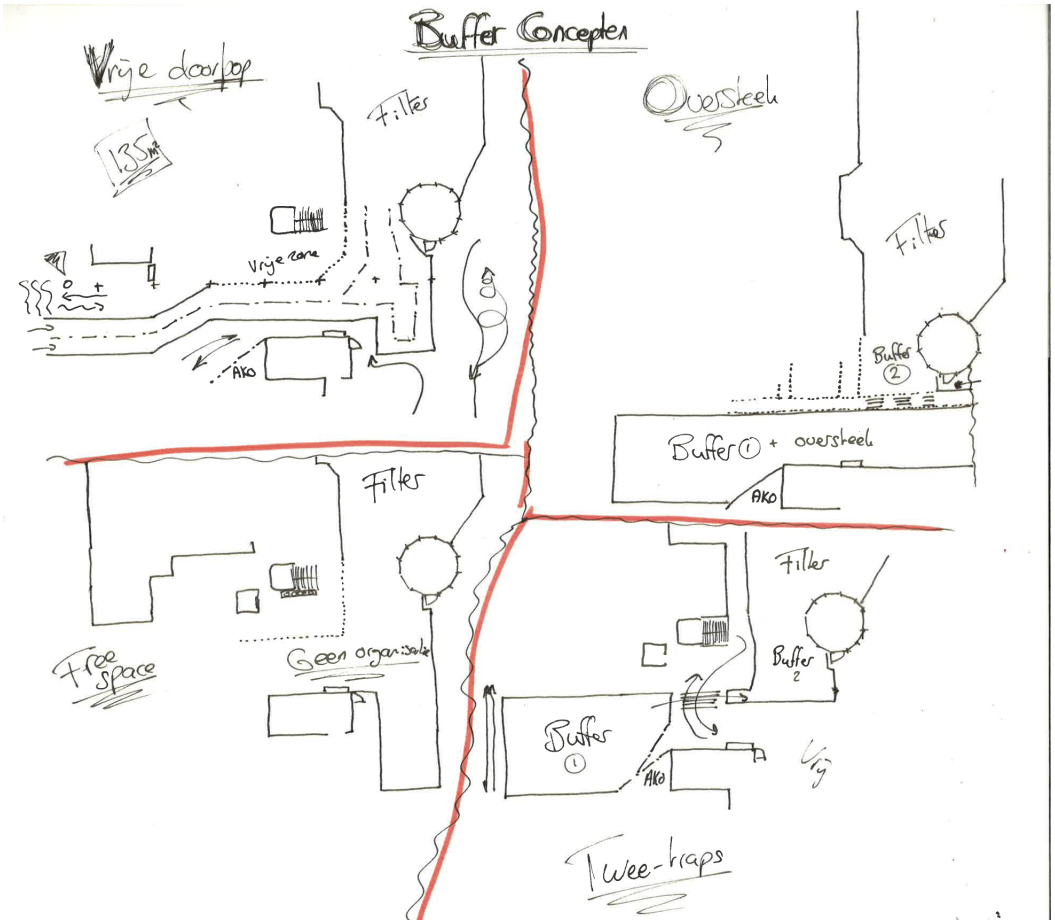

Figure E.1: Concepts of temporary buffer filter

E.1.3. Concepts

As a result of the measures and corresponding principles of traffic management, the following figures (E.1, E.2,E.3,E.4,E.5,E.6,E.7) and E.8 cover the concepts generated for the locations 1 to 7.

E.1.4. Grid

For the application of a grid floor plan, this could be performed by introducing a coordination system. This can be performed using a structured distance between certain fixed points within the area of interest. An schematically example is given in figure E.9 and E.10. As a result, this system could be used by those stakeholders responsible for the airport building operations (e.g.: Security is able to perform a banking line path by placing wickets at O21 and O71 or: Terminal Management are instructed to perform a change of lights within pillars R6, R7 and O6, O7.).

E.1.5. Improvement of temporary buffer concept

As a result of the selection process regarding the concepts, only the temporary buffer was improved to meet the variability as the measure states (table 4.1). In figures E.11, E.12, E.13 the different options are included. These are reflect on a worst case scenario, smallest option and intermediate option. The smallest option and intermediate option can be adjusted by adding/removing 2 lanes of banking line.
The bank lines are identified by lines connected with dots.

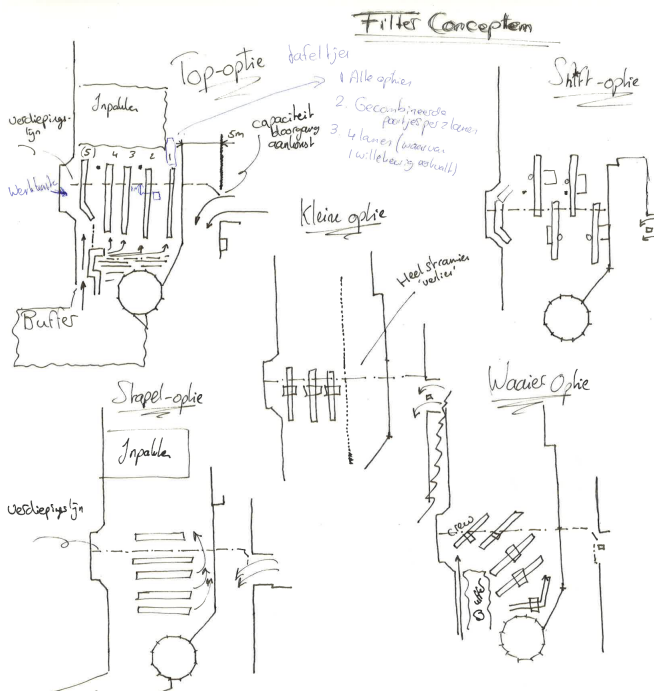

Figure E.2: Concepts of temporary security filter

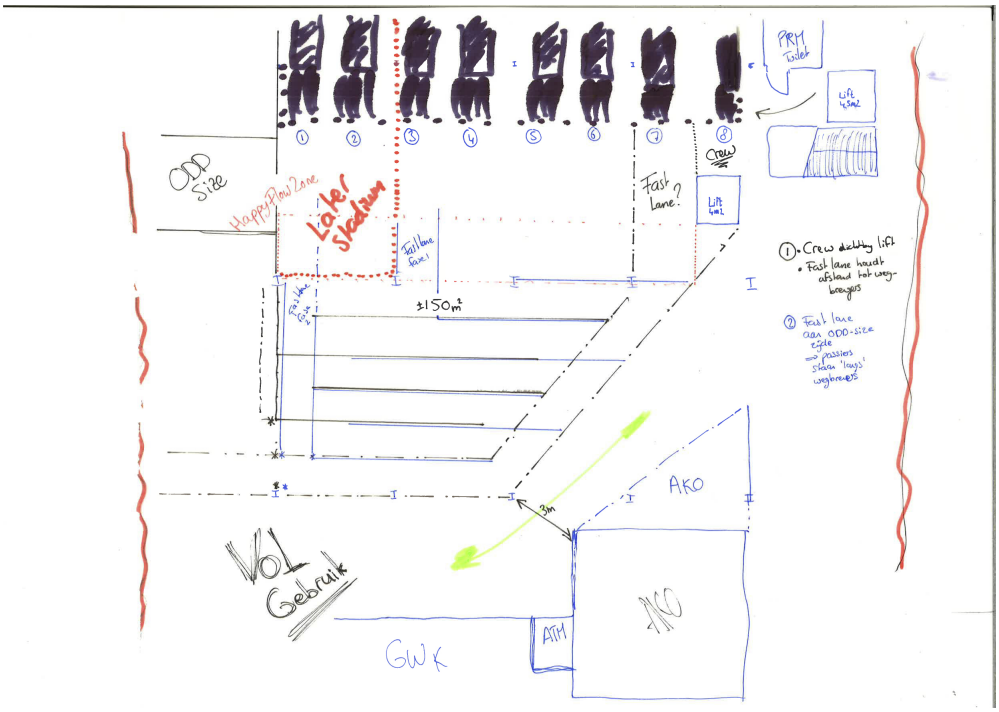

Figure E.3: Conceptual buffer lay out new security filter

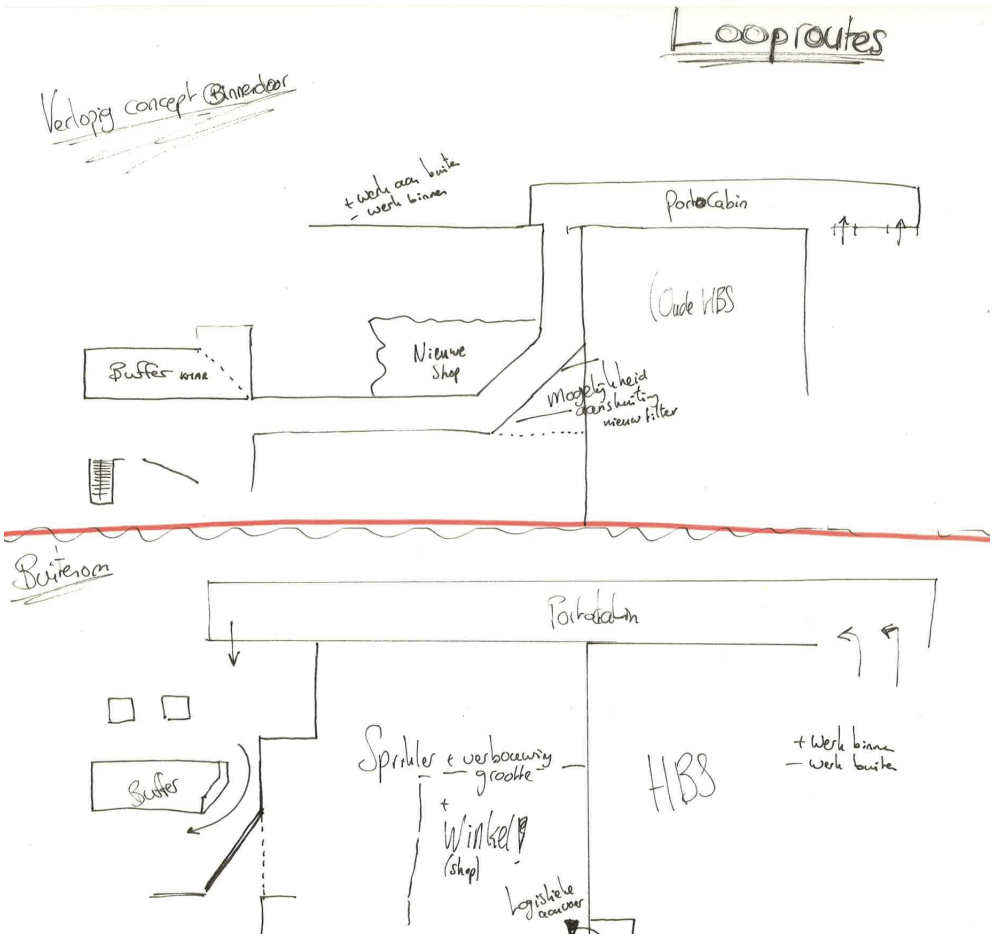

Figure E.4: Concepts of passenger route between temporary filter and KMAR-buffer

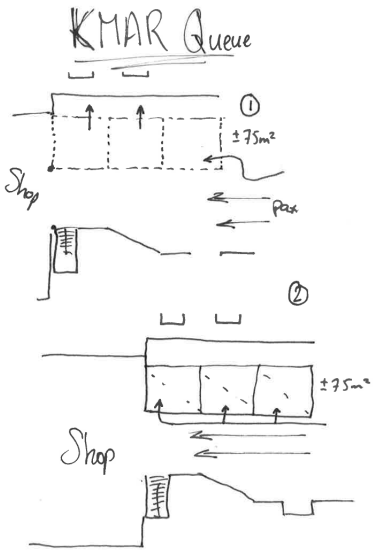

Figure E.5: Concept lay out buffer KMAR

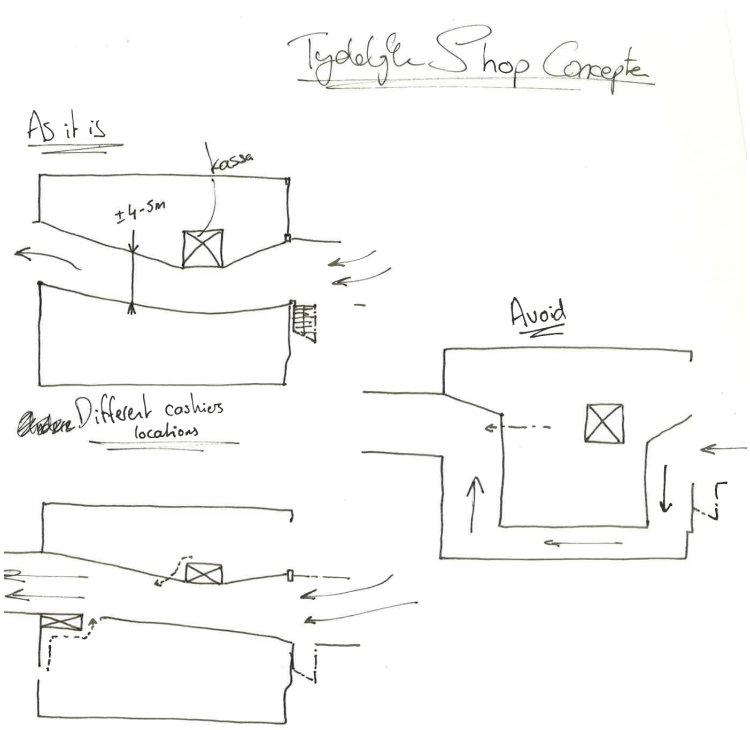

Figure E.6: Concepts of passengers route trough shop

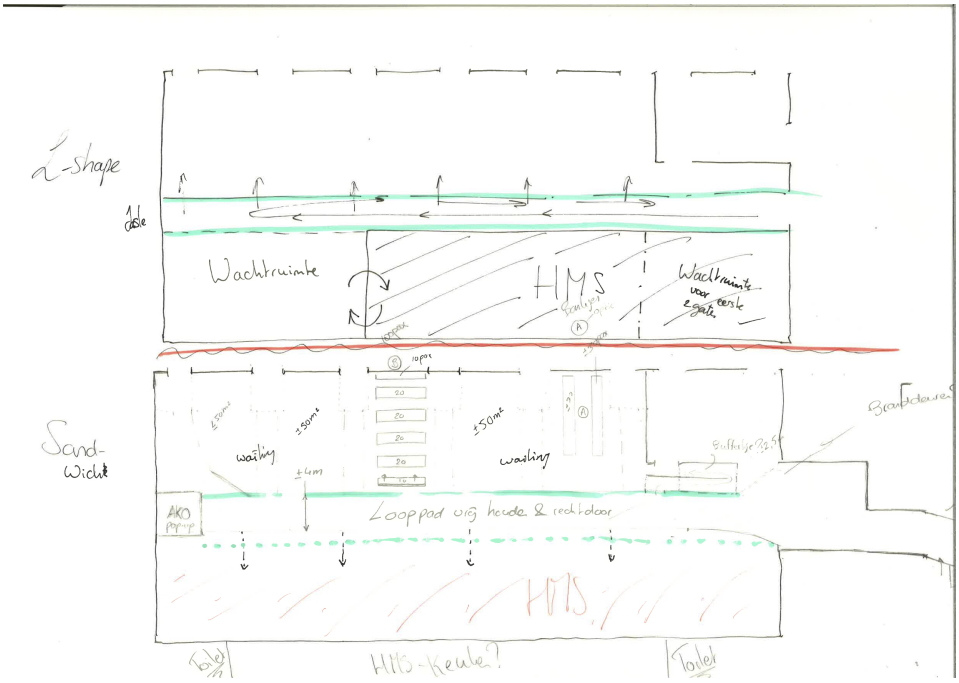

Figure E.7: Conceptual lay out restaurant and food courts - temporary structure

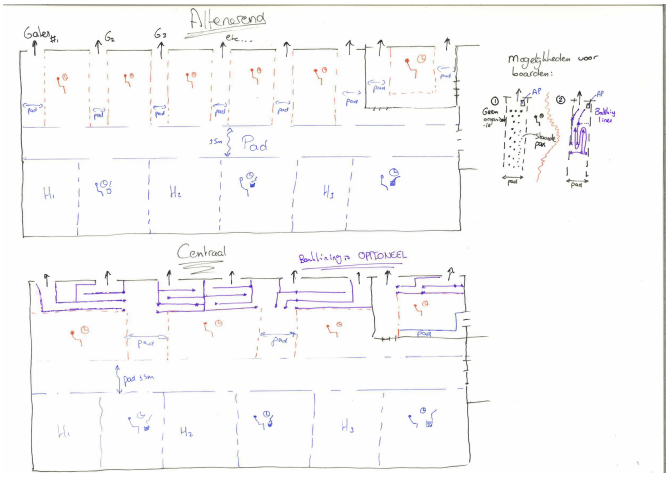

Figure E.8: Conceptual lay out waiting areas - temporary structure

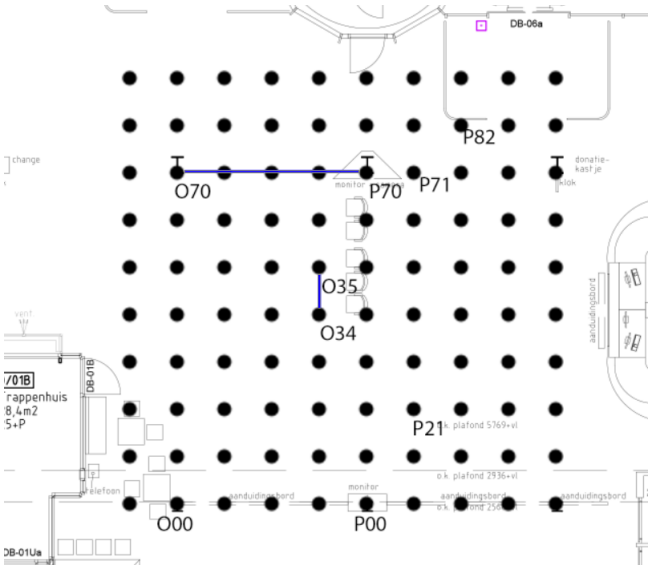

Figure E.9: Grid schematically

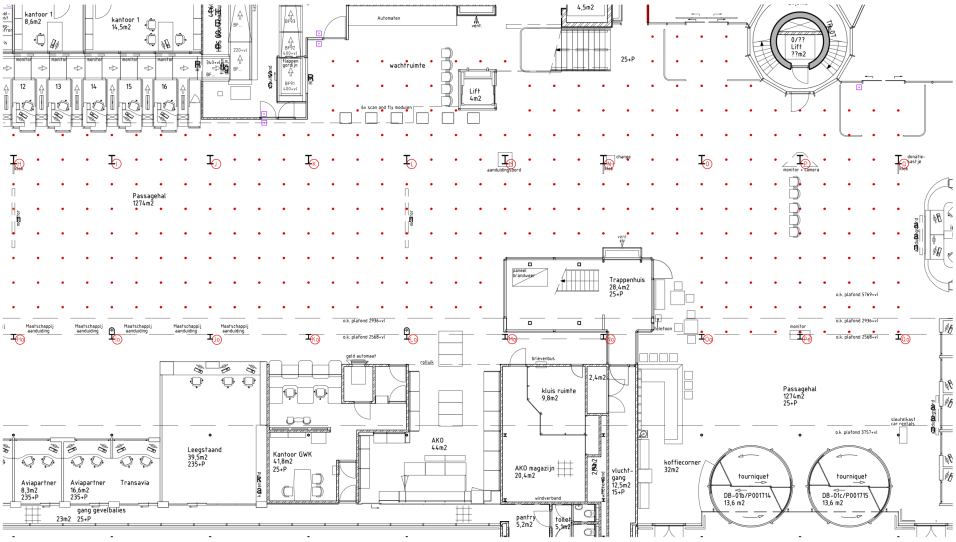

Figure E.10: Grid applied on passagehal at Rotterdam The Hague Airport

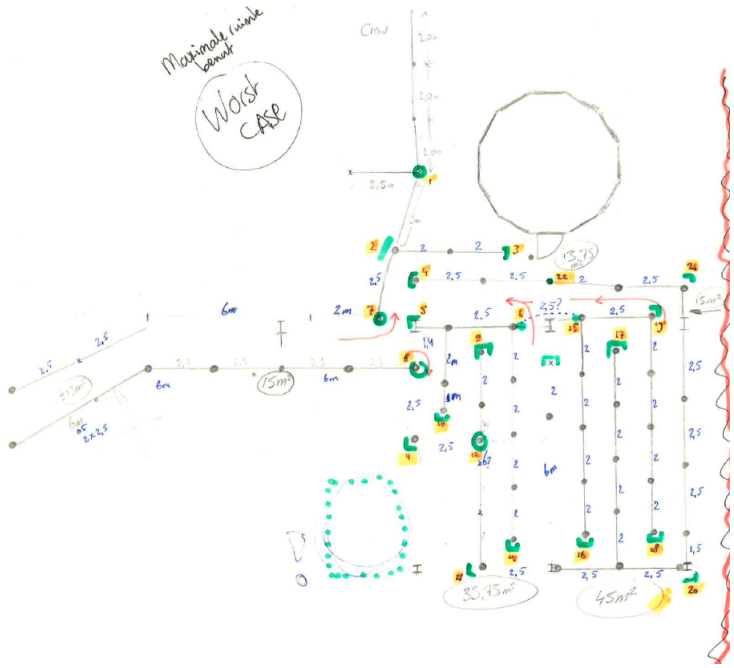

Figure E.11: Worst case scenario buffer option

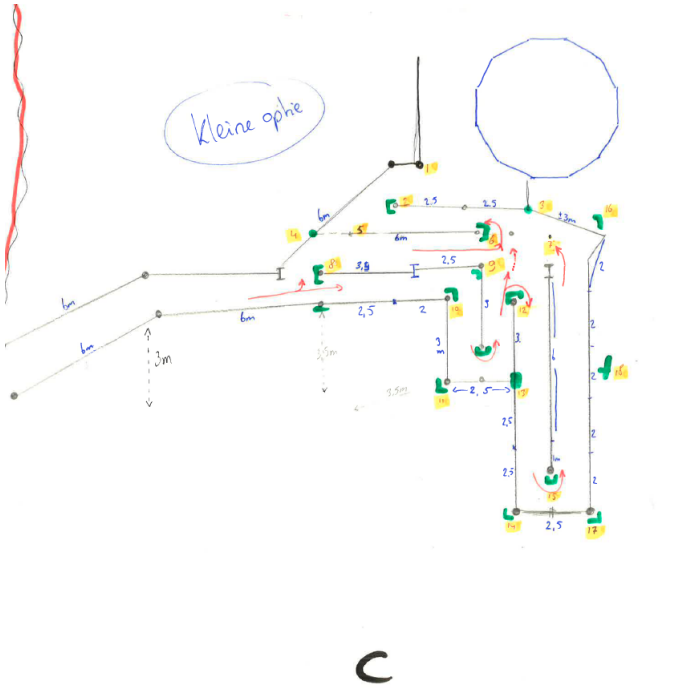

Figure E.12: Minimal buffer option

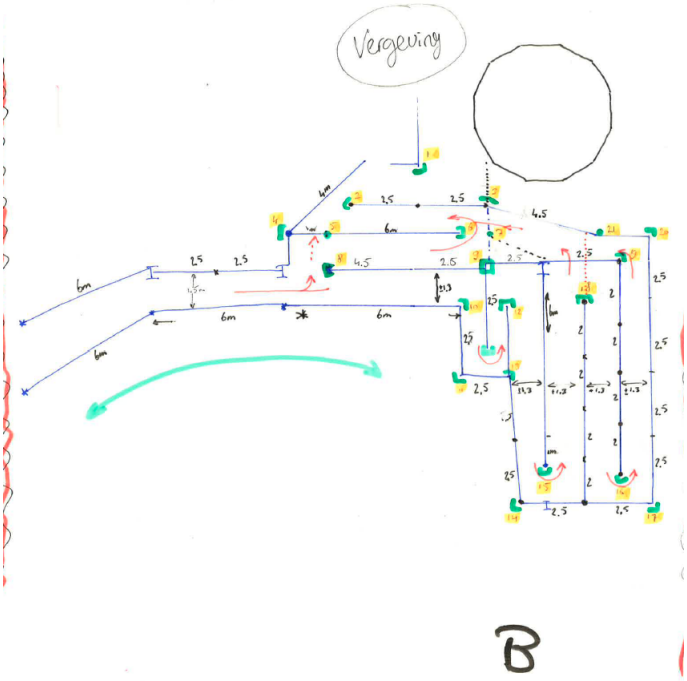

Figure E.13: Intermediate buffer option

E.1.6. Brainstorm session - minutes

Deel 1

Het informeren adviseren van de passagier – waarmee de ontvanger zelf kan/mag bepalen wat zij/hij er mee doet.

1.1. Wát wil de passagier écht weten tot hij/zij aankomt bij de deur van de luchthaven?

- Locatie

  Waar is het entree?

  Parkeren
  - Waar is het?
  - Moet ik dan ver lopen?
  - Kiss&Ride?

  Wat is de bereikbaarheid van het OV?

  Kan ik met de fiets komen?

- Informatie

  Zijn er nog andere punten van informatievoorzieningen aanwezig?

  Gaat mijn vlucht?

  Van waar gaat mijn vlucht?

  Moet ik eerder aanwezig zijn?

  Hoe druk is het bij de security, als men kijkt naar de ‘Schiphol-drukte’?

- Toiletten

  Zijn de toiletten (overal) beschikbaar?

  Kan ik mijn baby ook verschonen?

- PRM

  Waar is de rolstoel?

  Is het begaanbaar met rolstoel?

  Toegankelijkheid toiletten?

- Vrijetijdsbesteding

  Kan ik nog ergens eten? Zo ja, waar?

  Is er een winkel?

  Zijn er stoelen voor de check?

  Zijn er stroomvoorzieningen?

1. 2. Wát wil de passagier écht weten van binnenkomst tot het passeren van de laatste deur richting het vliegtuig?

- PRM (People Reduced Mobility)

  Hoeveel moet ik lopen?

  Kan men ergens zitten?

- Verplichte processen

  Check-in
  - Waar zijn de check-inbalies?

  Security
  - Waar is het securityfilter? - Wat wordt er van míj verwacht?

- Vertrekhal:

  Waar is de vertrekhal?

- Vrijetijdsbesteding

  Is er een (airport)shop (zoals Schiphol)?

  Waar kan ik eten/drinken/koffie krijgen?

  Waar kan ik roken?

  Waar kan ik naar het toilet?

- Baby

  Waar kan ik mijn baby verschonen?

- Toekomstperspectief/beeld

  Wat gebeurt er nu?

  Welk effect heeft het op mijn vertrek?

  Hoe komt het eruit te zien?

Deel 2

2.1. Met welke middelen denken jullie passagiers aan te kunnen sturen/begeleiden – van A naar B?

- Persoonlijk

  Gastvrouw/heer – positieve houding, goed geïnformeerd en gemotiveerd

  Floorwalkers – positieve houding, goed geïnformeerd en gemotiveerd

- Visueel

  Borden (statisch) of Schermen (dynamisch)

  App/site

  Mail

  Booking

  Pijlen (stickers of IKEA-stijl: lichtpijlen)

  Lijnen

  Kleuren

  Licht

  Posters/stickers/flyers

  QR-codes

  Koffiekopjes

- Audio

  Muziek

- Geur

Table E.1: Compliance table compared with concepts

	Requirements																							
Area and measures	**1.1**	**1.2**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.1**	**4.2**	**5.1**	**6.1**	**6.2**	**7.1**	**7.2**	**8.1**	**8.2**	**8.3**	**8.4**	**8.5**	**9.1**	**10.1**	**11.1**	**12.1**
1. Variable buffer	Y	N/A	N/A	N/A	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	N/A	N/A	Y	N/A	Y	N/A	N/A	Y
2. Lane positioning	Y	N/A	Y	N/A	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	Y
3. Variable buffer	Y	N/A	N/A	N/A	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	Y	N/A	N/A	Y	N/A	Y	N/A	N/A	Y
4. Space reservation	Y	N/A	N/A	N/A	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	Y
5. Variable buffer	Y	N/A	N/A	Y	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	N/A	N/A	N/A	Y	Y	N/A	N/A	Y
6. Space reservation	Y	N/A	N/A	N/A	N/A	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	Y
7. Space reservation	Y	N/A	N/A	N/A	Y	Y*	Y*	Y*	Y	Y	N/A	Y	Y	Y	Y	N/A	Y	N/A	N/A	N/A	Y	N/A	N/A	Y

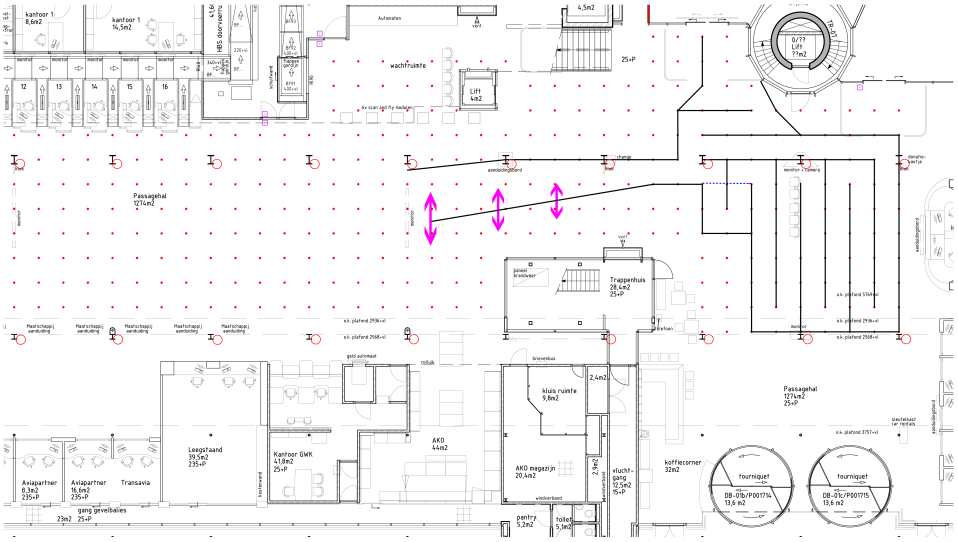

Figure E.14: Worst case scenario buffer option - detailed

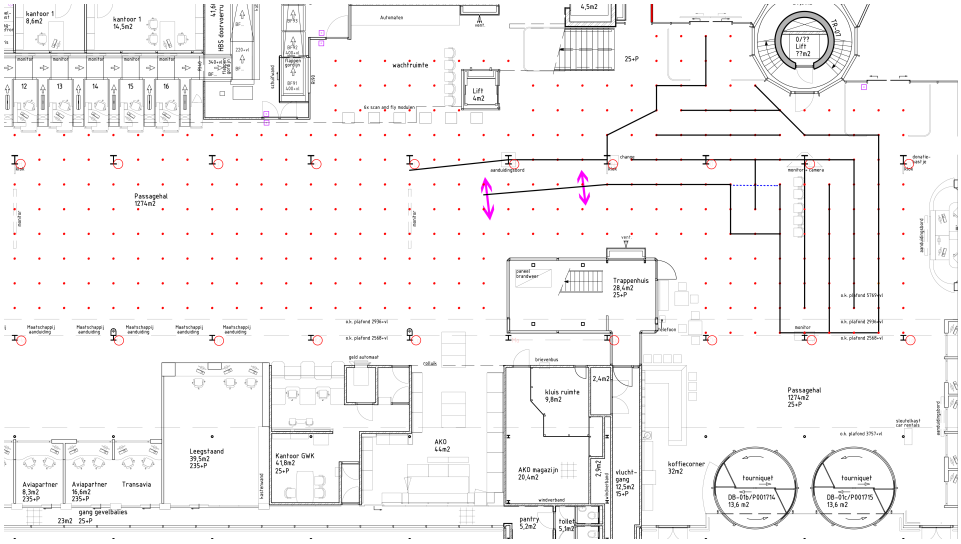

Figure E.15: Intermediate buffer option - detailed

E.1.7. Detailed floor plan temporary buffer options

As a result of the introduced grid system, the Technical Department was able to place the options of figure E.11, E.12, E.13 into detailed floor plans: E.14, E.16, E.15. The pink arrows indicate variable placements of the bank lines.

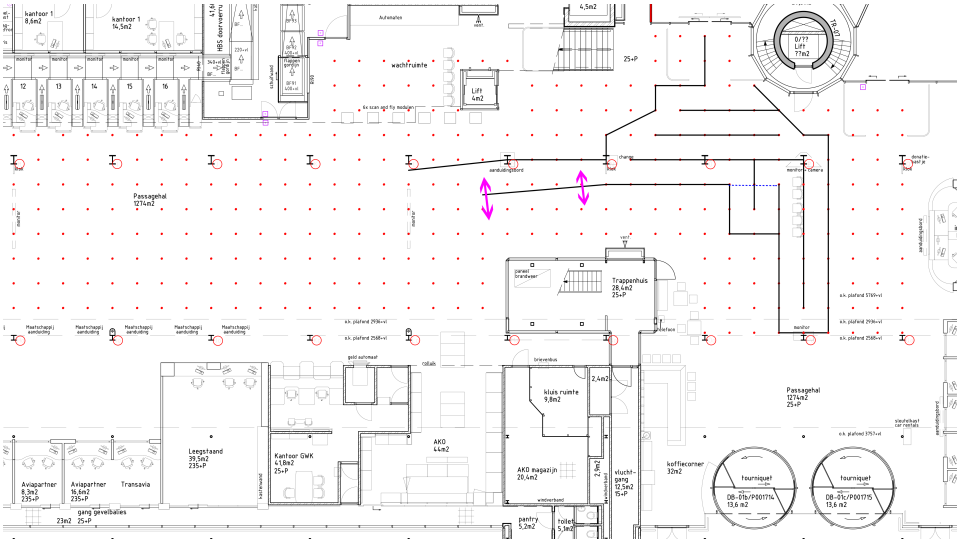

Figure E.16: Minimal buffer option - detailed

E.1.8. Test of temporary buffer options

For the execution of tests, the floor plans of figure E.14, E.16, E.15 were used.
The resources used were not those discussed in section D.1.3, but rather cordon made from plastic. The use of this was to simplify the setting of banking lines and increase the visibility when pictured. The execution of setting out the banking line options was to done by hand in the environment where the buffer will be placed. In this case, no waiting passengers were in this specific area.
Thre results of the test are visualised in figures E.14, E.16 and E.15.

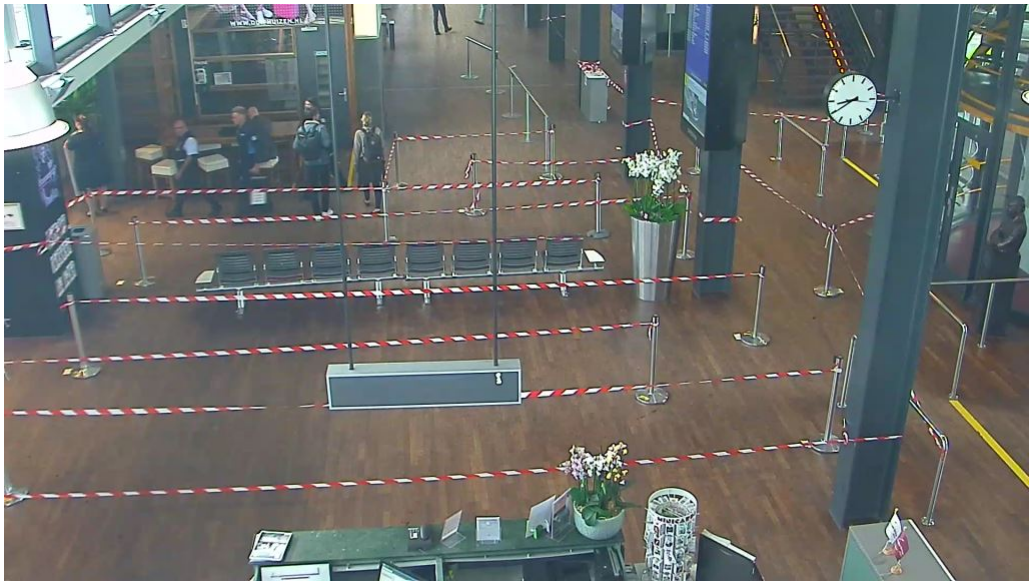

Figure E.17: Tested bank line option of figure E.14

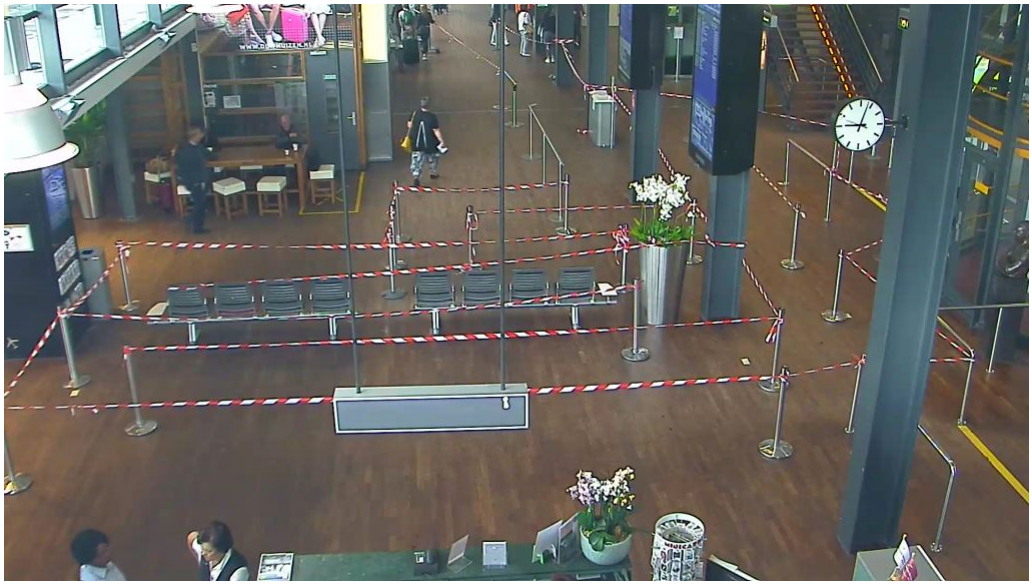

Figure E.18: Tested bank line option of figure E.15

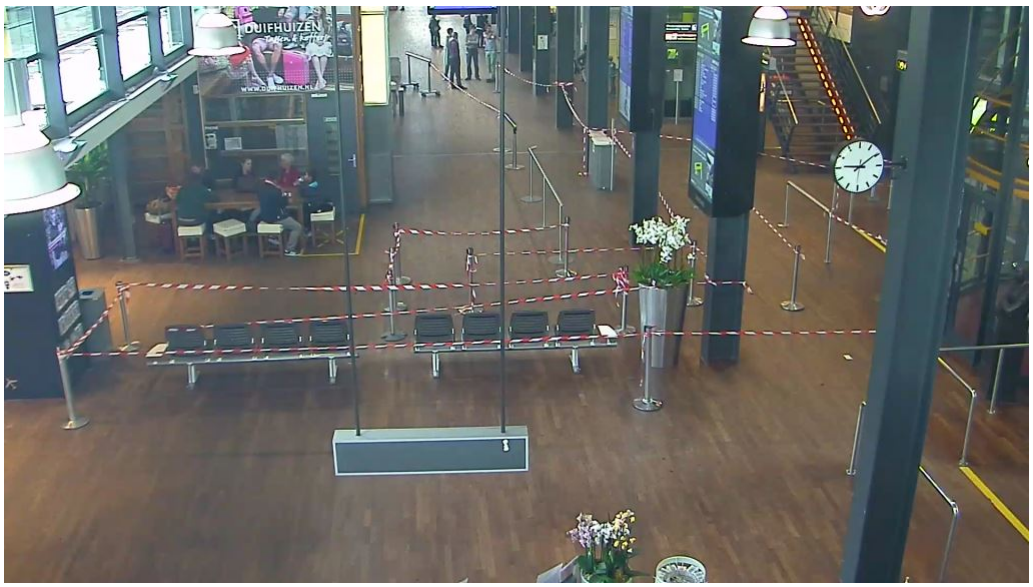

Figure E.19: Tested bank line option of figure E.16

F

Validation interview and results

This part of the appendices covers the interview minutes of measure and methodology validation of the Rotterdam The Hague Airport case. The interview was performed according to a semi-structured interview.
This information is used validate the methodology and is processed from chapter 5.

F.1. Minutes interview

1. Ondanks dat de maatregelen nog niet zijn toegepast: in hoeverre voldoen de omschrijvingen van de maatregelen aan de verwachting? Waarom? (per specifieke locatie, zoals aangegeven in het suggestierapport)
S.v.d. Kleij: *"Naar omstandigheden wel van toepassing. Tijdens het Management Team overleg (12-09-'17) is toen positief gereageerd op de uitkomst. Alleen zijn nu de maatregelen niet meer één-op-één toepasbaar. Dit komt door de aanpassingen in de verbouwingsplanning. Nu kijken we terug hoe je vooral met de problemen om kan gaan."*
R. W. Leutscher : *"Waarom is het ontwerp dan eigenlijk aangepast?"*
S.v.d. Kleij: *"De passagiersaantallen nemen toe. Wat betekent dat de capaciteit dus niet helemaal meer voldoet zoals initieel gedacht."*
R.W. Leutscher: *"Oke, dus de maatregelen van toen voldoen niet meer in capaciteit, maar als wij bijvoorbeeld het tijdelijk buffer kijken. Ik heb deze opgesteld in de aankomsthal om een indicatie te geven hoeveel ruimte dit zal innemen tijdens een worst-case-scenario. Ik veronderstel dat dit ook geholpen heeft?"*
S.v.d. Kleij: *"Zeker. Maar we zullen zeker een soort gelijk buffer toepassen"*

2. Gezien naar de inhoud van de maatregelen: In uw opinie, kijkend naar de maatregelen, welk van de omschreven onderdelen vindt u het meest toepasbaar als we kijken naar aanpassingsvermogen? En welke het minst? Waarom?
S.v.d. Kleij: *"Zoals eerder vermeld zijn de maatregelen van toen minder toepasbaar door de omstandigheden. Zelfs vanochtend (4-12-2017) zijn er nog aanpassingen aan de verbouwing gewijzigd. Het gaat dus niet zo zeer om de details van de maatregelen, maar het idee hierachter."*

3. De oplevering van de maatregelen is gebaseerd op een geteste methodologie op de casus. Hierbij is een gestructureerde aanpak gehanteerd: verzamelen van informatie, opstellen van eisen, genereren van de maatregelen en als laatst het communiceren hiervan. Als u kijkt naar de maatregelen en de tekortkomingen hiervan, waar denkt u dat de methodologie tekort is gekomen? Waarom? S.v.d. Kleij: *"Ik denk niet zozeer dat de algehele opzet van de methodologie tekort komt. Het zijn meer dat*

de maatregelen te snel verouderen. Je zou dus de hele methode moeten herhalen om tot nieuwe maatregelen te komen. Dat is misschien voor veranderingen in verbouwingen een nadeel."
R.W. Leutscher: *"Dus de methodologie komt in algemene zin wel ten goede, alleen moet sneller kunnen worden aangepast?"*
S.v.d. Kleij: *"Ja. Ik denk dat het dus niet zozeer aan opzet, maar meer aan de mogelijkheden om ad-hoc verbouwingsveranderingen toe te kunnen passen en niet álle methodologie stappen opnieuw te hoeven uitvoeren. Het zijn dus de grote(re) wijzigingen die invloed kunnen hebben in de uitkomst en aanpassingsvermogen van de maatregelen. Het zou dus mooi zijn als er dus nog ergens een ingang zou zijn die kan omgaan met wijzigingen van de verbouwingsplanning, en zodoende zonder al te veel stappen de maatregelen kan aanpassen. Timing en 'waar in te stappen in de methodologie' kunnen aanpassingen van de verbouwing worden ingevoerd is dan de meest voor de hand liggende tekortkoming."*

4. Als u kijkt naar de manier hoe de methodologie is opgezet. Welk van de onderdelen vindt ziet u als bruikbaar? Waarom?
S.v.d. Kleij: *"Zoals aangegeven zijn alle stappen van de methodologie toegelicht. Dit betekend dat alle stappen kunnen worden uitgevoerd. Ik zie dus de methodologie als bruikbaar voor dit soort verbouwingen/vraagstukken en kan dus door een nieuw persoon worden uitgevoerd. Een extra opzet voor een kleine herhaling van de stappen van ontwerp wijzigingen zouden een goede zijn."*

5. Als we kijken naar de opzet van de methodologie, welke stappen in de methodologie zou u omschrijven als een voordeel? En welke als een nadeel? - Voordeel terug te vinden in vorige vraag -
S.v.d. Kleij: *"De nadelige stappen, of tekortkomingen zie ik als: hoe ga je om met iteraties? Waneer bepaal je wel of niet een nieuwe iteratie uit te voeren? Indien deze iteraties worden uitgevoerd, kunnen deze dan ook nóg sneller?"*
6. In eerste instantie werd er een verzoek ingediend om maatregelen aan te laten leveren. Gezien het feit dat de maatregelen nu alleen een product zijn een methodologie van Fase 1 van de verbouwingen, en nog 2 andere fases komen: zouden jullie zelf deze methodologie gebruiken? Of zouden jullie het anders aan laten pakken? Waarom? S.v.d. Kleij: *"Je zou de methodologie opnieuw uit kunnen voeren, alleen niet alle stappen zo uitgebreid. Het zijn dus vooral de tekortkomingen van minder extensieve stappen die de methodologie aantrekkelijker zouden kunnen maken. Het is dus een uitdaging om te bepalen; hoe ga je om met verbouwingswijzigingen en wanneer stap je in de methodologie in, als alle stappen al een keer zijn uitgevoerd?"*

R.W. Leutscher: *"Ondanks dat de methodologie niet in eerst instantie tekortkomt, naast de opgeleverde maatregelen, zijn er nog andere aan,- en/of opmerkingen of aanbevelingen?"*
S.v.d. Kleij: *"Ik denk dus inderdaad dus niet zozeer dat de maatregelen van toen een tekortkoming zijn, maar dat vooral nu de manier van redeneren ván de maatregelen van invloed kan hebben. Omtrent de methdologie: 'wanneer start je opnieuw met aanpassingen' en 'waar voer je kleine iteraties uit'?"*

F.2. Preparation interview

Dit interview zal 2 onderwerpen omslaan:
Maatregelen - welke toepasbaar zijn op RTHA, specifiek voor het omschreven project.
Methodologie – welke is gebruikt om tot de maatregelen te komen.
Het doel van het interview is te bepalen of de maatregelen aan de vooraf gestelde verwachtingen voldoen en te bepalen of de methodologie hieraan een bijdrage heeft kunnen dragen.

Voor de voorbereiding heeft u de opzet van de methodologie toegestuurd toe gekregen, deze nemen wij eerst door.

De vragen:
1. Ondanks dat de maatregelen nog niet zijn toegepast: in hoeverre voldoen de omschrijvingen van de maatregelen aan de verwachting? Waarom? (per specifieke locatie, zoals aangegeven in het suggestierapport)

2. Gezien naar de inhoud van de maatregelen:
In uw opinie, kijkend naar de maatregelen, welk van de omschreven onderdelen vindt u het meest toepasbaar als we kijken naar aanpassingsvermogen? En welke het minst? Waarom?

3. De oplevering van de maatregelen is gebaseerd op een geteste methodologie op de casus. Hierbij is een gestructureerde aanpak gehanteerd: verzamelen van informatie, opstellen van eisen, genereren van de maatregelen en als laatst het communiceren hiervan.
Als u kijkt naar de maatregelen en de tekortkomingen hiervan, waar denkt u dat de methodologie tekort is gekomen? Waarom?

4. Als u kijkt naar de manier hoe de methodologie is opgezet. Welk van de onderdelen vindt ziet u als bruikbaar? Waarom?

5. Als we kijken naar de opzet van de methodologie, welke stappen in de methodologie zou u omschrijven als een voordeel? En welke als een nadeel?
6. In eerste instantie werd er een verzoek ingediend om maatregelen aan te laten leveren. Gezien het feit dat de maatregelen nu alleen een product zijn een methodologie van Fase 1 van de verbouwingen, en nog 2 andere fases komen: zouden jullie zelf deze methodologie gebruiken? Of zouden jullie het anders aan laten pakken? Waarom?

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