A Performance Measurement System for Schiphol´s Traffic & Transportation

Measuring Perceived Landside Accessibility of Multimodal Airports

MASTER THESIS

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SYSTEM ENGINEERING, POLICY ANALYSIS AND MANAGEMENT

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MAARTEN JOS JANSSEN

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- MASTER THESIS -

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A PERFORMANCE MEASUREMENT SYSTEM FOR SCHIPHOL´S TRAFFIC & TRANSPORTATION

Measuring Perceived Landside Accessibility of Multimodal Airports

Keywords: accessibility, PMS, airport, transportation, quality perception, multimodal

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Maarten J. Janssen (1150081)
m.j.janssen@student.tudelft.nl / janssen_m2@schiphol.nl
Msc. System Engineering, Policy Analysis and Management, ICT-track

Thesis Committee
Professor Yao-Hua Tan *(Chairman)*
Associate Professor Dr.ir. J. (Jan) van den Berg *(co-Chairman)*
PhD Researcher M. (Mohsen) Davarynejad Msc. *(Daily Supervisor)*
Assistant Professor Dr. S.J. (Sietse) Overbeek Msc. *(First Supervisor)*
Associate Professor Dr. Ir. V. (Vincent) Marchau *(Second Supervisor)*
Sr. Advisor Policy & Development Schiphol Drs. B.C.C.A. (Bibian) van Dorst MTL (*External Expert)*

Delft University of Technology
Faculty of Technology, Policy and Management
Section Information and Communication Technology

Amsterdam Airport Schiphol
Passenger Services
Traffic & Transportation

I. Executive Summary

Introduction

Daily approximately 150.000 individual travel movements are conducted by passengers and Schiphol-workers to and from Schiphol. For this they use cars, taxis, busses, shuttles, trains, motorcycles, scooters and bicycles. As such Schiphol is Holland's biggest mobility node. Understandably this makes accessibility of vital importance.

Within Schiphol the Traffic & Transportation (T&T) department has the responsibility for the accessibility of Schiphol. Separated in several modalities (public transport/taxi/private transport/roads) the goal is to improve the accessibility for Schiphol's customers (passengers/personnel/business partners/cargo).

T&T has the ambition to become "Europe´s most accessible multimodal hub". To achieve this the performance on the quality of accessibility will have to increase while facing an increased passenger volume and tougher constraints. Therefore increased insight in the performance of the accessibility operation is required. In short: the relevant performance delivered by T&T on airport accessibility has to be measured.

Design tracks

The objectives of this thesis is to (1) Design a method that can measure T&T´s performance and (2) Create a system that uses the designed method to report on the performance. To achieve these two objectives, two design tracks are undertaken

Design Track I

The first step is defining what is considered relevant performance for T&T. Through research and interviews, relevant performance is regarded as the quality of accessibility delivered to the client. This can be measured by *the amount in which the demands of a client group on the quality of accessibility are met by the characteristics of a modality*.

To be able to measure the regarded performance, the offered accessibility is analysed. It is found that T&T can influence the quality characteristics of each modality based on the relation with the stakeholder that operates the modality. There are three levels of influence: Control, Guide and Influence.

To get more insight in the accessibility demand of the different client groups (Passengers and Schiphol workers) an experiment is conducted. This experiment indicates a different demand profile on accessibility between the client groups, especially towards price and information.

A combination of literature on measuring accessibility and internal Schiphol documents is used to declare factors and criteria that determine the quality perception of the client on accessibility. Six factors (cost, time, reliability, quality, convenience and information) and 34 underlying quality criteria are declared. To measure these criteria there is a need for data points and sources that report on these criteria. A table of needed data points, sources and expected unities is created.

As it is found that the unities of the data points differ greatly and it is unknown what levels of performance are considered adequate, a measuring method is proposed that states the increase or decline of performance on the criteria. This is done through indices that are calculated by comparing performance on two different moments in time.

The declaration of 7 formulates enables the design of a measurement method that puts weights on the calculated indices. These weights are based on the found demand profiles. The criteria that are considered most important in the accessibility perception of a certain client group, are given a higher weight, resulting in a bigger influence on the overall index on airport accessibility. Combining all criteria, factors and weights on the different modalities and client groups with the seven formulas, gives the possibility to create an overall index on the delivered quality of accessibility of an airport.

Design Track II

As less than 40% of the needed data sources is available, it is not possible to implement the developed method in a Performance Measurement System (PMS). Therefore an alternative system is created. Based on an analysis of available data sources, supportive systems and existing KPI, a PMS System is developed. This system is based on Excel and can present indicators on a monthly basis. The PMS shows a comparison with the preceding month and the same month one year ago.

To enhance the insightfulness, coloured arrows are used to show high, medium of no decrease/increase between the periods. Also a graph is presented in the same fashion graphs are currently presented, for each indicator. Indicators are coupled for each modality. This gives modality managers the possibility to quickly look for the most relevant indicators.

As the developed PMS is not able to indicate the client perception of the current quality od accessibility, a second system is created. This system uses public messages on online social media (mostly twitter) to measure the sentiment on the accessibility quality offered on train, bus and taxis servicing Schiphol. The system is able to present the amount of positive, neutral and negative messages on a modality. This enables managers to react on incidents and to see the change in perception over a longer period of time.

Conclusion

A first draft design of a method to measure the quality of airport accessibility is created. Implementation is not possible to a shortage on data sources. It therefore proposed to start developing the needed data points. If more than 60% of the needed data is available, the designed measurement method can be implemented. It is advised to use the available Qlikview Business Intelligent system for an improved PMS.

Furthermore both design steps are first ventures into creating a system to measure performance at T&T. Due to limitations in time and resources, several assumptions had to be done. To increase the validity of the indicators presented by the measurement method, several recommendations on improvement are done.

II. PREFACE

General

This thesis is the result of research conducted at the Traffic and Transportation department at Amsterdam Airport Schiphol from July 2010 until February 2011. It also forms the graduation thesis (SPM5910) for the Master track: System Engineering, Policy Analysis and Management at the Technology, Policy and Management faculty, part of the Technical University Delft.

SIM

This research is conducted within the innovative mainport alliance 'Samenwerking Innovatieve Mainport' (SIM) (Figure 1-1). It is an alliance between aviation related parties, including Schiphol Group (SG), Delft University of Technology (TU Delft), Koninklijke Luchtvaart Maatschappij (KLM), National Aerospace Laboratory (NLR) and a Dutch knowledge institution for applied research (TNO).

SIM provides a platform for above mentioned parties to be involved in innovative aviation related projects, mostly executed by students as part of their Master's thesis. SIM aims to position Amsterdam Airport Schiphol as an innovative European mainport.

FIGURE 1-1: PARTNERS IN SIM

Acknowledgements

This thesis would have not been possible without the support and cooperation of many people. I am highly appreciative of the Traffic & Transportation department at Schiphol for offering me a professional, inspiring and warm environment during this thesis project. Furthermore I would like to thank the ICT section of TBM for their support throughout my study. It is an exceptional group of (associate) professors, researchers and PhD students.

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Maarten J. Janssen
Amsterdam, March 18th 2011

III. GLOSSARY

AAS	Amsterdam Airport Schiphol	Company that exploits Schiphol Airport
KPI	Key Performance Indicator	Figure that presents key performance on an objective
LOS	Level Of Service	The amount of delivered service quality
MRI	Market Research & Intelligence	Division of AAS that conducts market research
OD	Origin / Destination passengers	Passengers who either start (O) or end (D) their air travel at the airport
PMS	Performance Measurement System	System able to use organisational data to measure performance and present insightful indicators
PS	Passenger Services	Department under AAS responsible for services to passengers
SPL	Schiphol	Physical location (town)
	Schiphol Airport	Airport location at Schiphol
SG	Schiphol Group	Parent to AAS,
	Schiphol Workers	Workers from multiple companies working at the physical Schiphol area
T	Transfer passengers	Passengers who use the airport to transfer from one flight to another (often intercontinental to continental and v.v.)
T&T	Traffic & Transportation	Division of AAS responsible for the accessibility of the airport

The term Schiphol in its purest definition is the physical town. However in general use – as in this thesis – it refers to Schiphol Airport.

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- INTRODUCTION -

1 INTRODUCTION

This chapter provides an introduction to the subject (accessibility) and principal (Traffic & Transportation) of this thesis. The environment of the problem is also presented.

Amsterdam Airport Schiphol (AAS) provides direct connections to 284 worldwide airports in 93 countries (Schiphol Group NV, 2010b). AAS daily welcomes, on average, 40.000 passengers and over 50.000 employees from 544 companies that work at the Schiphol ground (Schiphol Group NV - T&T, 2009). As the national airport and located in the heart of the Netherlands, AAS is vital to Dutch travel and logistics. With an increasing amount of transfer passengers (transfer between flights) and the number 5 position the Europe´s biggest airports, AAS has a strong position in the worldwide network of major airports. Due to the jobs it provides and its logistic importance, AAS is vital to the Dutch economy.

Europe´s preferred airport

The air transportation market is expected to be growing significantly over the coming years (Schiphol Group NV - ACP, 2009). The upcoming low cost carriers combined with increasing globalisation result in more people flying more often. Schiphol has the goal to not only facilitate this increase in passengers but also increase its overall market share over the coming 10 years.

To achieve this, a program has been started to become "Europe´s Preferred Airport". The focus is on *"delivering premium quality to all customers in all processes"* (Schiphol Group NV, 2010c). This means an increased focus on the customer and assuring value to the customer in each process.

Part of this program and supporting the quest for increased quality and customer focus is a more "lean and mean" approach to improve on the effectiveness and efficiency of the airport operations. From a cost driven management system, AAS is moving towards a market and client driven approach (Schiphol Group NV, 2010a).

Landside Accessibility

Each airport is divided in an airside and landside activities. Landside is the publicly accessible area before security as shown in Figure 1-1 .

FIGURE 1-1: LANDSIDE VS. AIRSIDE

With landside accessibility is meant the approach (of the Schiphol grounds) by ground transportation. With almost 100.000 people going to and from Schiphol every day, an enormous combined logistic operation is needed to transport all these people to and from the Schiphol grounds. By a mixture of modalities consisting of trains, buses, cars and motors, taxis, shuttles, scooters and bikes, Schiphol is made accessible for the masses.

"It is recognized that airport accessibility is a major determinant of airport choice, because the availability and use of different access modes affects the perceived accessibility of different airports." (Airport Cooperative Research Program, 2008)

Multiple studies on the factors that determine the valuation of an airport have shown that the landside accessibility of an airport is a considerable factor on the total airport valuation (Airport Cooperative Research Program, 2008, Gosling, 2006, Humphreys and Ison, 2005). If an airport is considered badly accessible, this will have a direct and significant impact on the total appreciation of the airport by both passengers and employees. Landside accessibility is therefore of great importance to an airport both on acro level (connecting roads, train connections, bus lines, etc) as on a micro level (distance to terminal, curb side traffic flow, etc).

"With almost 100.000 people going to and from Schiphol every day, an enormous combined logistic operation is needed to transport all these people to and from the Schiphol grounds."

"At AAS the Traffic & Transportation (T&T) department is responsible for Schiphol´s landside accessibility"

Traffic & Transportation

At AAS the Traffic & Transportation (T&T) department is responsible for Schiphol´s landside accessibility. Their goal is to optimise the accessibility of the airport for all clients. T&T specifies three client groups in their focus on landside accessibility: Passengers, Schiphol Workers (Employees at the location Schiphol from varying companies) and Cargo. Each group has a different demand towards accessibility and a different travel pattern.

The department itself is grouped in an operational branch (responsible for the traffic flow on the Schiphol grounds), modality managers (bus, train, taxi, cars) and a tactical branch (accessibility projects). The company wide vision of becoming Europe´s preferred airport is translated within T&T to: *"Becoming Europe´s most accessible multimodal transportation hub."*

Chapter 2 and 3 will elaborate on the problem situation and the objective of this thesis. Paragraph 0 presents a fully detailed design plan that describes all phases, steps and chapters of this document.

2 PROBLEM & OBJECTIVES

The preceding chapter has provided an introduction to T&T, its surrounding and its main goal of "Becoming Europe´s most accessible multimodal transportation hub". This Chapter will present the problem in realising this goal: a measurement problem. The objective of this thesis are also set and used as a point on the horizon. The objectives lead the formulation of a Research and Design Process. Figure 2-1 shows the focus of this chapter in relation to the Research and Design process.

FIGURE 2-1: FOCUS OF CHAPTER 2, PROBLEM AND OBJECTIVE

2.1 PROBLEM

T&T is focussed on improving their operations and is ambitious in creating projects that are in line with the goal of becoming Europe´s preferred airport. Critical in deciding on what projects to select and what operations to improve, is knowing what the current performance of the accessibility operations is. After all how could otherwise be known where performance could or should be improved? Or as stated by Lohman, et al.: *The ability to measure performance of operations can be seen as an important prerequisite for improvement" (Lohman et al., 2004)*

On several parts of the T&T accessibility operation there is performance data available that is (sometimes) used by a modality manager and a few performance indicators are developed. However the relevance to the department's goals is not specified. The data is not put into context with other data or compared to the higher strategic goals of the department. Also the data and insights are not (automatically) shared among others roles and functions in the department. Furthermore most data depends on interviews and questionnaires that are undertaken on set intervals: the outcomes are post-performance (resulting) and low frequent. As a result the T&T department currently has a limited capability to measure and report on its overall performance.

Current indicators within T&T are:

- Not related to the department´s goals
- Not compared or combined with other (department) data
- Not shared with among functions
- Low frequently updated and oriented on post-performance (lagging indicators)

Measure Performance

And there lies the problem within T&T. There currently is no specified combined method or system to measure the resulting performance of the T&T operation. Or, as formulated by a manager: *"We just don't know how well we are doing our job". (Interview drs. B.C.C.A. van Dorst MTL, 2010).*

"There currently is no specified combined method or system to measure the resulting performance of the T&T operation"

Motivated by the expected increase in client volumes combined with a focus on quality to the clients, T&T is looking for a system to measure the performance of its department with regard to its goal of providing high quality accessibility to its clients.

2.1.1 Problem Formulation

T&T currently has insufficient insight in the performance of its operations to steer timely and accurately on incidents, notice trends and measure the effectiveness of the operation on strategic goals. T&T would there like to have a method and system that is able to measure and report on its performance of offering high quality landside airport accessibility to its clients..

It is currently unknown how such a system should be conceived from both a technical as organisational standpoint. As such the initial main problem formulation is:

"T&T wants to measure and report the resulting performance of its airport accessibility operation, but doesn't know how this can be achieved"

2.2 Objectives

In order to create a plan, this paragraph describes T&T´s desired situation. This can act as a beacon in the steps to creating a solution to the problem stated above. Consultation with T&T management has provided the two main objectives.

"Formulated in its most simple form, the resulting objective of this this thesis is to give T&T insight in its relevant performance"

Formulated in its most simple form, the resulting objective of this this thesis is *to give T&T insight in its relevant performance.*

Looking carefully at the stated problem, we can distinguish two main aspects that currently stop T&T from meeting this objective :

"T&T wants to *measure(1)* and *report(2)* the resulting performance of its operation, but doesn't know how this can be achieved"

This thesis has therefor *two* main objective that are both essential to create a solution to the T&T problem:

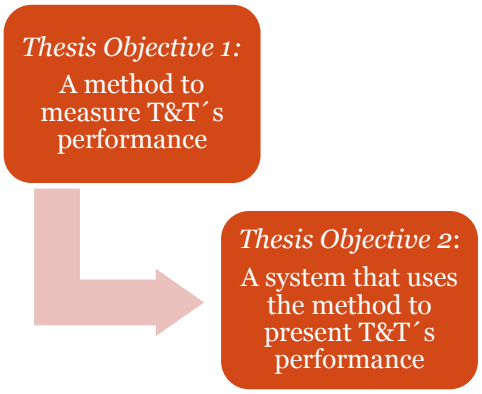

Figure 2-2: Two main Thesis objectives

Objective 1:	To design a method to measure the performance of T&T
Objective 2:	To create a system that is able to use the method and present the measured performance.

As can also be seen from Figure 2-2 , objective 1 is conditional to objective 2. Meaning that before a system can be created, first a method has to be designed.

"The T&T management has explicitly stated that this Thesis should result in (...) not only a design on paper, but an actual created and implemented system"

The T&T management has explicitly stated that this Thesis should result in an operational system that is used in the organisation to get insight in the performance. In short: not only a design on paper, but an actual realised and implemented system. An objectives is therefor that - given the limitations due to time, budget, ICT and lead time on changes – the resulting system is achievable. In the approach on developing such a system it is therefore critical to find a balance between the theoretical optimal and practical feasible.

This Thesis has the highest focus on Objective 1, as this is the more theoretical and academic challenge. Objective 2 is more practical, as it involves the realisation of a system. The steps taken on Objective 2 are also reported, but limited to the major findings and results.

3 Design Track

The described problem and the thesis objective set the baseline for the design challenge. To get from the current situation (IST) to the desired situation (SOLL) there are several unknowns. These unknowns have to be resolved by a design track in order to come to a solution (Figure 3-1).

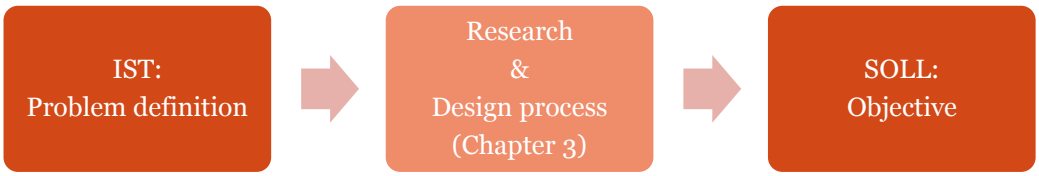

Figure 3-1: The Design track in relation to the Problem and Objectives

This chapter outlines the developed design track. Paragraph 3.1 discusses the design approach. Paragraphs 3.2 mentions the relevant design questions. The design steps, as outlined by paragraph 3.3, guide this thesis to resolving the design questions. Paragraph 3.4 presents the limitations to the design project.

3.1 Design Approach

The paragraph describes how the problem and the objectives are seen and what the approach towards achieving this objectives is. By framing this project in a design approach, the basic considerations of the author are expressed.

The T&T department wants to start measuring their performance. An initial thought could be that by centralising the already available measuring (data) points within the operation will provide the needed insight. In fact doing this would already greatly improve the insight and could proof to be valuable.

However there is a big risk that the collected and centralised data are in fact not really informative as the relation of this data to the departments' goals is not explicit (as stated in paragraph 1.2). Therefore the research has to take a step back and design a method and a system for the measuring and presentation of performance from the ground up.

There are two main objectives: (1) a method to measure performance and (2) the creation of a system able to employ the method. Objective 1 requires research but is a design process. Objective 2 requires a design but is a make process to create an actual system. Therefore the thesis is considered *a design track with research elements*.

Design process

A design project can be defined as: *"The process of devising a system, component, or process to meet desired needs."* (ABET, 1988) or *"a purposeful intellectual activity that produces a representation of an artifact that provides sufficient guidance for the realisation of this artifact"* (Bots, 2005).

We can make a separation in the design process as a whole by delineating the five sequenced steps: *design problem, design activities, design, realization activities and artifact*. When we combine these steps and actors with the two design objectives, it is possible to show how the two objectives are related to the design steps (Figure 3-2).

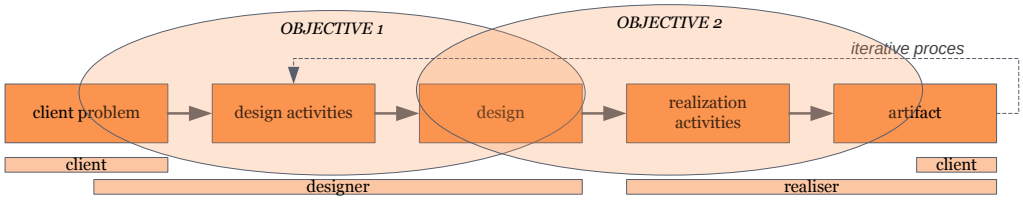

Figure 3-2: Objectives in Designtrack

As can also be seen from Figure 3-2, there are three different main roles in the design process *(Bots, 2005)*:

- The *Client*, in this project T&T, is the actor that considers the present state as unsatisfactory.
- The *Designer*, in this project the author this thesis, translates the client problem into a design problem formulation. He then uses what knowledge he has at his disposal to make a design: a representation of an artefact.
- The *Realizer*, in this project partly the author, who executes the design by making the artefact it represents real. This is done by taking actions prompted by the design.

As stated before, this thesis will mainly report on the steps taken on reaching Objective 1. Objective 2 has many practical elements that are not suitable for this thesis. Only its analytical steps and results are covered.

Performance Measurement System

"The Performance Measurement System should be able to transform operational & research data on the accessibility processes of Schiphol into valuable, insightful and informative performance indicators"

But what is the artefact to design and create? We want to create a system that is able to measure and report performance. Such a system is considered a Performance Measurement System (PMS) (Wolk et al., 2009). This Performance Measurement System should be able to transform operational & research data on the accessibility processes of Schiphol into valuable, insightful and informative performance indicators.

The two objectives can be seen as concurring in the aim for creating a PMS. Objective 1 renders a method on how performance on airport landsided accessibility can be measured. Objective 2 uses this method to actually create a PMS that transforms data into performance indicators.

Figure 3-3 presents how the objectives should be seen in relation to a eachother and a functional PMS.

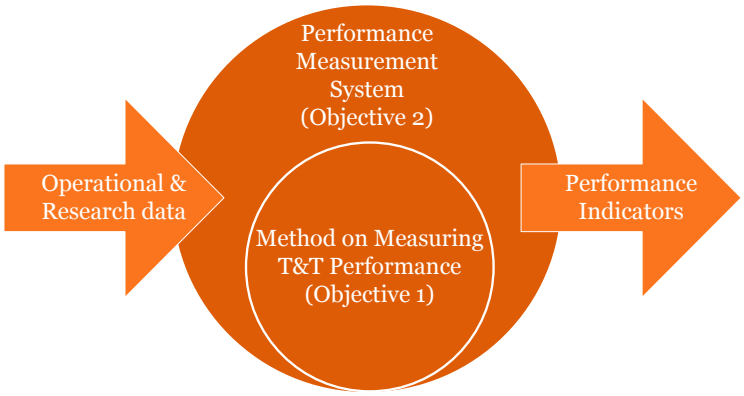

FIGURE 3-3: SIMPLIFIED T&T PMS

3.2 Design Questions

Due to limited available knowledge on performance measurement within the T&T department, it is currently not able to create the desired situation. This lack of knowledge- and ability has to be filled in thorough several research and design steps.

Guiding these steps are four main design questions. They state the four major knowledge gaps that prevent T&T from attaining the desired situation. The design plan (described in paragraph 3.3) will be aimed at answering these design question through several design steps and, as such, reach the desired situation.

Question 1: *What is Performance Measurement and how is a performance measurement method designed?*

> To be able to do performance measurements and develop a Performance Measurement System, knowledge is needed on how such a system functions and what steps have to be taken to create such a system.

Question 2: *What is considered to be Performance according to T&T?*

> When we want to measure performance, a major step is a clear definition of what is considered to be performance according to T&T and their objectives.

Question 3: *How should the considered Performance be measured?*

> As the goal is to present the performance, it must be known how relevant performance can be measured. Answering this question should provide a methodology for measuring relevant performance.

Question 4: *What is an achievable Performance Measurement System for T&T given the limitations?*

> Given the limitation in data sources, IT systems, time, budget and company willingness, a PMS has to be created that incorporates the developed Performance Measurement method.

To answer these four questions, a design plan is created that is aimed at answering the questions through several research and design steps.

3.3 Design Plan

The two main objectives are succeeding but require different approaches. The first objective (developing a method to measure performance) is a more theoretical objective while the second objective (developing an operational PMS) is a more practical objective.

To be able to meet both objectives, two design tracks are considered. The first track is aimed at achieving objective 1, the second at achieving objective 2. The results of the first design track are used as input for the second design track.

A detailed design plan is created based on the standard design process as described in paragraph 3.1. Both design tracks require several analytic steps to come to a valid and substantiated design. Therefore both design tracks consists out of an Analysis, Specification, Design, Verification and Validation phase. These design steps are further described per Design track below:

It is advised to consult Figure 3-4 while reading the design steps to better comprehend their relation with the chapters and phases. This figure gives a full and step-by-step explanation of the chapters in this design thesis.

Design Track I:
Design of a Performance Measurement method for landside airport accessibility

Analysis (ch. 4):
This step analyses what the basic concepts are surrounding performance measurements methods and systems. It stated what information is needed to design a measurement method in an organisational environment. Based on literature findings and expert interviews a framework is proposed that guides Design Track I.

Specification (ch. 5, 6, 7)**:**
The specification step of Design track I has three element. Firstly the performance objectives of T&T are analysed and defined. By analysing literature on airport accessibility, reviewing internal documentation and interviews with higher management, the considered performance, that has to be measured by the measurement method, is defined.

Secondly the accessibility that is offered by Schiphol through T&T is specified. Through an organisational, volume and stakeholder analysis theoffered transportation solutions and it characteristics are described.

Thirdly the demands from clients on airport accessibility are specified. On the basis of literature and expert opinions, the factors and criteria used by clients to determine airport accessibility are revealed. These criteria are weighted through a conducted experiment to define demand profiles for client groups.

Design (ch. 8, 9):
The three blocks in the specification phase give the possibility to fill in the framework described in the analysis phase. This results in an insight on how and where measurements on performance can be taken. This theoretical design is complemented with an actual quantitative measurement method on the Level of Service based on the clients demands on airport accessibility.

Verification (ch 10):
As the design of a method to measure the perceived quality of airport accessibility has not been conducted before, the design steps and results have to be thoroughly verified on relevance and insufficiencies. Shortcoming in the process and design are mentioned.

Design Track II:

Creation of a Performance Measurement System for T&T

Analysis (ch. 11):
A design of the measurement method is created, the next step is the realisation of the design. The Input, Support and Output of a PMS have to specified before realisation is possible. On the basis of literature analysis a framework is proposed that leads Design Track II.

Specification (ch. 12, 13, 14)**:**
The specification step consists of three elements that are specified. Firstly the input, this specified the dataneed and availability for the T&T PMS. Secondly the supportive Soft and Hardware that are needed to run a PMS and thirdly the (presentation of) indicators that show the relevant performance measured.

Design (ch. 15):
Based on the specification, the realisation of the PMS can be executed by selecting and implementing data sources, hard- and software and KPI for the PMS. A method of presentation is developed and the resulting indicators are linked to functions and goals to achieve a PMS that has managerial value.

Verification (ch 16):
As the developed PMS is implemented in the T&T organisation, it is important to verify is functioning and define any shortcomings in design and function.

Conclusions

Final conclusions and validation (ch 17)**:**
To come to a conclusion, the four design questions are answered in this chapter, based on the findings from the two design tracks. Verification is done by observing whether the two design objectives are met.

Recommendations (ch. 18):
As both the measurement method and the PMS are first draft designs, many recommendations on future improvement can be done. The recemndations are based on the two verification steps and the conclusions.

Figure 3-4 consists out of different colours. As can be seen from the colour box in the lower right corner each colour represents a function of the chapter or paragraph. Possible functions are: Introduction, Analysis, Experiment or Conclusion.

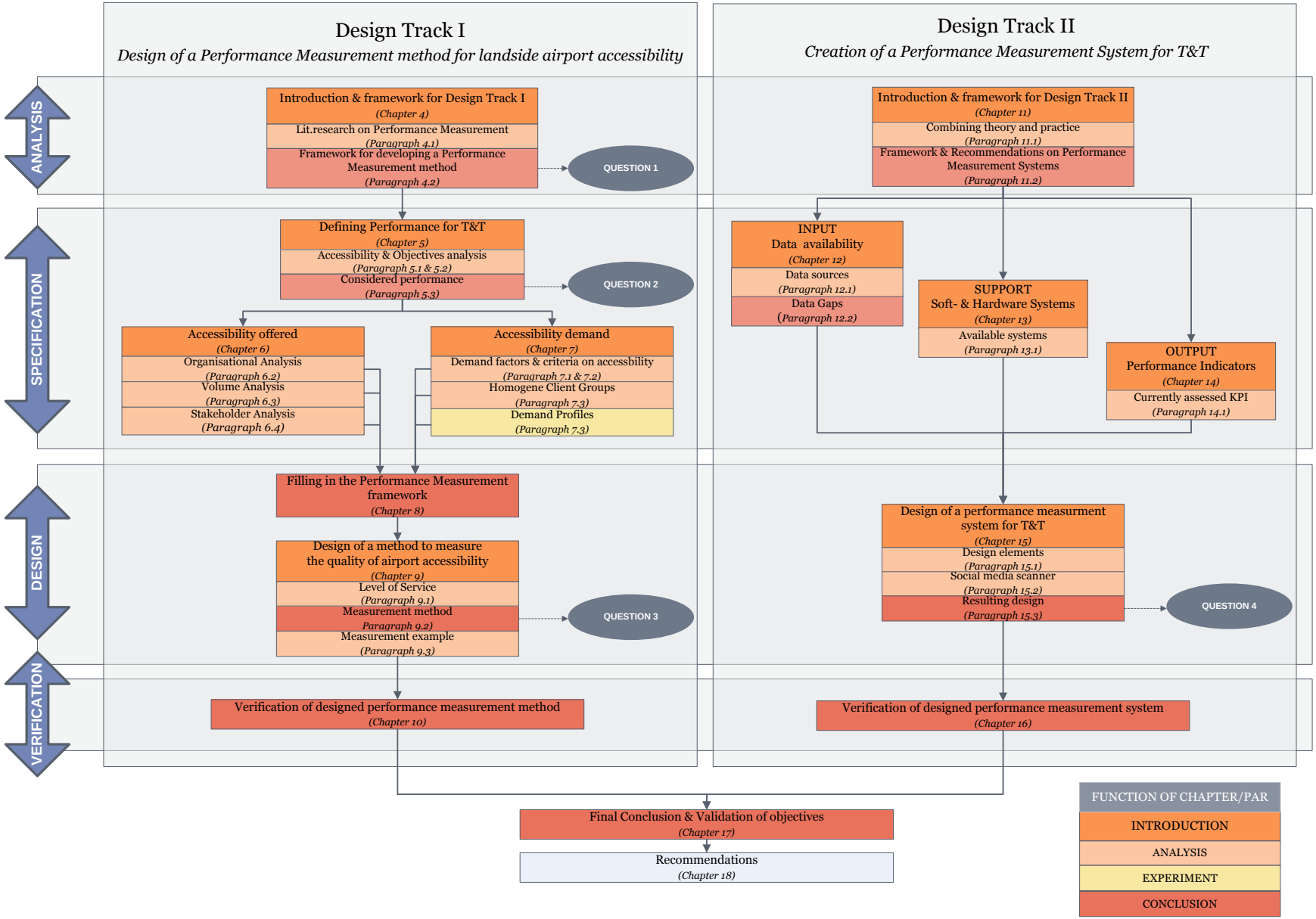

FIGURE 3-4: REPRESENTATION OF DESIGN PLAN

3.4 Assumptions & Limitations

Data collection

The operational data used for the system is data that is being measured at this moment. Although other data points might be very valuable for providing better performance figures, this research is limited to “work with what is available”. The implementation of new data points is too time demanding to considerer within the timeframe of this research. The exploration of landside accessibility measuring will provide recommendations for additional, data measurement that, if implemented, could improve the quality of the performance measurements.

Limited Implementation

The implementation of the system has several organisational challenges. For instance the expected hesitation of the operators and modality managers to share insight in their operation. Especially the fact that higher management has insight it operational performance figures might worries several modality managers. The quality of the delivered data and developed KPI strongly relies on the willingness of the operators and modality managers to cooperate, it is vital to convince them of the advantages of such a system. In practise it means that the enhanced insight the system gives, should also be of value to the operators and modality managers. They should commit themselves to providing a (future) system with timely and accurate data. This demands a practical and organisational approach that cannot be a part of this research. Therefore the step of implementation is limited since ensuring employee willingness and managing the process of change are left to T&T higher management.

Measuring resulting performance

The Performance Measurement system has to measure the performance that is delivered to the T&T clients on the goals set by themselves. The indicators to be developed are therefore stating the resulting performance. It will not state in what amount the T&T department has actually contributed to the result. An increase in performance as the result of an external force is therefore also mentioned. The PMS will not state how efficient or effective T&T undertakes its business, but purely measures and states the outcomes of the activities.

Influence not of importance

Although this thesis will address T&T´s stakeholders and its relation to T&T, the explicit instruction is given to address all factors of influence on the accessibility performance. Even if the influence of T&T on the (improvement of) the factor is limited, the T&T management still wants to know that a certain factor has a negative influence on the (quality of) accessibility of Schiphol.

- DESIGN TRACK I -

Design of a Performance Measurement method for landside airport accessibility

4 Introduction & Framework for Design Track I

This chapter aims to get insight in the basic principles on performance measurement. An extensive literature analysis on performance measurement is conducted to acquire this insight. The full findings can be found in Annex 0. A summary is present in this chapter.

The concept of Performance measurement and Performance Indicators is explained in paragraph 4.1. Paragraph 4.2 presents a framework and several recommendations that will guide Design Track 1

4.1 What is Performance Measurement?

In answering this question, it is useful to look for definitions that are used in existing literature. Neely states that *"Performance Measurement is a topic often discussed but rarely defined" (Neely, 1998)*. After stating several characteristics of performance measurement, they proposed several definitions on aspects of performance measurement. Neely stated that *(Neely, 1998)*:

Performance measurement:

"Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action."

Performance measure:

"A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of action."

Performance measurement system:

"A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions."

Lohman, Fortuin et al. state that the ability to measure the performance of operations can be seen as an important prerequisite for improvement *(Lohman et al., 2004)*

Wolk, Dholakia et al. state that performance measurement makes it possible for organisations to collect data that, on their turn, help identify (potential) improvements to their business models. By acting on the insight provided by this data gives, the organisation can eventually increase its performance.*(Wolk et al., 2009)*.

A differentiation has to be made between performance measurement and performance management. According to Folan and Browne they follow each other in an iterative process. They state that: *"management both precedes and follows measurement, and in doing so creates the context for its existence" (Folan and Browne, 2005)*

Based on the findings of Folan and Browne we can state that performance management means using the outcomes of performance measurements to achieve positive change in organisational culture, systems and processes. The measurements enable managers to set agreed-upon performance goals, allocating and prioritising resources, confirm or change current policy or programs.

4.1.1 Performance Indicators

Measuring the performance of a business or a business operation will eventually produce results on the measurements. These results capture, in any form, the performance of that what is measured. It gives an indication of the performance.

A thoroughly and meticulously created PMS, produces indicators that are very indicative of actual business performance. By ensuring a strong relation with goals, clients and resources it possible to have performance indicators that are very insightful on actual performance.

KPIs can tell how the business is performing according to certain parameters. Organisations use this knowledge to pre-empt problems, quickly resolve issues before they impact the end-user experience, and document performance as seen from the customer point of view. (Andonov-Acev et al., 2008)

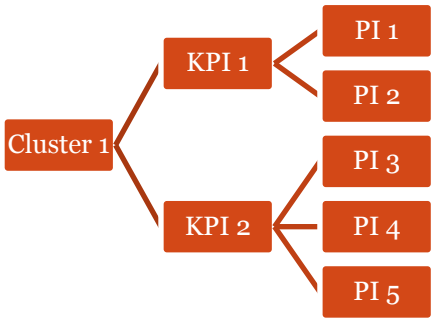

Figure 4-1: Clusters, KPIs and PIs

When multiple Performance Indicators (PI) are grouped and combined as they all indicate on similar performance issues, they are considered Key Performance Indicators (KPI). On their turn KPI can be combined into clusters to get an even higher level of overview on performance as depicted in Figure 4-1

Characteristics of Performance Indicators

When composing KPIs, the acronym SMART is often used. This stands for the need for KPIs to be: **S**pecific, **M**easurable, **A**chievable, **R**esult oriented and **T**ime-based. (Andonov-Acev et al., 2008)

Azofra, Prieto et al. argue that some indicators provide delayed information to performance. As they give insight in the result of past actions instead of the cause, they do not have the ability to anticipate future performance. *(Azofra et al., 2003)*

In line with the findings of Azofra, Prieto et al. are the known categorization of performance indicators, as also stated by Peng, Sun, et al., into three types:

1. **Leading indicator**: a KPI that measures activities that have a significant effect on future performance. (ie. the number of clients that sales people meet with face to face each week)
2. **Lagging indicator**: a KPI that measures the output of past activities. (ie. revenue)
3. **Diagnostic measure**: a KPI that is neither leading nor lagging, but signals the health of processes or activities.

Leading indicators are the most powerful indicators as they possess not only the predictive and insightful causal relationship with the business processes, but also give the possibility to set a course for continuous improvement. Therefore, creating effective leading KPIs is critical to the capability of a business to respond quickly on events or even be prepared to respond on changes in advance (Peng et al., 2007). Figure 4-2 shows how indicators are related to the whole value chain.

Figure 4-2: Position of leading/lagging indicators in the value chain

4.2 Framework for developing performance measurement method

In the analysis of literature on Performance Measurement, several design steps & frameworks (Annex 0 & A.3) and design recommendations (Annex A.1) are evaluated.

By combing these findings with our problem situation, it is possible to create a tailored framework that guides the steps towards the design of a method of performance measurement. Furthermore, the most applicable recommendations are combined and presented. These will also guide the design process.

Framework

Based on the literature analysis it is valid to state that when the goal is to develop a method that measures performance related to the department's goals, the system designer has to "*crawl into the DNA of the organisation and processes that have to be measured and get to know all and everything*".

This design challenge therefore demands a thorough knowledge of the goals of the department, the workings of landside transportation & mobility, the needs of the different client groups, the way service are currently offered and the organisation of the T&T department. By putting these information needs into a framework, the needed steps on Design Track I can be structured.

Based on the findings on Performance Measurement Frameworks (Annex A.3) and the background of airport accessibility, a framework is composed. Figure 4-3 depicts the building blocks for getting performance measurements and their interrelation in a framework.

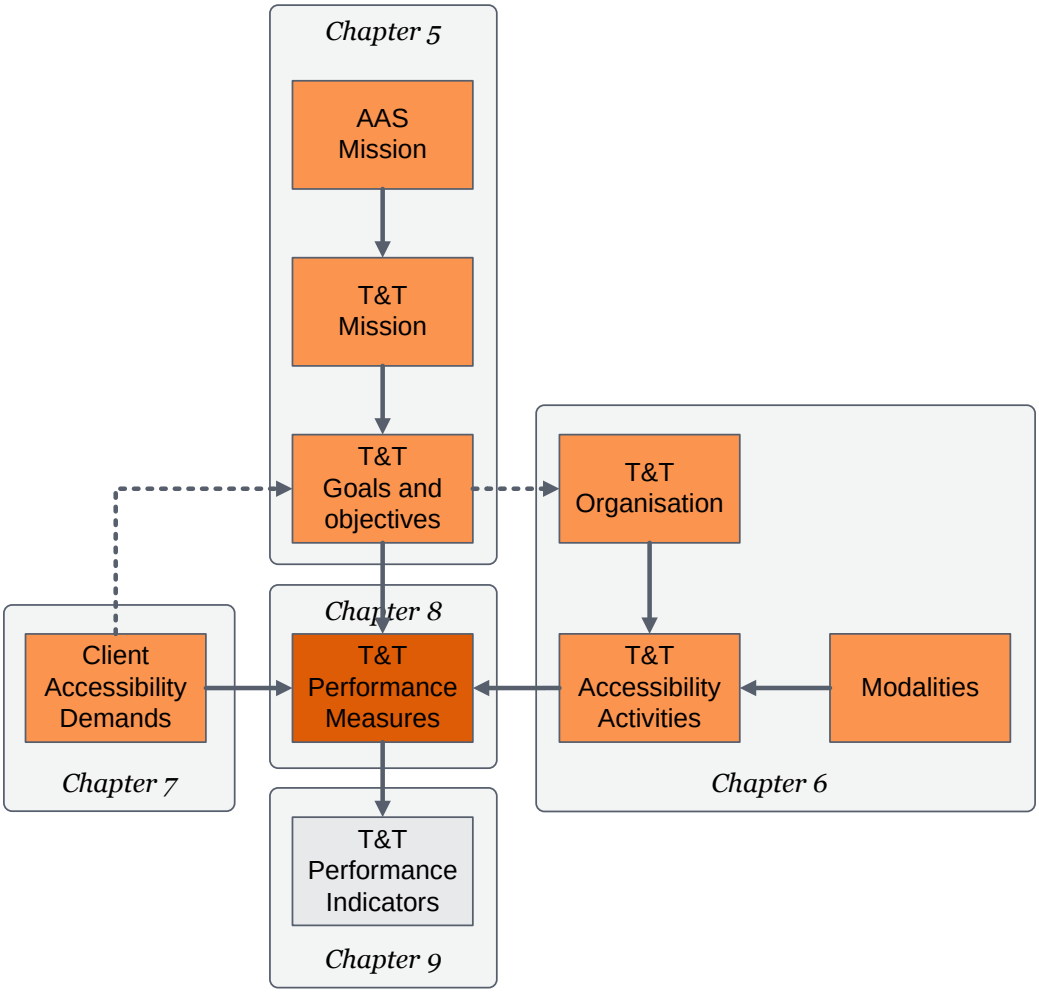

Figure 4-3: Framework for Design Track I

Framework explanation

First the mission of AAS has to be stated and how this is translated into a T&T mission. This T&T mission will dictate the T&T goals and objectives, which are also influenced by the client needs. Chapter 5 will outline how the company´s and department´s objectives are related and how they result in relevant performance objectives. Based on limitations of this thesis the most relevant performance objective is selected. This objective is the performance on which the method will have to report.

The next step is to assess the offered transportation solutions. The T&T organisation has to be analysed. What are the roles and responsibilities within T&T?. Another essential factor are the current modalities. What are the possible modes of transfer to and from AAS? The mode possibilities combined with the T&T organisation will spur activities. What does T&T do and how do they influence the modalities? Chapter 6 will focus on the offered accessibility at Schiphol by T&T.

The client needs have to be known. What does the client expect from accessibility to AAS? In fact this has to be known for each client/target groups recognized by T&T. Chapter 7 therefor focuses on setting clients demands on airport accessibility.

The client needs combined with the T&T activities and the T&T goals and objectives will provide indicators on performance. This combines what the client wants, with what T&T aims for and what is done to achieve this. The indicators on performance will dictate what to measure. It will show what needs to be measured to know the performance.

4.2.1 Recommendations

Besides the design steps, the literature analysis on performance measurement also rendered several recommendations. A full list can be found in Annex A.1. The most applicable recommendations are mentioned below and are used throughout Design Step I.

- Performance measures should be derived from the company´s strategy
- Measurements should be mutually supportive and consistent with the business's goals, objectives, critical success factors and programmes
- Measurements should reveal how effectively customers' needs and expectations are satisfied
- The measure should be taken as close to the customer as possible
- Provide measures that allows all members of the organisation to understand how they affect the entire business
- Focus upon measures that customers can see
- Measures should convey information through as few and as simple a set of measures as possible
- The purpose of each performance measure must be made explicit
- Ratio based performance measures are preferable to absolute numbers

5 Defining Performance for T&T

Although the department has made (some) statements on what is considered performance, there is no overall definition and some statements are not motivated by arguments and therefore not directly useable (Interview mr. A.J.C. Lensvelt, 2010). Therefore a very relevant question is: *What should be considered performance for T&T?*

To answer this question an analysis of literature on airport accessibility is conducted in paragraph 5.1. Next the analysis on the objectives of T&T, with regard to airport accessibility, is conducted in paragraph 5.2. The resulting objectives are used to set the uptake of performance for the remainder of this thesis. Figure 5-1 depicts the steps taken in chapter 5 to set the considered performance.

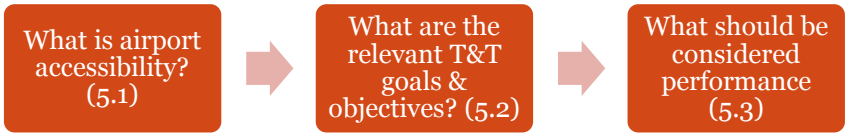

Figure 5-1: Steps in Chapter 5

5.1 Airport Accessibility

In the most basic notion, accessibility can be seen as the capability to reach the destination. It can be seen as a feature to which only to possible outcomes are possible: yes or no. For instance a field with a gated entrance. When the gate is closed the field is not accessible, so the notion of accessibility is not met and can only be answered with no. Is the gate open then the field is accessible and the outcome on the accessibility issue is yes.

However when we take this notion a step further we can look at the conditions under which the accessibility is achieved. Examples are the time it took and the resources it demanded. If we look at the field again and the gate is open, there can still be accessibility issues. Is the entrance for instance very wet and muddy, than it will take more time and may require boots to access the field. This metaphor illustrates that although accessibility in its basic form is quite clear, when looking to the conditions under which accessibility is achieved, it becomes more complex.

The term “accessibility” is often used in transportation planning with a relatively abstract definition. A more to the point definition of accessibility is given by Dong et al.: “the ease and convenience of access to spatially distributed opportunities with a choice of travel” (Dong et al., 2006). According to this definition, accessibility means the ease and convenience of access to the opportunities in an area. Describing accessibility therefore implicates describing this “ease and convenience”. (Shi and Ying, 2008)

According to Shriner and Hoel, the main function of the landside access system is to provide service to airport passengers and visitors. Superimposed on this continuous activity is the travel conducted by airport workers and cargo transport. The accessibility services offered by an airport must be focused on furnishing circulation, distribution, and storage of vehicles. Shriner and Hoel also state the most of the time the available infrastructure is limited and quick new facilities unlikely. Therefore the challenge for those responsible for with airport accessibility is to operate existing facilities more efficiently. (Shriner and Hoel, 1999)

5.2 Relevant Objectives

The T&T objectives can have two sources:

1. Resulting from the general strategy and goals of its parent departments: Schiphol Group, Amsterdam Airport Schiphol and Passenger Services
2. Following from the specific accessibility responsibilities of T&T in the Schiphol processes

To create a an actual Performance Measurement System (PMS) within the thesis timeframe, not all objectives can be measured. The project limitations will therefore result in a selection of objectives that are considered to be most relevant to this thesis. (Figure 11-3).

Figure 5-2: Combining goals and thesis limitations to relevant objectives

5.2.1 Schiphol and T&T

To get an insight in the T&T objectives an extensive strategy & objective analysis on the Schiphol Group, Amsterdam Airport Schiphol, Passenger Services and Traffic & Transportation is conducted. The full analysis can be found in Annex 0. This paragraph will state the main findings.

Figure 5-3 mentions the central objectives & strategies of the departments that are parent to T&T. The figure is further explained

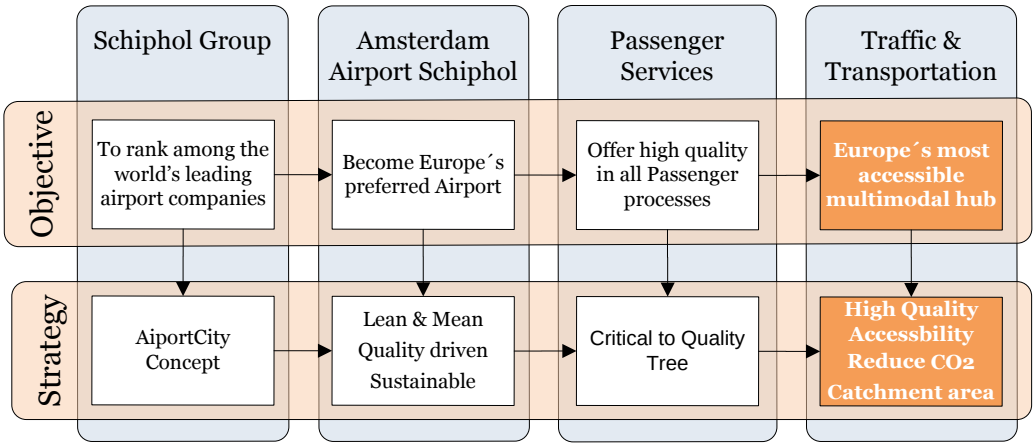

Figure 5-3: Objectives & Strategies of Schiphol departments

Schiphol Group

The Schiphol Group, parent to AAS, wants to rank among the world´s leading airport companies. It has therefore created the AirportCity concept (Annex 0). It wants to develop airports that create added value on multiple levels and offers and inspiring environment to all travelling, working and visiting guests

Amsterdam Airport Schiphol

Amsterdam Airport Schiphol is by far the most important airport to the Schiphol group and provides the vast majority of its income. AAS is the embodiment of the AirportCity

concept.

The goal of AAS is to become and stay *Europe´s most preferred airport*. With preferred is meant that the focus is on offering quality to the client (not on price or volume).

Becoming Europe´s preferred airports asks for a strong strategy. The strategy has three main pillars:

- Schiphol´s board pushes for a more *lean and competitive operation* throughout the whole AAS organisation. With outsourcing non-core activities, six sigma optimisation projects, increased management insight and steering capabilities and a solid company vision, Schiphol creates an environment where competitiveness is enforced.
- An increased focus on *sustainable* and *environmental responsibility*. The social responsibility that AAS recognises, pushes to commit to a leading position in thriving for sustainability *(Schiphol Group NV, 2007)*.
- A *quality driven approach*: AAS aims to set itself apart from other airports by offering a true quality experience for the customer. This approach is communicated to all business areas through a core focus *"connecting"* and five core values: *Reliable – Efficient – Innovative – Hospitable - Sustainable (Schiphol Group NV, 2010c)*.

Passenger Services

As a result from the Quality driven approach as formulated by AAS, the Passenger Services department (direct parent to T&T) has focused on offering high quality in all passengers processes (accessibility is considered part of passenger processes). The strategy to achieve this is formulated in the CTQ tree (Figure 5-4) that is developed with input from underlying departments (including T&T). CTQ stands for "Critical to Quality" and shows "the voice of the customer". The five AAS core quality values are translated to the CTQ tree and result in stating six major factors that should lead to delivering high quality to the client, these are:

- coping with abnormalities
- predictability
- steady basic processes
- hospitality
- atmosphere
- pleasant stay

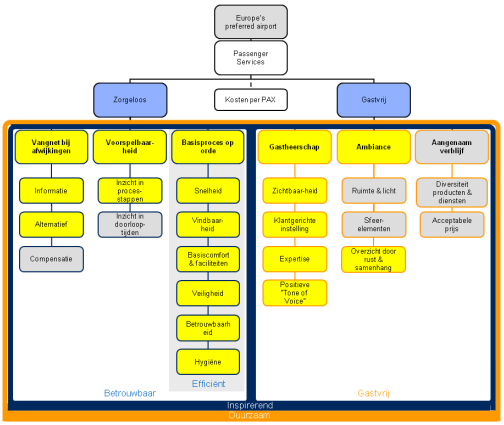

FIGURE 5-4: CTQ TREE

In annex B the elements of the CTQ tree are fully explained.

Traffic & Transportation

The T&T goals are a combination of the strategy and goals as formulated by the parent departments (AAS and PS) and the department´s responsibilities and customer groups. The ultimate goal is, in line with the AAS goals, formulated as: *To become Europe's most accessible multimodal hub*. There is a strong customer focus.

The resulting T&T objectives can be put in a simplified objective tree. Figure 5-5 depicts this tree. The sub objectives are further explained below the figure.

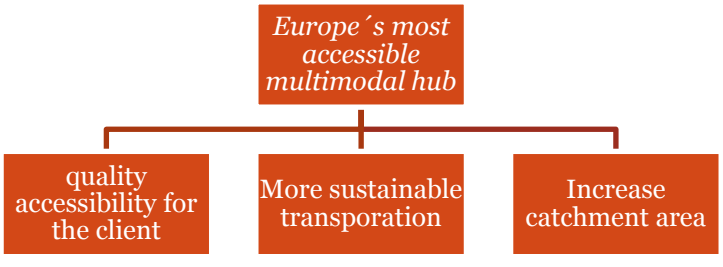

FIGURE 5-5: SIMPLIFIED OBJECTIVE TREE T&T

Offering high quality accessibility
T&T is currently developing a business plan based on the AAS strategy and T&T focus points that sets the vision for the coming five years (2011-2016). The business plan describes a main focus area: increase quality to the customer with regard to accessibility. Very relevant to the design process is therefore the developed CTQ tree as discussed in the last paragraph.

More sustainability transportation
A key point in current developments is the increasing focus on sustainability. The targets set are impressive. The goal is to be CO_2 neutral in 2012 and have a reduction of 30% (compared to 1990) by the year 2020 *(Schiphol Group NV, 2007)*. This ambition has influence on the strategy of T&T. For instance there is an increasing focus on influencing the modality choice of passengers (public transportation instead of cars) and multiple incentives for Schiphol workers to travel by environmental friendly car.

Increase catchment area
As T&T is responsible for accessibility, they are focussed on not only the quality of the accessibility, but also the pure ability to get to Schiphol. In interviews with the department manager it became clear that a main focus is the catchment area (Interview drs. B.C.C.A. van Dorst MTL, 2010). With catchment area is meant the amount of people that are can reach Schiphol within a certain amount of time(Schiphol Group NV - T&T, 2009). I.e. the amount of people within 1 hour travel time of Schiphol is approximately 6,2 million.

5.2.2 Limitations

The previous paragraph has showed the focus of AAS, PS and T&T with regard to strategy and goals. Not all objective can be measured given the limitations of this thesis. A selection has to be made which renders the *relevant T&T objectives* on which performance has to be reported.

A selection is made on the goals mentioned by T&T and the general company vision. The criteria for making this selection are:

1. The feasibility of measurements
2. Are within design definition (not in limitations)
3. Fit within the timeframe

This selection in combination with interviews with responsible managers has resulted in a core focus for the performance measurement on (Figure 5-6):

the quality of accessibility delivered to the client

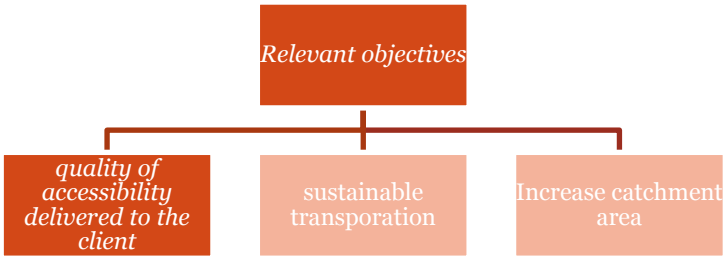

Figure 5-6: Relevant measurement objective

This objective will be leading in the remainder of our design.

5.3 Considered Performance

The relevant objective that guides the further design of the PMS is set: the quality of accessibility delivered to the client. However this is not yet the answer to the first design question of what should be considered performance. Therefor this paragraphs answers how performance is delivered on the relevant objective.

Performance on quality to the client in the service industry, as we can consider T&T, can be described as*: "The degree in which a company is able to offer service solutions that meet the client's demands"* (Abe et al., 2007)

When this view is used on the T&T situation we can describe the different modalities as service solutions. After all in the action of arriving at or departing from Schiphol, the clients have several options to those from. These options are the offered modalities, each with typical benefits and disadvantages in providing airport accessibility.

The client´s demands in the T&T situations are the demands of the different client groups of T&T on the quality of accessibility. T&T has several client groups: Passengers, Schiphol Workers and Cargo. Each client group can have different transportation needs and therefore demands towards the quality of accessibility

Performance at the T&T department will be considered, from a high perspective, the degree in which the (characteristics of the) offered modality solutions match with the accessibility demands of the different client groups. This depicted by Figure 5-7

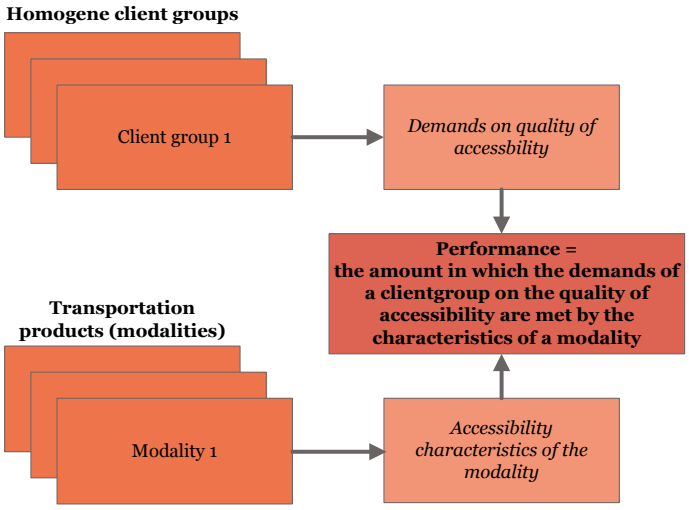

Figure 5-7: Accessibility demands vs. modality characteristics

Performance on quality of accessibility delivered to the client =
the amount in which the demands of a client group on the quality of accessibility are met by the characteristics of a modality

6 AIRPORT ACCESSIBILITY OFFERED

Chapter 5 has set the considered performance. This chapter focuses on how this performance is delivered by/through the T&T organisation, operation and its direct surrounding. T&T aims at offering high quality airport accessibility. It does this though offering multiple accessibility services. This chapter analyses how and with whom these services are provided through three analyses.

To come to a full understanding, three aspects surrounding the offered accessibility are analysed: the T&T organisation (6.1), Passenger Volumes (6.2) and the Stakeholders (6.3).

- Through a Work Centred Analysis (WCA) four aspects of the T&T organisation are reviewed: Clients (6.1.1), Accessibility Services (6.1.2), Processes (6.1.3) and Roles (6.1.4)
- Through an analysis of the Schiphol data and external research papers on the amount of passengers and the use of modalities, and overview is created of the volumes, split over the client groups and modalities (6.2).
- In providing accessibility to SPL, T&T operates with many stakeholders. This paragraph (6.3) reports on the most important stakeholders and their relationship to T&T.

Figure 6-1 presents the steps in Chapter 6 in a single overview.

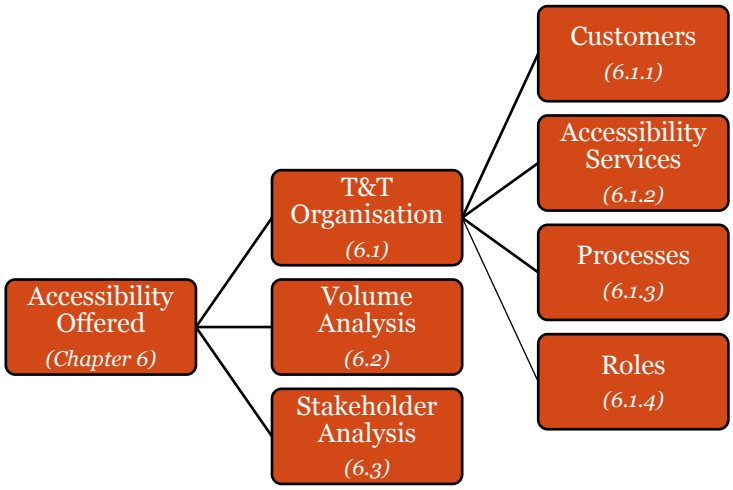

FIGURE 6-1: STEPS & PARAGRAPHS IN CHAPTER 6

6.1 Traffic & Transportation

Traffic & Transportation is a subdivision of the Schiphol Group, but there are several departments in between. Figure 6-2 provides a simplified overview of the position of T&T in the whole Schiphol organisation.

The Schiphol Group is owned by four public bodies (Dutch government, City of Amsterdam, City of Rotterdam and Airport Paris). Amsterdam Airport Schiphol is positioned below the Schiphol Group and is its major asset. AAS is separated in Aviation (A) and non-Aviation businesses (consumers, real estate, etc), T&T is considered an aviation department. A part of Aviation is the branch Airport Operations (OPS) consisting of all operational activities on the airport. Those activities focussed on the passengers are combined in the Passenger Services (PS) department. T&T is a subdepartment of PS.

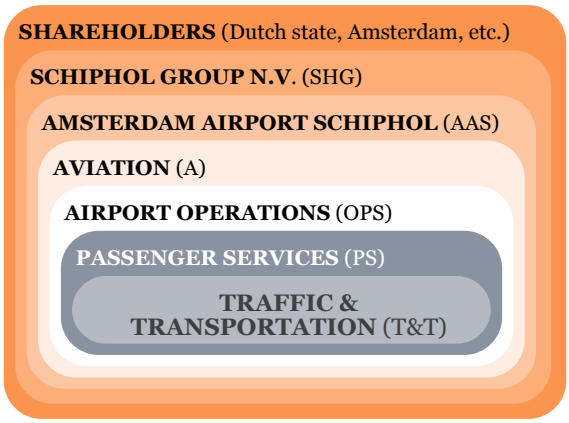

Figure 6-2: Organisational position of T&T

The two major "parents" of T&T, Schiphol Group and Amsterdam Airport Schiphol, are discussed in this paragraph.

Schiphol Group NV

The Schiphol Group is an airport operator headquartered in the Netherlands (Schiphol Group NV, 2010b). They create sustainable value for their stakeholders by developing AirportCities. AAS is their biggest (fully operated) airport and a prime example of their AirportCity concept. The functions of the Schiphol Group are divided in four main segments: Aviation, Consumers, Real Estate and Alliances & Participations.

Besides the four airports in the Netherlands (AAS, Rotterdam The Hague Airport, Lelystad and Eindhoven airport), the Schiphol Group is active in the USA, Australia, Italy, Indonesia, China, Aruba, Sweden and France.

Run and structured as a commercial enterprise with a socio-economic function, its revenues were EUR 1,145 million over 2009. The net result totalled EUR 132 million. (Schiphol Group NV, 2010b). Interesting to note is that the net result on aviation is, compared to the revenues, rather small while the result on consumers and real estate is relatively large. The financial split between the segments is shown in Figure 6-3.

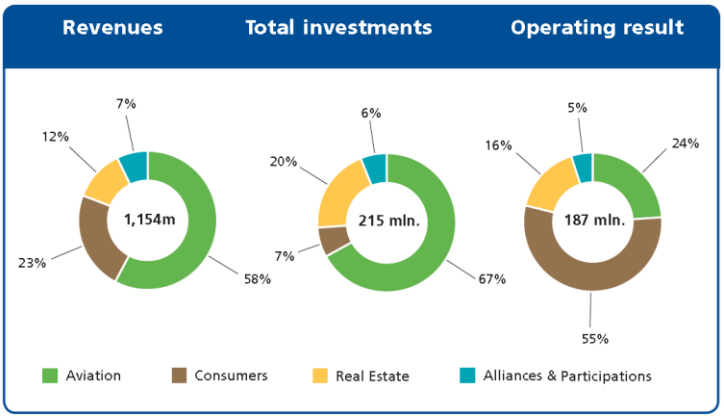

Figure 6-3: Financial figures Schiphol Group 2009

The profits are shared amongst its owners which are public bodies. 69.8 % is owned by the Dutch government, 20.0 % by the City of Amsterdam. 2.2% by the City of Rotterdam and 8.0% by Aéroports de Paris.

Amsterdam Airport Schiphol (AAS)

Amsterdam Airport Schiphol (AAS) is part of the Schiphol Group NV. In 1916 AAS started as a military airfield. Four years later (1920) the first KLM flight departed from AAS and marked the beginning of it civil aviation function. After being fully destroyed in the WOII (runways and buildings) the NV Airport Schiphol is erected in 1958 to finance, develop and operate a new airport. In 1967 the new terminal is opened which forms the basis of the current airport.

In 2009 AAS was Europe´s fifth-largest airport in passenger numbers and third in Cargo (Schiphol Group NV, 2010b). In provides flight connections to 284 airports located in 93 countries which can take off or land from any of the 6 runways. Since 1980 it has won over 160 European and Worldwide awards for the best airport.

AAS develops, operates and administers the almost 2.800 hectares of land owned by the airport. This land is home to 544 companies that employ around 60.000 people (Schiphol Group NV, 2009). The airport is an indispensible location factor, attracting international and high-end economic activity to the Netherlands. Schiphol-related activities yield an added value of EUR 8 billion: 1,5% of the Dutch GDP (Schiphol Group NV, 2010d).

AAS is not only an airport but also a hub of rail and road connections and offers a wide range of services and facilities to passengers, companies, employees and visitors. This is in line with the vision of the Schiphol Group to create an AirportCity and use the aviation as a catalyst for business, commercial and transportation activities.

Traffic & Transportation

In 2009 AAS welcomed a total of 43,5 million passengers. 56,7% of these passengers, almost 25 million, were O&D passengers that had to arrive at or depart from the airport (Schiphol Group NV, 2010b). Besides the airline passengers, almost 60.000 people work at the Schiphol premises that have to reach their workplace almost every day. Additionally AAS has transported a total of almost 700.000 tonnes of freight (unrelated to passengers) over 2009 that had to reach or leave the Schiphol premises. Finally Schiphol is used as a landside hub to transfer between trains, buses, cars and bicycles by 5.000 to 10.000 people per day (Lensvelt A., 2008).

By using the Schiphol infrastructures and connections to highways or the offered public transportation modes, all these people and goods were able to arrive or depart AAS. They used the modes: trains, buses, trucks, private cars, rental cars, motorcycles, taxis, shuttles, mopeds and bicycles for their transportation, all accommodated by AAS.

The Traffic & Transportation department is responsible for the landside accessibility of AAS and ensures that all modalities are able to connect with the airport and surrounding areas.

Figure 6-4 depicts the passenger processes that can be distinguished in both departure and arrival. T&T has a responsibility in the beginning of the process and in the end of the process (marked with T&T in the figure).

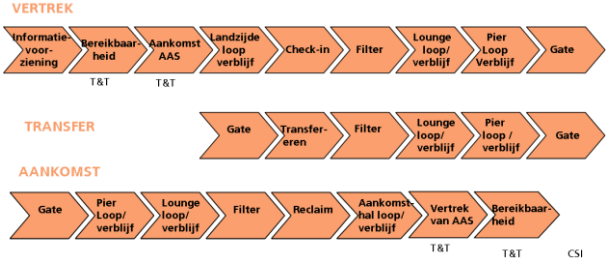

Figure 6-4: Whole passenger process

Work Centred Analysis

An helpful method in gaining insight in an organisation is using the Work Centred Analysis (WCA) framework (Hengst, 2003). It reduces the complexity of the organisational systems by looking at the organisation in a structured fashion.

The WCA frameworks consists of four blocks as can be seen from Figure 6-5 that summarizes the framework.

The Clients are whoever receive and use the products (services) of the T&T organisation.

The Services are the service that the T&T organisation produces for the Clients.

The Business process is the set of work steps that are performed within T&T.

The roles are the functions at T&T who perform the business processes.

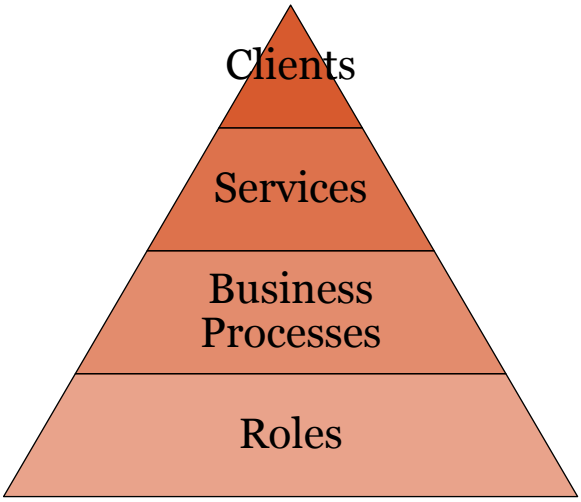

Figure 6-5: WCA Framework

6.1.1 Clients

The used WCA term is Customers, within this analysis we will refer to them as Clients as they are not a direct customer of T&T but are the entity that the T&T products (services) are directed to. Interviews with both the T&T management as the Passenger Services management (parent to T&T) have provided insight is the considered clients.

T&T´s clients are all parties that require land sided access to the Schiphol premises. T&T currently separates three bodies of clients since each of these groups has different demands towards accessibility:

Passengers

The main body of passengers are those that are at Schiphol due to air travel. However there are also passengers that are at Schiphol for shopping or those that use Schiphol as a connecting hub for public transportation. In fact passengers are considered all people visiting Schiphol that are non Schiphol workers.

Passengers are defined by three different groups:

O&D passengers: Originating and destinating passengers. Those whose journey by air starts or ends at AAS.

Transfer passengers: Those who change planes within 24 hours without leaving the customs area.

Transit passengers: Those who leave the airport on the same flight number as the one by which they arrived. Mostly a very short stay.

Schiphol Workers

All people that work at the Schiphol area. At Schiphol there are 226 active companies with a total of over 65.000 employees.

Cargo

Cargo is all air cargo that has to be transported to and from Schiphol. At Schiphol there are three locations that are cargo related. The major location is Schiphol South East, two smaller locations are Schiphol South and the KLM Cargo department at Schiphol Centre. Cargo is increasingly more important for AAS, the income from Cargo is increasing and currently composes for 23% the total income. Cargo has proven to be a lucrative and unattached with the passenger volumes. As such it can provide a solid basis when passenger volume is (temporary) lower.

6.1.2 Accessibility Services

The used WCA term is products, but it the case of T&T we consider this the provided accessibility services to the clients. As T&T is responsible for the accessibility of Schiphol, the *modes of transportation* to access Schiphol, are considered the services.

Shiriner and Hoel classify Airport access modes into two categories: private and for-hire. The primary private mode is the automobile and rental car. For-hire modes consists out of public transportation such as conventional bus or train and paratransit such as taxi, airport limousine/shuttle and charter service. Each mode has unique characteristics with regard to the accessibility performance elements. (Shriner and Hoel, 1999)

Each mode of transportation consist out of a modality and access facilities that together provide access to Schiphol

$$Accessibility\ Service = Mode\ of\ Transportation = Modality + Access\ Facilities$$

In the two following subparagraphs all modalities and used infrastructures are mentioned.

It is important to notice the mentioned service are not directly offered or operated by T&T. This is done by different operators or by the clients themselves. T&T merely facilitates the use of these modalities and strives to increase the transportation´s utility to the clients by optimising the (quality of) accessibility.

6.1.2.1 Modalities

With modalities is meant the different types of transportation that clients can use in arriving or departing AAS. Figure 6-6 gives a full oversight of all modalities (including specification) that service Schiphol.

Private Modes

The major private access mode is the automobile. Private modes typically have the higher levels of quality and convenience. For this reason they often get the largest mode share. However limited infrastructural space and is placing constraints on the facilities these modes operate on, which causes increased time and decreased reliability. (Shriner and Hoel, 1999)

The private modes also includes rental cars, parked cars and card dropping off/picking up passengers at the airport. Worthwhile to note is that Drop-off/pick-up private automobile trips put a greater strain on access facilities as two round trips are made by the driver for one passenger movement. (Shriner and Hoel, 1999)

For-Hire Modes

For-Hire modes are the public transportation modalities and the taxi/shuttle services. Public transportation costs are typically lower than private transportation but trip time is usually longer and multiple stops increase time further. The most for-hire modes do not provide door-to-door service, have no baggage assistance and limited hours of operation. The result is poor convenience and quality performance. The assumption is that if high-quality public transportation is provided, access mode choice will shift from private modes to for-hire modes . (Shriner and Hoel, 1999)

For-hire access modes include the Train, Bus services, Taxi and Ordered transportation (shuttles/charters). Rental cars are not considered a for-hire mode since their characteristics and access demands are comparable to those of the private modes. (Shriner and Hoel, 1999)

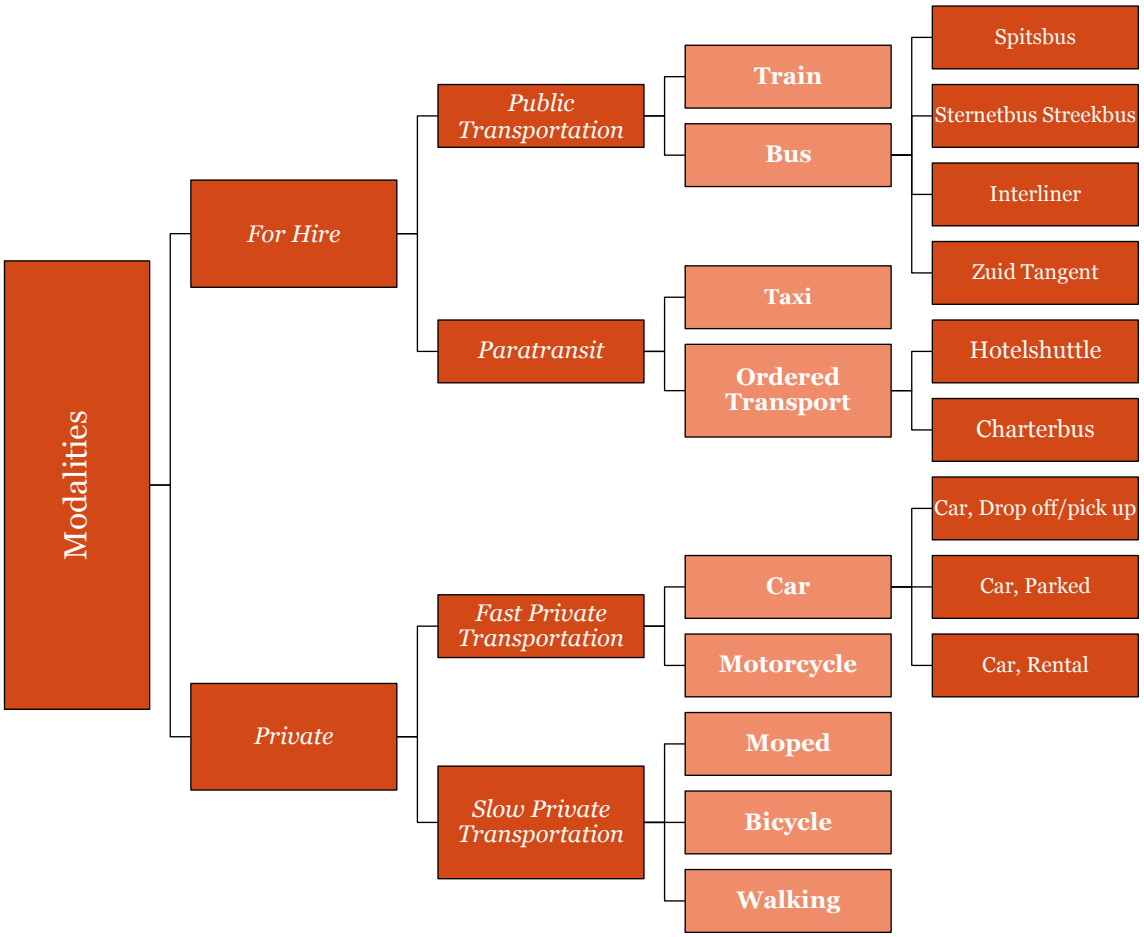

FIGURE 6-6: MODALITIES AT SCHIPHOL

6.1.2.2 ACCESS FACILITIES

The resulting quality of accessibility is greatly influence by the by the access facilities on which modalities operate, since congestion and related delay increase time and decrease reliability. Constraints on land use, physical limitations and environmental concerns and regulations often restrict the expansion of access facilities. To optimize the quality of accessibility, the objective must be to optimize efficiency of the access facilities, in conjunction with exploring alternate access services. (Shriner and Hoel, 1999)

The infrastructures provide the access facility. A separation is made between rail and road infrastructures. For the road infrastructure a separation is made between Schiphol roads – the roads that connect the access road to the location at Schiphol - and the Access roads.

The Schiphol roads are located on Schiphol grounds and are therefore under the direct control of T&T. Two types of Schiphol roads are recognised, Public roads that are accessible for all and bus lanes dedicated for bus services.

The Access roads and Rail are owned (and maintained) by other entities and therefore not under control of T&T.

Figure 6-7 presents the different access facilities in a diagram, where the Schiphol roads are highlighted as they are under the direct influence of T&T.

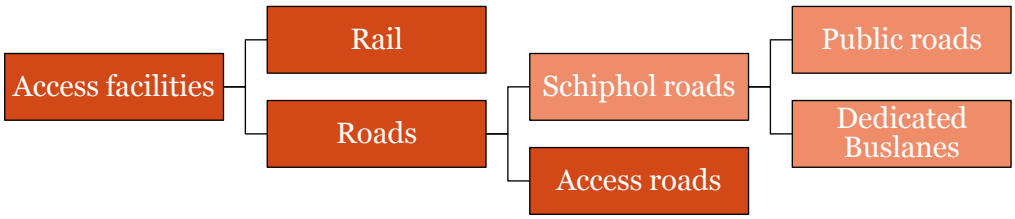

FIGURE 6-7: DIFFERENT INFRASTRUCTURES

RAIL

The rail infrastructure is owned and maintained by Prorail. The train is the only modality that uses the rail infrastructure. T&T has no direct influence on the rail.

SCHIPHOL ROADS

Schiphol roads are all roads that are located on Schiphol grounds. Simplified it is possible to separate the *Ring road* that directly connects the access roads to the different Schiphol locations and the *Arrival & Departure courts*.

Ring road

The ring roads are the connecting roads on Schiphol grounds. Schiphol consists out of seven different areas that are connected with one ring surrounding the airport.

Arrival & Departure courts

All passengers and most Schiphol workers arrive at Schiphol Centre. Here are the arrival and departure courts located as shown in Figure 6-8. The arrival court is located on ground level, while the departure gate is located on the first floor.

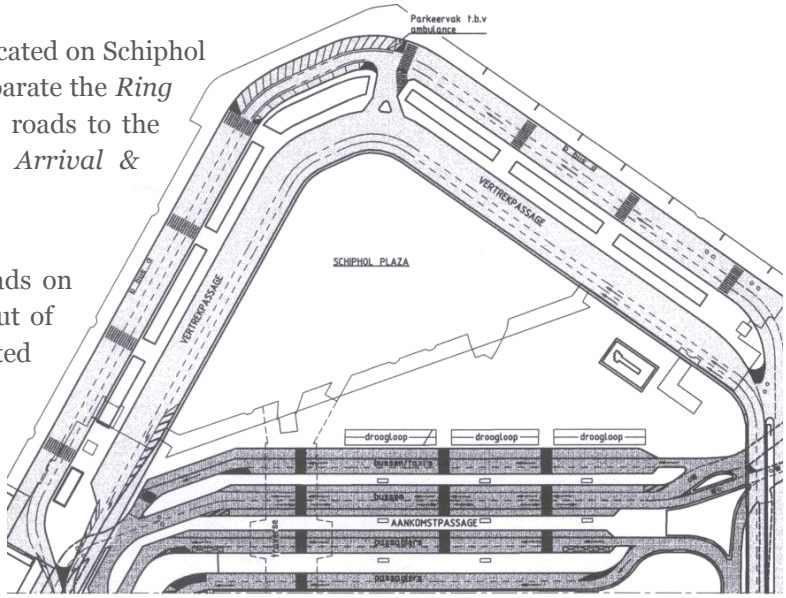

FIGURE 6-8: AAS ARRIVAL AND DEPARTURE COURTS

The arrival court has four lanes, each with its own modality:

- **A lane** (restricted): dedicated for taxis and ordered transportation
- **B lane**: dedicated for public buses
- **C lane**: dedicated for private cars picking up passengers
- **D lane**: dedicated for private cars (incl. rental cars)

The departure court has two lanes:

- **Service lane** (restricted): dedicated for service vehicles (suppliers, marechaussee, taxis with drop off passengers) and cars with temporary permission (builders, VIP parking) regulated by T&T.
- **Public lane**: dedicated for private cars to drop off passengers.

Two lanes, the A lane on the arrival court and the Service lane on the departure court, are restricted and access is granted by gates. On the A lane this is done by an automated system (TRS) that is regulated by transponders on taxis. On the service lane this is done by an operator that checks vehicles on access passes or against an existing list op permissions.

Access Roads

All highways and local roads that lead to Schiphol and connect to the Schiphol roads are considered the access roads. The major highway access roads are the a4 and the a9. The major local roads are the N201 and the N232.

6.1.3 Business processes

This main responsibility of providing landsided accessibility to clients can be divided in four major processes: Operational, Product Development, Analysis and Program management. Figure 6-9 provides a graphic representation of the Key tasks of T&T

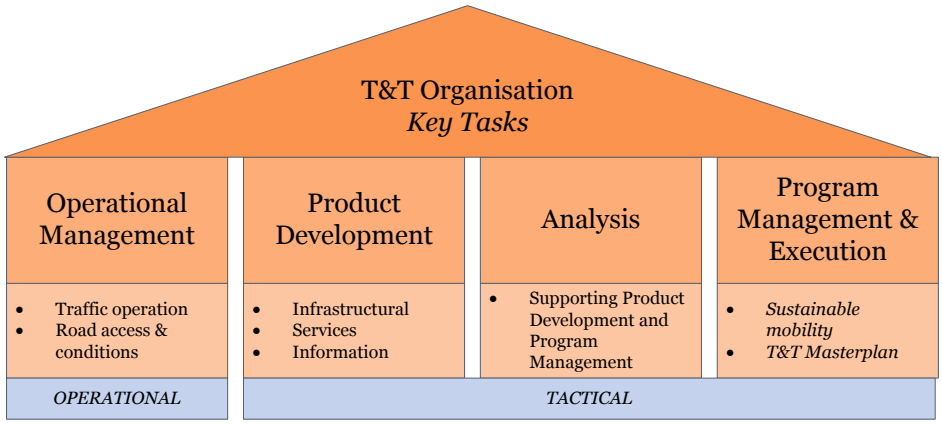

Figure 6-9: Business processes within T&T

1. **Operational management**
   T&T has two major operational responsibilities that require constant monitoring and on-going time investment:
   a. Warranting an on-going flow of arriving and departing vehicles on the Schiphol departure and arrival courts
   b. Warranting constant optimal road conditions, overseeing road maintenance, solving unexpected road imperfections and providing licences for (temporary) access to private roads on the arrival and departure courts (behind gates).
2. **Product (service) development**
   T&T is responsible for all transportation services offered to and from the airport. The operation itself is done by third parties (trains, buses, etc) but assuring access to Schiphol grounds, offering information to the clients, assuring products (services) in line with client needs, etc are the responsibility of T&T. The product development can be divided in three major development tasks:
   a. Infrastructural developments: improving/altering road access or curb side flow, adding lanes or increasing traffic separation, awarding dedicated access/roads.
   b. Service developments: providing new or improving on existing transportation services offered to clients
   c. Information: Assuring that the clients are provided with sufficient information on transportation possibilities and times.
3. **Analysis**
   The analysis tasks are supportive to product development and program management. Using conducted research (both done internally as commissioned) and available data, an analysis of needs and weaknesses can be conducted.
4. **Program management & execution**
   Key focus areas are developed into programs that target to improve the T&T services and performance. Current programs are: Sustainable mobility and Traffic & Transportation Masterplan

6.1.4 ROLES

T&T has created positions in line with its business processes. There is a separation between the operational activities, modality managers and the tactical activities. Figure 6-10 shows all the different positions within T&T..

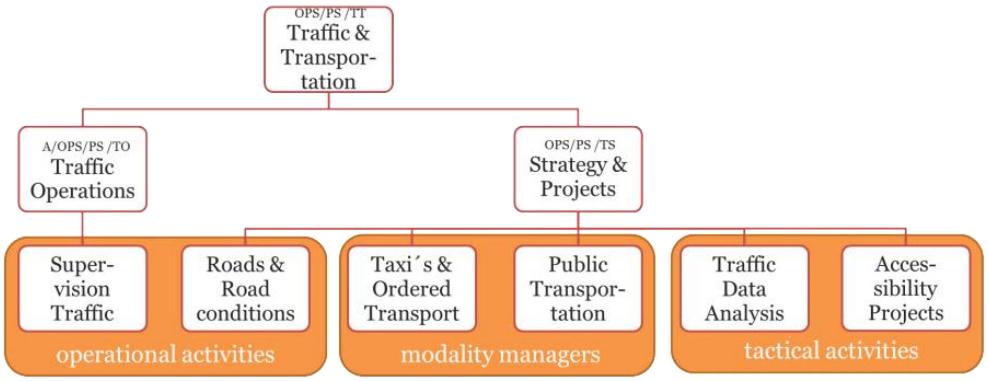

FIGURE 6-10: T&T PARTICIPANTS

T&T department manager: the T&T department has one general manager that is ultimately responsible for the department and is in contact with the higher positions in the AAS organisation.

- **Traffic Operations** (TO): One manager concerned with the curbside trafficflow: safeguarding a constant flow of traffic on the arrival and departure courts by deploying Traffic supervisors
    - **Supervision Traffic:** 12 special investigation officers concerned with the operational controlling and fining of traffic

- **Strategy & Projects** (TS): Branche of T&T that has specific responsibilities towards the different modalities or tactical/project management responsibilities.
    - **Road & Road conditions:** Responsible for the condition and safety of the road infrastructure on Schiphol premises. Oversees roadworks and signing. Also provides authorisation to vehicles to access restricted parts of the arrival and departure courts. Advises on road alterations and capacity issues.
    - **Taxis & Ordered Transportation:** Responsible for taxi operation and all ordered transportation (hotelshuttles, charted buses, ordered taxis) at Schiphol. Grand access, bill and oversee taxi organisations that provide services.
    - **Public Transportation:** Responsible for ensuring high quality train and bus transportation to and from the airport. Also awards contract for onsite employee transportation. In close contact with Dutch Railways (NS) and public buses organisations (GVB, Connexion)
    - **Traffic Data Analysis:** In close contact with the Marketing Research & Intelligence department from Schiphol. Analyses use of transportation modalities and road infrastructures by clients. Provides information and advice on trends and developments.
    - **Accessibility Projects:** Major developments, either initiated by T&T or by higher management, are controlled by projects. This position is, together with the T&T general manager, responsible for managing and executing these accessibility projects.

6.2 Volume Analysis

To get an idea of the total volumes and the relationship between the modalities and the clients, an analysis of existing volume data is conducted and presented in this paragraph.

To get an equal comparison between the different client groups, data was used over the same year. Data on passengers is widely and continuously available at Schiphol. Data on Schiphol workers is scarce (as most Schiphol departments do not consider them their clients). Only once every two years a major research on Schiphol workers is conducted (SOAB, 2009). The latest extensive dataset available on Schiphol workers is from 2008.

The amount of transportation data available on Cargo is very limited. Every year a research is conducted on the qualitative aspects of the accessibility of Schiphol for Cargo transporters (TNS NIPO, 2008), furthermore there is high level data available on tonnes of Cargo transported, but not specified to exact method of access or modality. As such, Cargo is not considered in this Volume Analysis.

To compare figures 2008 is taken as a basis year. All figures presented are scaled to a single average day. Only departing passengers or workers are counted, for total transport movements (Arriving & Departing passengers, Arriving & Departing Workers) the figures have to be doubled. The full justification for the figures is provided in Annex D.

Following are the most essential findings on the Volume analyses on Passengers and Schiphol Workers. The full findings can also be found in Annex D.

6.2.1 Schiphol workers

Based on the combination of the Mobility research among Schiphol Workers (SOAB, 2009) and the Regioplan on amount of workers per region (Regioplan Beleidsonderzoek, 2008), Table 6-1 could be constructed. It presents the *average daily* amount of Schiphol Workers that come to the Schiphol premises. The Total amount is split over the different modalities and over the three recognized work areas.

Table 6-1: Schiphol Workers numbers split over Modalities and Schiphol Areas

	Grand total	Train	Bus	Car	Taxi/ taxibus	Other Order.	Motor-cycle	Moped	Bicy-cle
Schiphol Workers Total	**37.909**	7.304	3.407	23.540	0	0	1.178	1.134	1.218
Schiphol Centre workers	22.291	5.504	2.201	12.910	0	0	592	554	506
Schiphol non-Centre workers	10.018	794	660	7.061	0	0	460	483	537
Schiphol Rijk / AF Bus. Parc	5.607	715	498	3.798	0	0	151	124	226

To provide a better insight on the use of different modalities by the Schiphol workers, Figure 6-11 presents the percentage split in a Pie-diagram. As can be seen the Car is the most popular modality among Schiphol Workers. The bus is (relative to Passengers) also popular.

To insightfully show the volume split over the different location relative to another, Figure 6-12 provides a stapled bar chart. Also a comparison between an average and a top day is given (a top day is when every possible worker would go to work). This makes clear that the difference is almost a factor 2.

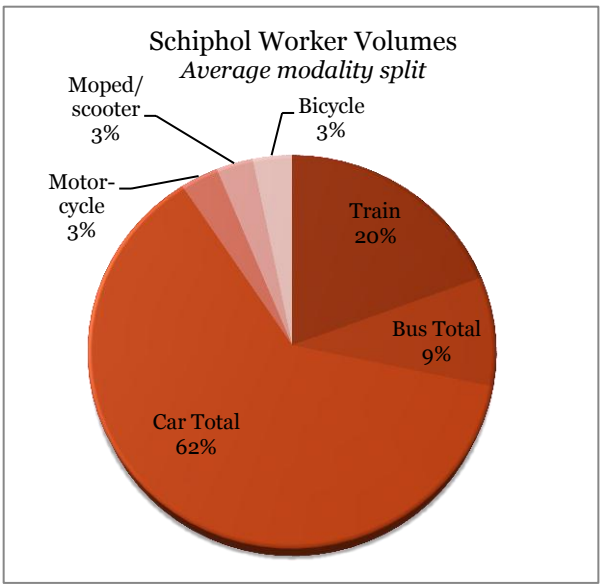

FIGURE 6-11: SCHIPHOL WORKERS MODAL SPLIT

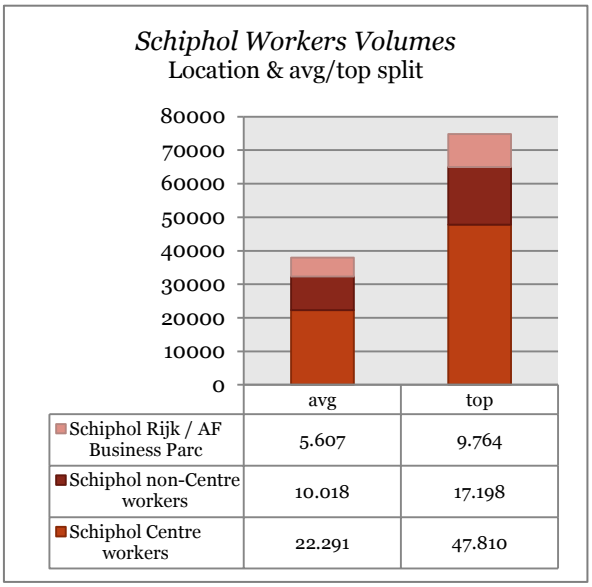

FIGURE 6-12: SCHIPHOL WORKERS LOCATION & AVG/TOP SPLIT

6.2.2 DEPARTING PASSENGERS

Based on the continual research conducted at Schiphol, could be constructed. It presents the *average* daily amount of departing passengers, split over the different modalities and travel background.

TABLE 6-2: DEPARTING PASSENGER NUMBERS SPLIT OVER MODALITIES AND PASSENGER TYPE

	Grand total	Train	Bus	Car	Taxi/ taxibus	Other Order.
Passengers Departure	**35.124**	13.458	685	14.337	5.117	1.149
Dutch Business	6.084	2.127	91	3.119	679	42
Foreign Business	6.886	2.838	129	1.369	1.828	463
Dutch Leisure	14.497	4.537	263	8.004	1.525	148
Foreign Leisure	7.658	3.957	202	1.845	1.084	496

To show the differences between the passenger travel backgrounds more insightfully, Figure 6-14 presents the total departures relative to the amount of departures per background. To get further insight in the difference between top volumes and average volumes, a side-by-side comparison is presented. (for method of calculation of top volume, please see Annex D). The highest passenger volume result from Dutch leisure passengers

To show the average modal split (the total passengers split over the different modalities), Figure 6-13 presents the percentages of the used modalities. It becomes clear that the passenger have a high preference for the train and car. The difference in modality split between an average and a top volume day is limited (please see annex D).

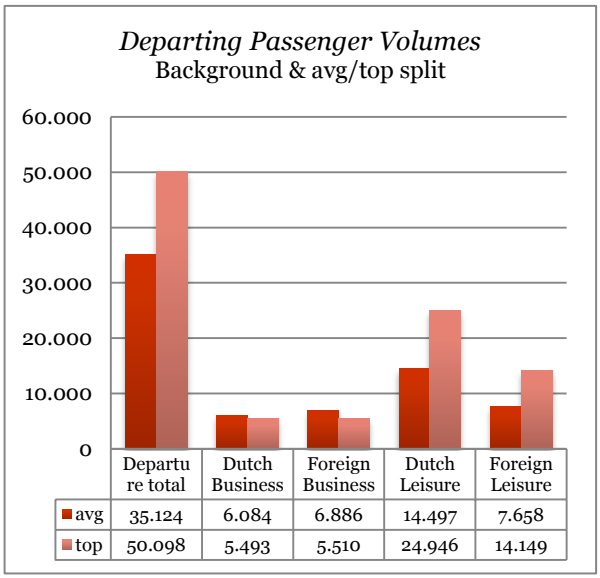

FIGURE 6-14: DEPARTING PASSENGERS ON BACKGROUND

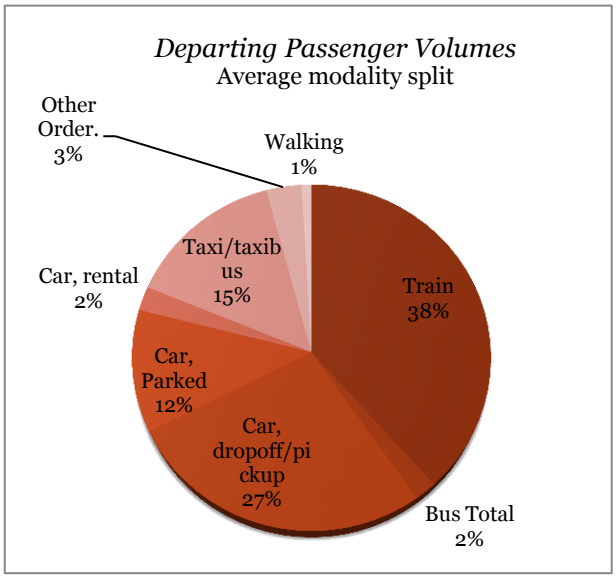

FIGURE 6-13: DEPARTING PASSENGERS ON MODALITIES

A final insight is provided by showing the course of the total amount of monthly departing passengers, split over the different modalities over 2008 (Figure 6-15). It is interesting to note that the top days are around the beginning of May and July. This puts a high strain on the Train and Car volumes.

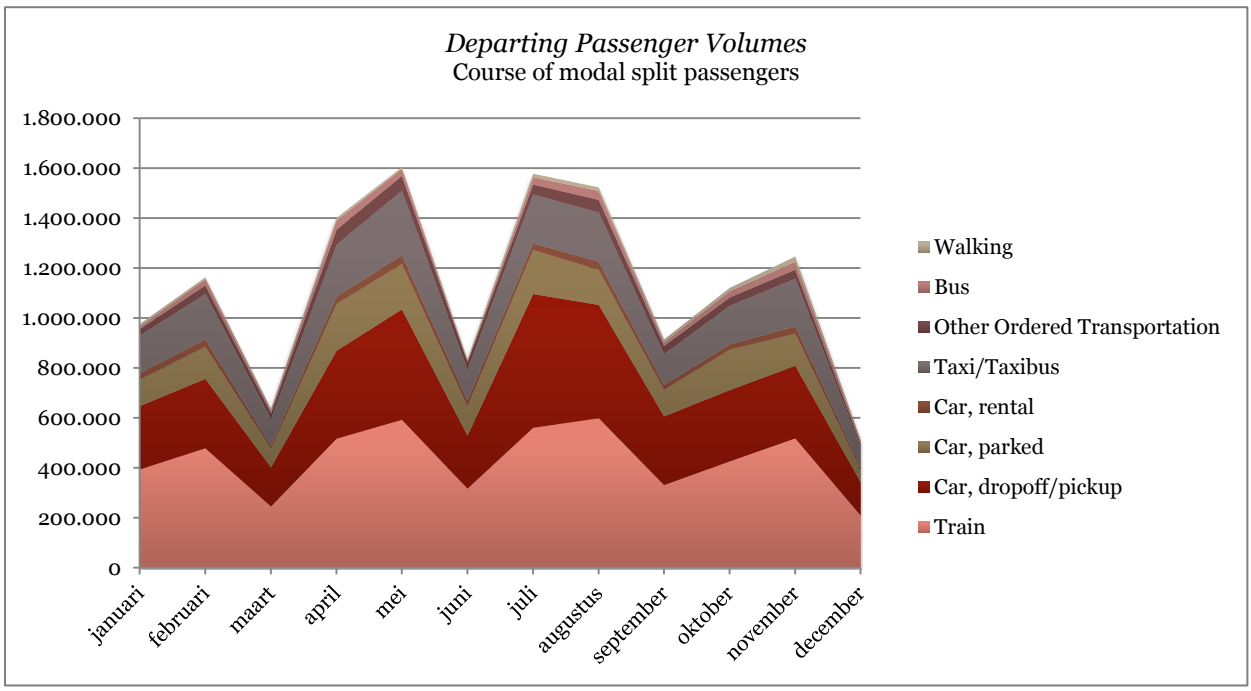

FIGURE 6-15: DEPARTING PASSENGER COURSE OF MODAL SPLIT

6.2.3 Workers & Passengers side-by-side

For a final overview Figure 6-16 is constructed that presents the daily number of people per modality (the four major modalities), split over the different recognised client groups (location of worker and type of passenger). This gives insight in what modalities are most popular and used by what client group.

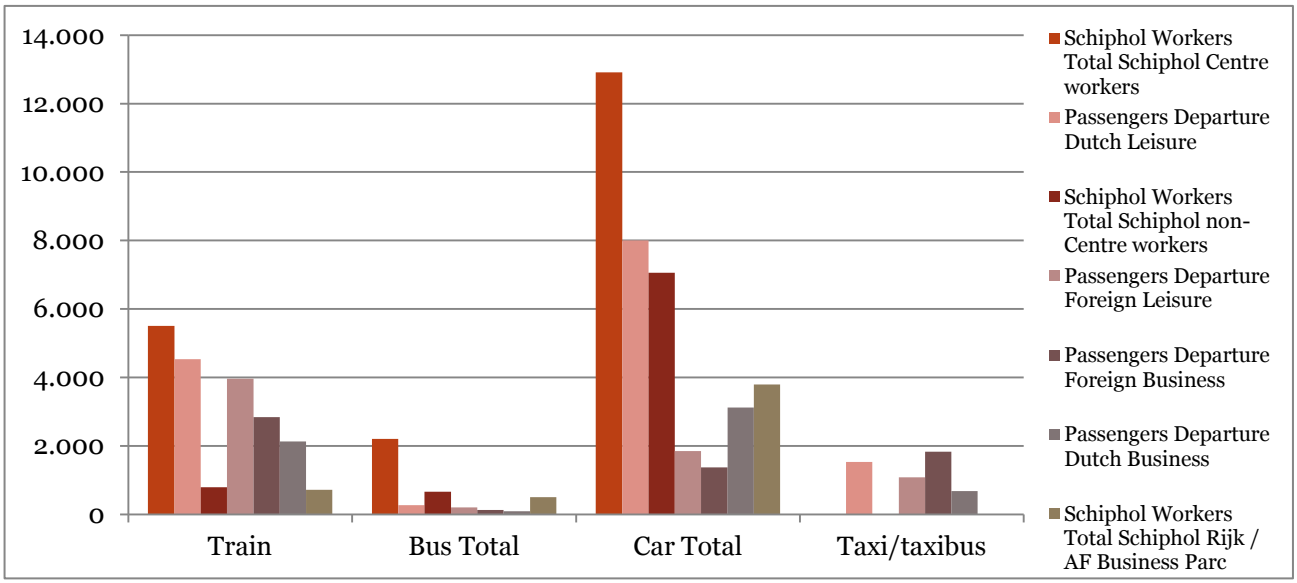

Figure 6-16: Use of Modalities by Client Groups

6.3 Stakeholders & influence

This paragraph present the different stakeholders in landside accessibility and the type of influence that T&T has on these stakeholders.

T&T is responsible for the accessibility. However the accessibility of Schiphol is determined by the combination of modalities, which are operated and/or influenced by many other companies. As a result it is important for T&T to know what their relation is to this stakeholder that co-determines the accessibility of Schiphol.

6.3.1 Control, Guide and Influence

T&T recognises three different levels of Influence.

- *Control*: When T&T has full control over the stakeholder, it falls in this category. This means that T&T directly decides on how and when the stakeholder operates
- *Guide*: The stakeholder operates independently. T&T does have certain power resources (e.g. contracts, dependencies) to steer the stakeholder
- *Influence*: The stakeholder operates fully independent. T&T does not have any direct power resources. Only indirect methods are available to influence the stakeholder.

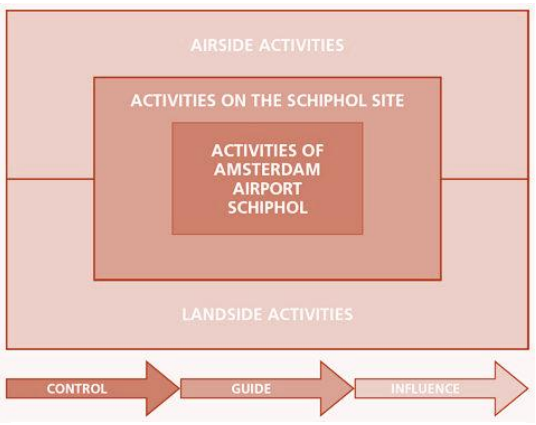

Figure 6-17: Levels of Influence on Schiphol location

When these levels of influence are fit on the physical Schiphol location, we can draw Figure 6-17. The T&T accessibility operations on AAS are under direct control, those on the Schiphol site are guided and those on the access roads are influenced.

6.3.2 Analysis

The stakeholders that are considered are those that are directly tied to T&T due to accessibility responsibilities. To find all relevant stakeholders, interviews were held with T&T managers. In this interviews all business partners were discussed. For each stakeholder the related modality, its function, it relationship to T&T and the level of influence (from T&T on this stakeholder) is questioned.

The results of the interviews are 10 recognised stakeholder. Their relation to T&T (modality) is mentioned in Table 6-3.

Table 6-3: Stakeholders & Influence

Name	Modality	Function	Relation	Level of Influence
Stadsregio	Buses	Selects bus operators for local, Sternet & Zuid Tangent buses	Contractor	*Guide*
NS	Train	Operate trains	Partnership	*Influence*
ProRail	Train	Maintain railways	Informative	*Influence*
Concession Taxis	Taxi	Organised private taxi transportation	Membership	*Guide*
Free rider Taxis	Taxi	Private Taxi transportation	Contractor	*Guide*
Rijkswaterstaat	Access Highway (traffic)	Maintain highway access roads	Informative	*Influence*
Marechaussee	all	Safety & Security	Informative	*Influence*
To Serve & Protect	Taxi	Monitor taxi process	Hired	*Control*
Traffic Operations	Curbside roads (private cars)	Ensure trafficflow and prevent unauthorised parking	Part of organisation	*Control*
STA	Shuttles & ordered transportation	Regulates access to gated curbside traffic	Part of organisation	*Control*

7 Client Accessibility Demand

Chapter 5 has set the considered performance as the amount the client demands on accessibility are met by the transportation characteristics. Chapter 6 has given insight is the provided transportation options and their characteristics. This chapter will focus on the accessibility demand. By looking for factors and criteria that are of influence on the clients perception of accessibility, we can profile accessibility demands. With other words: finding out what is important to the clients when considering the level of accessibility quality of an airport.

7.1 Factors

Critical to Quality Tree

T&T wants to offer their clients a reliable, seamless, predictable and fast connection with multiple travel alternatives to Schiphol (Schiphol Group NV - T&T, 2009). As discussed in Paragraph 5.2, Passenger services has developed a tree that also states factors that are considered essential in reaching optimal quality for the passengers.

The Critical to Quality tree, developed in conjunction with Schiphol´s Passenger Services, gives direction to what clients find important in their airport quality experience (Figure 7-1). The mentioned factors can therefore be considered essential in the goal to deliver quality to the client as it provides “the voice of the customer”. The five AAS core quality values are translated to the CTQ tree and result in stating six major factors that should lead to delivering high quality to the client, these are:

- coping with abnormalities
- predictability
- steady basic processes
- hospitality
- atmosphere
- pleasant stay

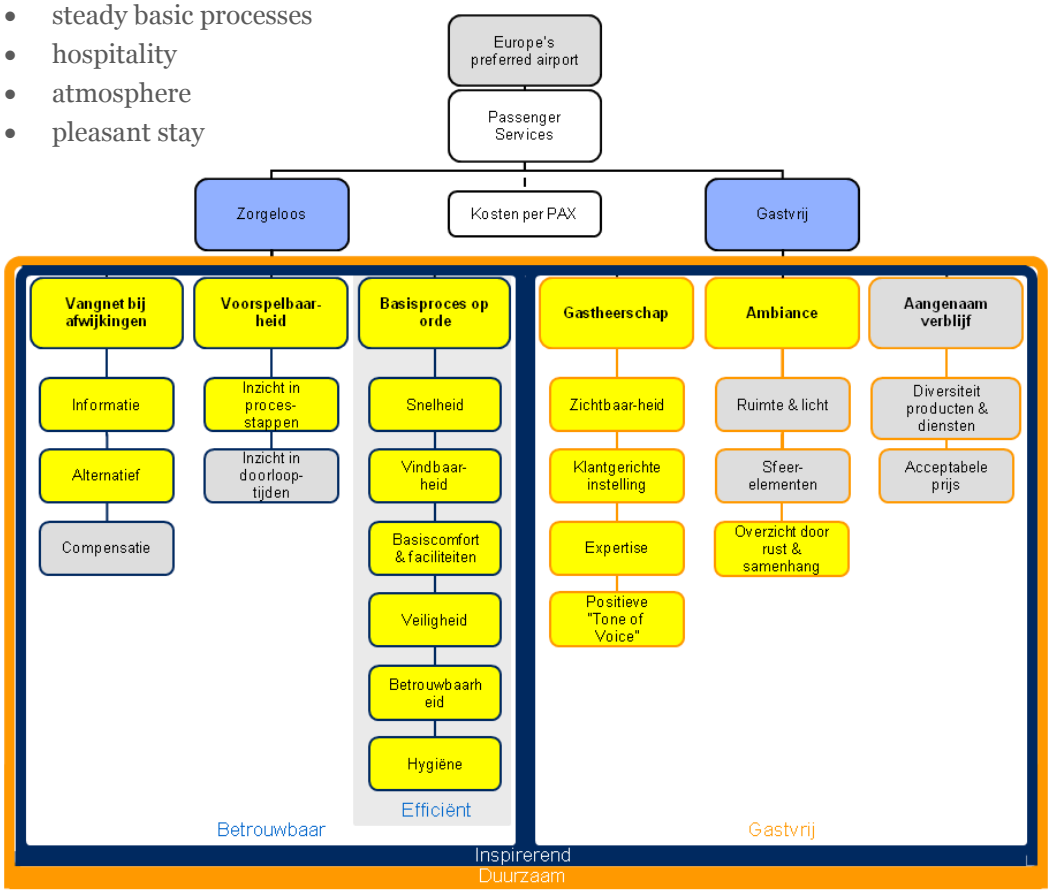

Figure 7-1: CTQ Tree

The CtQ tree is developed meticulously and based on expert judgement and research conducted by Schiphol´s MRI department (Interview van Boxtel). It can therefore be used as a solid basis in selecting criteria of influence on the quality perception of passengers.

Unfortunately these criteria cannot be use 1 on 1 for the measurement of accessibility. Although both PS as T&T are focussed on offering services to clients, there are a few major differences to be noticed:

Clients are less homogenate
The clients considered by PS and subsequently the CtQ tree are all O/D or transfer passengers. While the O/D passengers are also part of the T&T clientele, the transfer passengers are not. And as already covered by paragraph 6.1, the clients of T&T also consist out of cargo and Schiphol workers. As such the clients are more diverse and different from PS.

Demands on accessibility are unique
The CtQ tree is developed with the needs from the airport Passenger in the back of the mind. But the demands towards terminal processes are very different from the demands passengers (and other clients) have towards airport accessibility. The CtQ tree is therefore expected to be not directly suitable to state all client needs on airport accessibility.

Literature on accessibility quality demand factors

An interesting overview of market studies on passenger experiences on accessibility is presented by Appendix A from Report 46 of the Transportation Research Board (TRB); "The Role of Transit Amenities". This report states that (Transit Cooperative Research Program, 1999):

- Amenities, by themselves, will never be more important to passengers than the reliability, frequency and safety of the service.
- In general **efficient, on-time service** and **safety** (absence of crime) appeared as the highest priority in the different surveys
- Although amenities are relatively unimportant, the importance is relative. With this is meant that when the basic need towards transportation (safety, reliability, frequency) are met, there is a much stronger passenger focus on amenities such as transit shelters, padded seats, added lighting.

Hoel and Shriner have selected 5 performance measures that relate to passenger concerns and are part of the 12 measures that are identified to be useful to intermodal system measurement *(Shriner and Hoel, 1999)*. These five measures are Cost, Time, Reliability, Convenience and Quality (Figure 7-2).

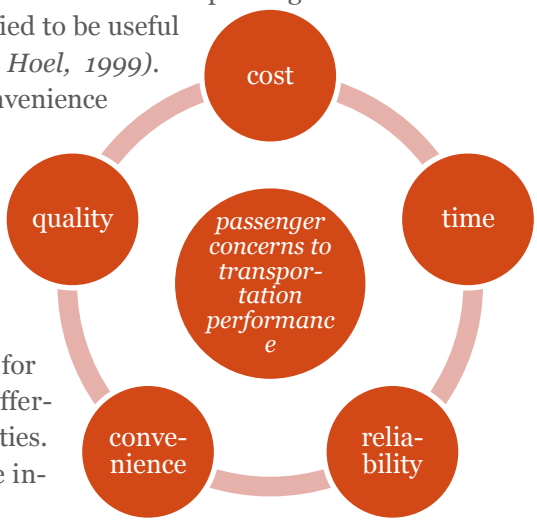

Figure 7-2: Five quality aspects of accessibility

- **Cost:** The amount of money spend to reach or depart the airport. This can either be "out-of-pocket" expenses for private automobiles/transportation or expenses for public transportation like fares and gratuities.
- **(Trip) Time:** The amount of time needed for reaching the airport. More important is the difference in access time between multiple modalities. An interesting notion is delay (unexpected time increase) due to congestion, transfers, waiting time, etc. According to Hoel and Shriner a key element for the trip time performance of public transportation is waiting time, especially since perceived waiting time is twice the actual time *(Shriner and Hoel, 1999)*.
- **Reliability:** The dependability of an access mode and as such the certainty of

the stated arrival time. Especially in airport access there is a high focus on arriving on time as the consequences of arriving too late are substantial (missing flight). On-time performance can therefore proof a valuable indicator. Worthwhile to note is that Hoel and Shriner mention that "*the passenger perception of reliability does not always reflect actual performance*"(Shriner and Hoel, 1999).

- **Convenience:** The ease of travel. Examples of convenience factors are the distance between the arrival point and the terminal entry, the number of level changes and the availability of baggage assistance (Shriner and Hoel, 1999).
- **Quality:** The passenger satisfaction with qualitative service factors such as the numbers of transfers, number of stops, provision of information, cleanliness, safety etc. Some of these factors might overlap with trip time and convenience.

Combination

In discussion with T&T management the five factors mentioned by Hoel and Shriner were used in setting the major accessibility quality factors for T&T. The CTQ factors (and criteria) can be placed (were relevant) below these five factors (as done in the following paragraph).

However one aspect is not covered by these five main factors is Information. Information is the amount of insight a client is given on travel times, prices, deviations, etc. As T&T finds providing information critical in offering quality to the client, this factor is added. The final six considered accessibility demand factors (F) are therefore (Table 7-1):

Table 7-1: Resulting demand factors

F1: COST	F2: TIME	F3: RELIABILITY	F4: QUALITY	F5: CONVENIENCE	F6: INFORMATION

7.2 Criteria

Each of the six determined factors (cost, time, quality, reliability, convenience, information) consists out of many underlying criteria. In fact the factors are a constructed value (do not consists of a single dimension). These underlying criteria together determine the overall accessibility quality.

Therefore the criteria for each of the six factors have to be set. These criteria have to meet two key requirements:

(1) Relevant: The criteria must be directly related to the parent factor
(2) Measurable: The criteria should be measurable as it otherwise is useless in a PMS

To come up with relevant and measurable criteria a literature study is conducted and combined with the expert interviews on modalities and characteristics of the Schiphol transport system.

CTQ

The CTQ tree mentions several criteria that are of influence on the quality perception of the client (passengers in this case). Although the overlying factors are not used, the criteria are valuable information. As not all criteria are (directly) measurable, not all can be used. They do give direction is what quality aspects are of importance to airport passengers and should be considered in setting the criteria for the six factors (
7-2).

TABLE 7-2: CRITERIA FROM CTQ TREE

Coping with abnormalities	Predictability	Steady basic processes	Hospitality	Atmosphere	Pleasant stay
Information	Insight process steps	Speed	Visibility	Space & light	Affordable
Alternatives	Insight turna-round time	Findability	Customer focus	Cosiness elements	Diversity
Compensation		Basic Comfort & Facilities	Expertise	Oversight	
		Safety	Positive attitude		
		Reliability			
		Hygiene			

Literature

Based on the five factors selected by Hoel and Shriner, Table 7-3 can be constructed (Shriner and Hoel, 1999). It mentions the commonly used performance measurement criteria on the five factors. The criteria are selected by Hoel and Shriner, based on their survey among 75 American airports

The aspects mentioned are focussed on measuring Level of Service (LOS) performance towards the passenger (client). Other possibilities are measuring operation and implementation costs or the effects on community members (environmental, noise and traffic concerns). However as stated before, our goal is to measure quality to the client and therefore the LOS performance factors are considered.

Cost
- Dollars per passenger trip ($/trip)

Time
- Comparison between modes or
- Total one-way trip time/base case travel time (min/min)
- Waiting time (min)

Reliability
- Reputation of reliability
- Percentage of vehicle arrivals with less than 4 min. deviation from schedule (%)

Convenience
- Total walking distance with baggage (m)
- Total walking distance without baggage (m)
- Total number of level changes when walking (#)
- Availability and extent of baggage assistance (yes/no; location available)
- Availability of baggage storage areas on vehicles (yes/no)
- Handicap-accessible (yes/no)
- Radius of service provided from the airport (km)
- Hours of operation

Quality
- Number of transfers required (#)
- Number of stops between embarkation and destination (#)
- Service frequency or headway (# departures/hour)
- Total time for stops and transfers (min)
- Adequacy of information and directions(E/G/A/P)
- Maintenance of vehicles (E/G/A/P)
- Degree of physical comfort (E/G/A/P)
- Degree of protection from the elements (E/G/A/P)
- Friendly, helpful service (E/G/A/P)
- Adequacy of lighting, security patrols, and level of safety (E/G/A/P)

TABLE 7-3: COMMONLY USED PERFORMANCE MEASURES ACCESSIBILITY

Combination

Based on the six recognised factors and the finding in Schiphol Literature and literature on (airport) accessibility, a combined concluding list of factors and criteria is constructed that are found to be of importance to the quality demands of the clients of T&T.

A total of 34 criteria are considered and located under the factors. The selection and creation of these criteria was done under the consideration that:

- the CTQ criteria are more specific for the Schiphol passengers but applicable to all passenger processes (with a focus on terminal processes)
- the criteria found in literature are more specific to airport accessibility demands but not specific to the Schiphol situation.

Table 7-4 mentions all 34 regarded criteria

TABLE 7-4: RESULTING SELECTED ACCESSIBILITY CRITERIA

F1:	**COST**	TRANSPORATION COSTS	PRICE TRANSPARANCY	PARKING COST				
F2:	**TIME**	TRANSFER/ WAITING TIME	TRAVELDISTANCE	AMOUNT OF TRANSFERS	DISTANCE ARRIVAL AND TERMINAL/OFFICE	TOTAL TRAVELTIME	FEELING OF EFFICENCY (DISTANCE/TIME)	WAITING TIME ON SPL ON EGRESS
F3:	**RELIABILITY**	CHANCE ON CANCELLATION	TRAVEL ALTERNATIVES	DELAY DUE TO UNCLEAR SIGNPOSTING	DELAY ON SPL GROUNDS	CHANCE ON DELAY	DELAY (IN TIME)	
F4:	**QUALITY**	WAITING COMFORT ON SPL	LUGGUAGESPACE DURING TRANSPORT	SAFETY MODALITY	DRIVINGQUALITY OF CHAUFFEUR	WORK/ENTERTAINMENT DURING TRANSPORT	SEATCOMFORT	CLEANLINESS INTERIOR
		ATTITUDE STAFF MODALITY	FINDABILITY TERMINAL	ATTITUDE SPL TRAFFIC OPERATIONS PERSONELL	CURBSIDE SAFETY ON SPL GROUNDS	FINDABILITY MODALITY		
F5:	**CONVENIENCE**	INCREASED WAITING DUE TO UNDERCAPACITY	TRAVELFREQUENCY	OPERATIONAL TIMES MODALITY				
F6:	**INFORMATION**	TRAVELINFORMATION IN MODALITY AND STOP	REAL TIME INFORMATION ON DEVATIONS	PRICE INFORMATION IN MODALITY AND STOP				

7.3 HOMOGENEOUS CLIENT GROUPS

Understandably not every client of T&T has equal demands towards airport accessibility. Based on the features of the client (passenger, worker, leisure, business, etc) the demands are expected to defer.

Paragraph 6.1.1 already mentioned the client groups as recognised by T&T. However our objective is to make a differentiation on accessibility demands. Therefore we want to make an additional differentiation based on typical accessibility demand and create relatively homogeneous client groups.

All T&T clients are considered and a differentiation is made based on four criteria:

- Theory suggests clients have different demands
- Internal Schiphol research among clients show different demands
- The volumes show a quantifiable homogeneous group
- Some groups are a focus of management and need to be monitored separately

This paragraph proposes an alternate client separation based on the four criteria. A prerequisite is that categorisation and definitions are in line with other Schiphol departments.

Cargo (car)

The definition in the original separation can be upheld. The only suggestion done is based on the location the Cargo has to be delivered/picked up. Schiphol has three major Cargo locations. Since there might be a (managerial) focus on one of these location or the physical difference might pose different demands towards accessibility. The three main cargo locations are (Interview H.J. Duursma, 2010):

- Cargo South
- Cargo South-east
- KLM Cargo Centre

Schiphol Workers (work)

The definition in the original separation can be upheld. Based on the biannually conducted Mobility Research (SOAB, 2009) we can separate the Workers based on their work location. The three primary locations are:

- Schiphol Centre Workers: All workers at business locations close to the Schiphol terminals
- Schiphol non-Centre Workers: All workers at business locations South, North, Technical area East, East, South-east
- Schiphol Rijk / Anthony Fokker Business Parc: All workers at these two locations

Passengers (pax)

In conjunction with other parts of the Schiphol organisation, it is recommended to defining passengers as only those that are at Schiphol due to air travel. Schiphol wide there is a separation between O/D (arriving and departing) passengers and Transfer passengers.

Interestingly T&T has a different group of clients than the other Schiphol departments. First of all they have no interest in the transfer passengers as they do not pass landside grounds. Furthermore, people who are just visiting Schiphol (and not flying) are considered clientele and therefore should be put in a separate client group. Figure 7-3 graphically represents the group of passenger and visitors that visit the terminal and are related to T&T.

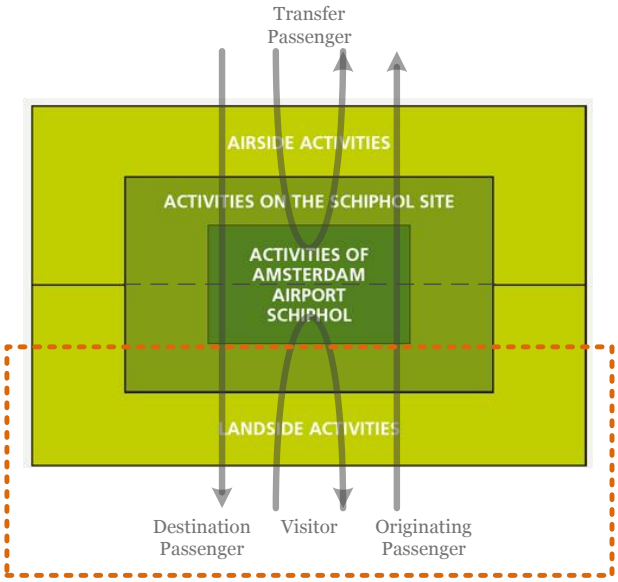

FIGURE 7-3: PASSENGERS AND VISITORS RELEVANT TO T&T

Furthermore several Schiphol departments make a classification based on nationality and reason for travelling. Since these groups might have a different attitude towards accessibility and/or have a different demands towards arriving/departing the airport, this separation is advisable for T&T as well:

- Dutch business traveller
- Dutch holiday traveller
- Non-Dutch business traveller
- Non-Dutch holiday traveller

Visitors (vis)

T&T recognises three (major) client groups . However it is advisable to make a fourth division. This is based on the fact the Schiphol Marketing, Research & Innovation department, a department within Schiphol, defines passengers as those at Schiphol for air travel. At T&T however, also visitors are considered passengers. To keep the terms equal with each other, it is proposed to make a fourth client category: Visitors

T&T has made explicit that it wants to support a hub function of Schiphol, not only for airline passengers but also for Public transportation (Interview drs. B.C.C.A. van Dorst MTL, 2010). Furthermore from commercial standpoint there is a focus on attracting shoppers for Schiphol Plaza, the publicly accessible shopping area. These groups of clients used to be part of the group Passengers is the former classification.

CONCLUDING

There are four main client groups that can be separated. Each of these main groups can be further specified based on the suspicion of different demands towards accessibility, or large volumes. In total 18 client groups can be recognised (Figure 7-4)

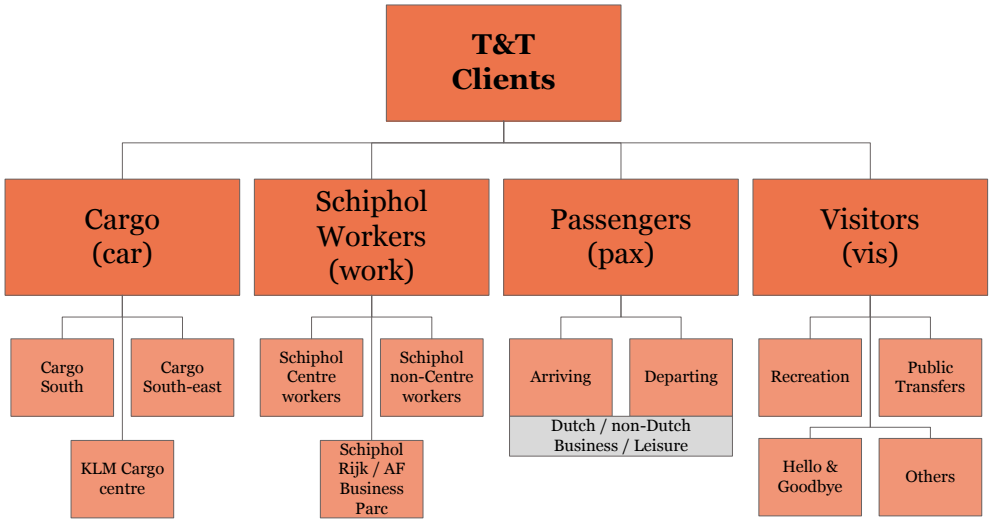

FIGURE 7-4: DIFFERENT HOMOGENEOUS CLIENT GROUPS

Due to limited time and research capability, it is not possible to district all recognised client groups. For each client group the demand profile has to be known, which requires extensive research. For the remainder of this thesis we will therefore focus on the two biggest general client groups: *Schiphol workers* and *Passengers*

7.4 DEMAND PROFILES OF CLIENT GROUPS

To know/predict what influences the demand profile of airport travellers is difficult according to the ACRP Synthesis 5 report on Airport Ground Access Mode Choice Models. They state that the decision for a mode choice (modality) is: *"not only on the price and level of service of the alternative modes but also on the characteristics of the individual travellers" (Airport Cooperative Research Program, 2008).* These characteristics include:

- trip purpose
- residents of the region or visitors
- how long residents of the region will be away from home on their trip
- whether visitors to the region will need a rental car for local travel during their visit.

The distribution of these characteristics across the population of airport travellers not only varies seasonally but also in response to external influences, such as currency exchange rates and the state of the regional economy, and changes in the air services offered at the airport.(Airport Cooperative Research Program, 2008)

No additional literature on the actual demand differences between airport client groups could be found. Separations in client groups are considered, but the differences in demands are not researched. As we need to be aware of the differentiation on demands between client groups to design a method to measure performance, additional research in needed.

7.4.1 Experiment

The assumption is that there is a difference in demand towards quality aspects of accessibility between the client groups. To confirm this and to recognize what the difference is, an experiment is developed and executed.

As concluded in paragraph 7.3, only the two biggest client groups (Passengers and Schiphol workers) are considered in the remainder of the thesis. The experiment is therefore aimed at differentiating accessibility demand between these two homogeneous client groups.

Experiment setup

Criteria: Based on the findings from paragraph 7.2 on demand criteria, a list of the 34 quality criteria on accessibly is created (Table 7-5). Al these criteria were put on post-it notes and collected in random order in containers.

Table 7-5: Experiment criteria on accessibility quality

TRANSPORATION COSTS	PRICE TRANSPARANCY	PARKINGCOST	TOTAL TRAVELTIME
TRANSFER/WAITING TIME	TRAVELDISTANCE	AMOUNT OF TRANSFERS	DISTANCE ARRIVAL AND TERMINAL/OFFICE
FEELING OF EFFICENCY (DISTANCE/TIME)	WAITING TIME ON SPL ON EGRESS	CHANCE ON DELAY	DELAY (IN TIME)
CHANCE ON CANCELLATION	TRAVEL ALTERNATIVES	DELAY DUE TO UNCLEAR SIGNPOSTING	DELAY ON SPL GROUNDS
WAITING COMFORT ON SPL	LUGGUAGESPACE DURING TRANSPORT	SAFETY MODALITY	DRIVINGQUALITY OF CHAUFFEUR
WORK/ENTERTAINMENT DURING TRANSPORT	SEATCOMFORT	CLEANLINESS INTERIOR	ATTITUDE STAFF MODALITY
FINDABILITY TERMINAL	ATTITUDE SPL TRAFFIC OPERATIONS PERSONEEL	CURBSIDE SAFETY ON SPL GROUNDS	FINDABILITY MODALITY
INCREADED WAITING DUE TO UNDERCAPACITY	TRAVELFREQUENCY	OPERATIONAL TIMES MODALITY	
TRAVELINFORMATION IN MODALITY AND STOP	REAL TIME INFORMATION ON DEVATIONS	PRICE INFORMATION IN MODALITY AND STOP	

Factors: The colours on the criteria refer to one of the six main quality factors as described in the general demands on accessibility (paragraph 7.1). The people who were asked to execute the experiment were unaware of the function of the colour and didn´t know the related factor.

Table 7-6: Quality factors on Accessibility

COST	**TIME**	**RELIABILITY**	**QUALITY**	**CONVENIENCE**	**INFORMATION**

Posters: Next two large posters were created. One for the client group Passengers and one for client group Schiphol Workers. On this poster a single axis was drawn. This axis would go from No Influence to Some Influence to Great Influence

Figure 7-5: Axis of influence

Experiment execution

The two posters (Passengers and Schiphol workers) with the axis were hung on different locations at Schiphol. People were then asked to take one of the post-it notes with an accessibility quality criterion. From their viewpoint (either as Passenger or as Schiphol Worker) they had to decide on the question:

"Is this criterion of influence on your perception of Schiphol´s accessibility?"

By putting the post-it on the posters along the axis, it is possible to rate the perceived influence on accessibility. This would result in posters full of post-it's with accessibility quality criteria as can be seen from Figure 7-6.

FIGURE 7-6: EXAMPLE OF RATED POSTER ON PASSENGERS

EXPERIMENT RESULTS

The experiment described above has been executed eight times among Passengers and eight times among Schiphol Workers. The executed posters were photographed and analysed.

Visual inspection

First a visual inspection was done to determine whether any demand difference between the Passengers and Schiphol Workers could be noticed. By highlighting the different colours on the posters, a difference in rating on factor level could be established.

An example of this can be seen in Figure 7-7 and Figure 7-8, that show the result of two different client gorups. This visual inspection confirmed that a difference in demand rating between the two client groups was occurring.

FIGURE 7-7: HIGHLIGHTED FACTORS ON RATED PASSENGER POSTER

FIGURE 7-8: HIGHLIGHTED FACTORS ON RATED SCHIPHOL WORKER POSTER

7.4.2 Resulting Demand profile

Based on the position of the post-it notes from the 16 conducted experiments, it is possible to create a demand profile. This profile states what the importance is of the different demand criteria.

On all resulting posters a grid was placed that would separate the criteria in five (5) different segments. Each segment was given a rating (from 1-5) and all criteria within that segment were valued according to the rating. An example of a segmented and valued poster is given by Figure 7-9. All 16 posters were evaluated and valued.

Figure 7-9: Segmented and valued poster

Differentiation scores

The average score of each criterion was calculated together with the standard deviation, modus and median to get further insight. The criteria that belonged to the same factor (colour) were also averaged to get a score on factor level.

The scores of both the criteria as the factors for each experiment conducted for the group Passengers is presented in Table 7-7. The scores of the Workers group can be found in Annex E.

Table 7-7: Scores Passengers based on experiment

		PAS1	PAS2	PAS3	PAS4	PAS5	PAS6	PAS7	PAS8	AVG	STD DEV (σ)	MED.	MOD.	RELIMP	COM FAC AV(	RELIMP
w11	TRANSPORATION COSTS	4	5	4	2	4	5	4	3	3,9	0,99	4	4	0,33		
w12	PRICE TRANSPARANCY	2	2	4	5	3	3	2	5	3,3	1,28	3	2	0,28	3,9	0,19
w13	PARKING COST	5	3	5	5	5	4	5	5	4,6	0,74	5	5	0,39		
w21	TRANSFER/WAITING TIME	2	3	3	4	3	3	2	4	3,0	0,76	3	3	0,12		
w22	TRAVELDISTANCE	4	4	3	2	2	3	2	2	2,8	0,89	2,5	2	0,11		
w23	AMOUNT OF TRANSFERS	3	2	4	5	4	3	2	3	3,3	1,04	3	3	0,13		
w24	DISTANCE ARRIVAL AND TERMINAL/OFFICE	2	4	4	5	4	5	4	4	4,0	0,93	4	4	0,16	3,6	0,17
w25	TOTAL TRAVELTIME	4	5	3	5	4	3	4	5	4,1	0,83	4	4	0,17		
w26	FEELING OF EFFICENCY (DISTANCE/TIME)	4	4	5	4	4	5	3	2	3,9	0,99	4	4	0,16		
w27	WAITING TIME ON SPL ON EGRESS	5	4	4	2	4	5	4	3	3,9	0,99	4	4	0,16		
w31	CHANCE ON CANCELLATION	4	5	4	3	4	5	5	4	4,3	0,71	4	4	0,16		
w32	TRAVEL ALTERNATIVES	4	5	5	4	4	5	5	5	4,6	0,52	5	5	0,17		
w33	DELAY DUE TO UNCLEAR SIGNPOSTING	5	4	5	5	3	5	5	5	4,6	0,74	5	5	0,17	4,6	0,22
w34	DELAY ON SPL GROUNDS	4	3	5	5	4	5	5	4	4,4	0,74	4,5	5	0,16		
w35	CHANCE ON DELAY	5	5	5	4	5	5	5	5	4,9	0,35	5	5	0,18		
w36	DELAY (IN TIME)	5	5	4	4	5	5	5	4	4,6	0,52	5	5	0,17		
w41	WAITING COMFORT ON SPL	4	3	4	2	2	4	4	3	3,3	0,89	3,5	4	0,08		
w42	LUGGUAGESPACE DURING TRANSPORT	4	2	4	3	4	4	3	4	3,5	0,76	4	4	0,09		
w43	SAFETY MODALITY	2	4	2	3	5	5	4	3	3,5	1,20	3,5	2	0,09		
w44	DRIVINGQUALITY OF CHAUFFEUR	3	2	4	3	4	3	2	4	3,1	0,83	3	3	0,08		
w45	WORK/ENTERTAINMENT DURING TRANSPORT	4	5	5	4	5	3	3	4	4,1	0,83	4	4	0,11		
w46	SEATCOMFORT	3	2	4	5	4	5	3	3	3,6	1,06	3,5	3	0,09	3,3	0,16
w47	CLEANLINESS INTERIOR	2	1	5	4	4	3	4	2	3,1	1,36	3,5	4	0,08		
w48	ATTITUDE STAFF MODALITY	2	2	5	4	5	3	3	2	3,3	1,28	3	2	0,08		
′491	FINDABILITY TERMINAL	2	4	3	5	3	4	4	3	3,5	0,93	3,5	4	0,09		
′492	ATTITUDE SPL TRAFFIC OPERATIONS PERSONEEL	3	2	4	3	5	5	2	3	3,4	1,19	3	3	0,09		
′493	CURBSIDE SAFETY ON SPL GROUNDS	2	2	3	2	1	1	2	3	2,0	0,76	2	2	0,05		
′494	FINDABILITY MODALITY	3	2	2	3	4	3	3	2	2,8	0,71	3	3	0,07		
w51	INCREASED WAITING DUE TO UNDERCAPACITY	3	4	2	4	4	5	4	3	3,6	0,92	4	4	0,30		
w52	TRAVELFREQUENCY	4	5	4	5	4	5	5	4	4,5	0,53	4,5	4	0,37	4,1	0,20
w53	OPERATIONAL TIMES MODALITY	4	4	5	4	4	3	4	5	4,1	0,64	4	4	0,34		
w61	TRAVELINFORMATION IN MODALITY AND STOP	1	2	1	1	2	2	1	1	1,4	0,52	1	1	0,32		
w62	REAL TIME INFORMATION ON DEVATIONS	2	2	1	2	2	1	2	2	1,8	0,46	2	2	0,41	1,4	0,07
w63	PRICE INFORMATION IN MODALITY AND STOP	1	2	1	1	1	1	1	1	1,1	0,35	1	1	0,26		

All the interviewees were asked to give their view on the influence of the criteria on the

overall perception of accessibility. The average (AVG) scores on the criteria give a substantiated figure for the weights of the different criteria. Also mentioned are the combined averages of the criteria that belong to the same factor (COM FAC AVG). This figure indicates the importance of this factor on the total quality perception of accessibility.

When the combined factor scores are compared between the two client groups, the differences in demands between the groups becomes clear (Table 7-8).

Table 7-8: Resulting Factor Scores of Experiment

FACTOR	COST	TIME	RELIABILITY	QUALITY	CONVENIENCE	INFO
PASSENGER	4	4	5	3	4	1
SPL WORKERS	2	4	3	2	4	3

As can be seen from the results, there is a significant difference in the quality demands towards accessibility between Passengers and Schiphol Workers. This difference will be used in the remainder of this Thesis to differentiate in the demand and as such in the performance scores on the different client groups.

8 FILLING IN THE FRAMEWORK

Design track 1 started with the presentation of a framework that could be filled in to develop a method for performance measurement. Through several analyses the required information is gathered and it becomes possible to fill in the framework and design performance measurement method.

To fill in the framework (Figure 8-1) and create a method for performance measurement, the most relevant result from chapters 5, 6 and 7 are used. These are:

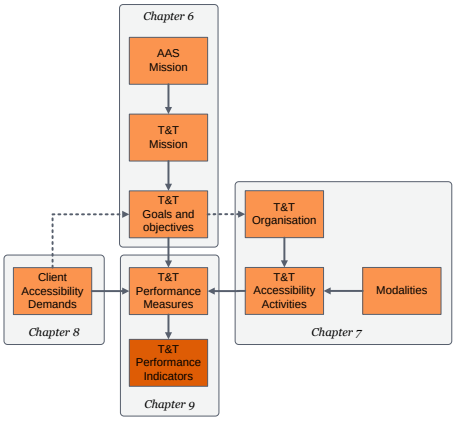

FIGURE 8-1: FRAMEWORK TO BE FILLED IN

Considered performance:

- The amount in which the demands of a client group on the quality of accessibility are met by the characteristics of a modality

Client Needs

- Four major client groups are recognised: Passengers, Schiphol Workers, Visitors and Cargo. The first two (passengers and Schiphol workers) are the biggest volumes and most relevant to T&T.
- The four client groups can be further specified to subgroups, based on suspected demand homogeneity.
    - For Passengers this is Arriving/ Departing, Business/Leisure and Dutch/Non-Dutch.
    - For Schiphol workers this separation is based on the location they work. Three major locations are considered: Schiphol centre, Schiphol non-centre and Anthony Fokker Business park/Rijk. Furthermore a separation can be made between flying and non-flying personnel.
- The needs towards the quality of accessibility can be expressed on six different factors: Cost, Time, Reliability, Quality, Convenience and Information. Each factor has several criteria.
- Each client group has a certain demand profile that rates the importance of the different accessibility factors for the client group. Some factors are considered of higher importance (relatively) than others.
- Based on a first experiment a difference in demand profile towards accessibility between passengers and Schiphol Workers is noticed. Especially Cost, Reliability and Information score differently among the two client groups.

Service Offering

- Eight major modalities are recognised: Car, Bus, Train, Taxi, Ordered Transportation, Motorcycle, Scooter, Walking. The first three of these modalities (Car, Bus, Train, Taxi) are by far the biggest volumes and therefore of the greatest importance.
- The T&T organisation can be separated in four different roles: Operational management, Product development, Analysis and Program Management.
- The main consideration is that all modalities have certain performance characteristics on accessibility that are influenced due to the activities from T&T. These activities alter the quality characteristics of the offered service by the modality and as such the quality of the provided accessibility.

- The amount of influence that T&T has on (the quality aspects of) a modality, can be distinguished in Control (big influence), Guide (reasonable influence) and Influence (some influence). The relation with each modality is different
- Each modality has resulting quality aspects that can be measured.

Performance Measures

- T&T has stated that its goal is to meet the quality demands of its clients.
- As such, the six factors recognised to state performance perception of clients on accessibility quality, are considered performance measures. The underlying criteria have to be measured to capture performance.
- Measurements on these criteria have to be done by data sources that are representative for these criteria. Ideally the data sources are equal to the quality criteria found.

Based on the initial framework and supplemented with the concluding findings described above, Figure 8-2 could be created. This figure represents what is considered relevant performance in airport accessibility and what measurements should be taken to measure airport accessibility performance.

By filling in the framework it is known what is considered performance and what criteria have to be measured to state performance. Next step is to design a method to quantify the performance, based on taken measurements.

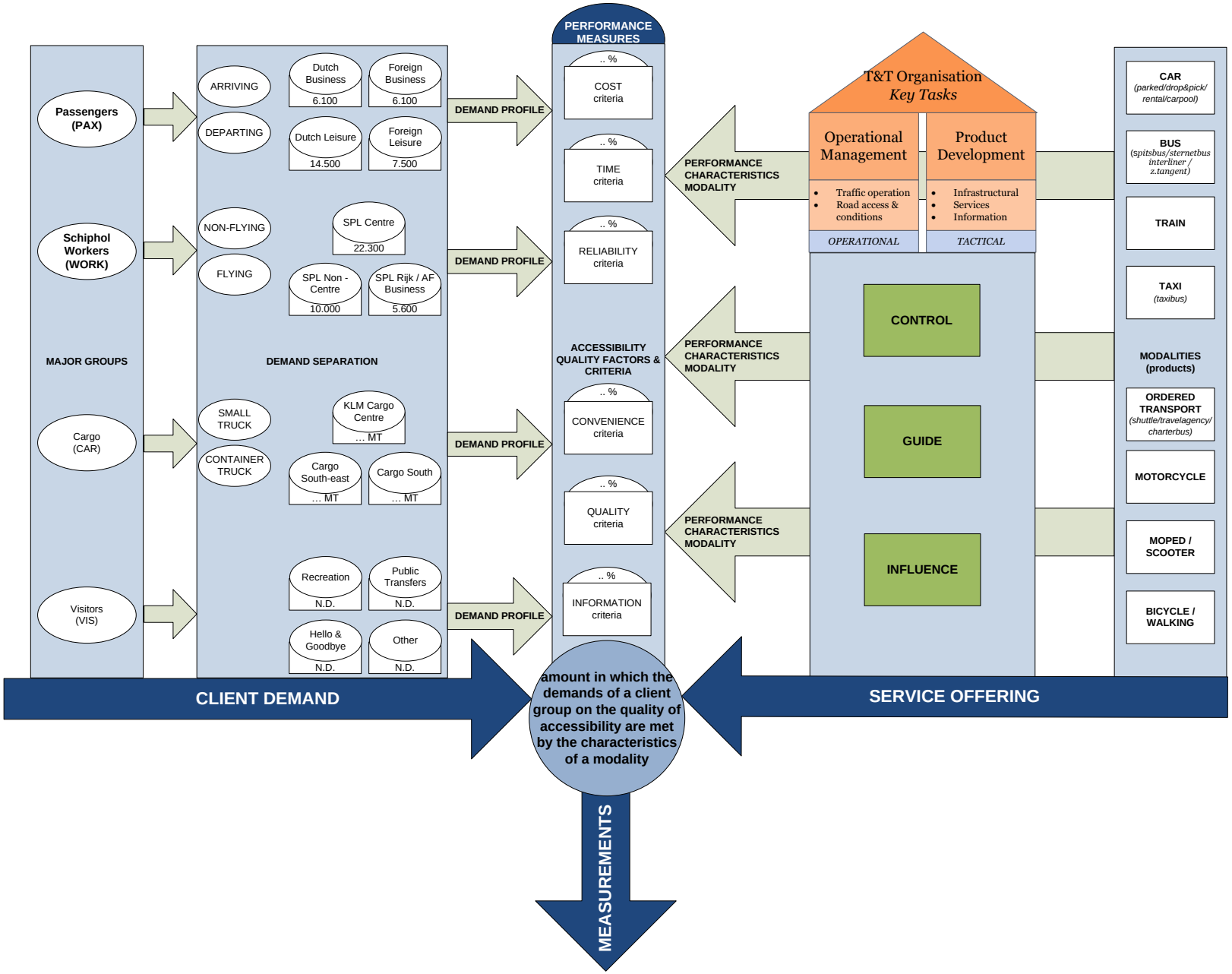

FIGURE 8-2: RESULTING PERFORMANCE FRAMEWORK

9 Design of a performance measurement method

The analyses and the filled in framework have shown what should be considered performance and what criteria have to be measured. This chapter aims at designing a method to use these measurements to create relevant performance indicators on the quality of the airport accessibility.

According to Shriner and Hoel, measuring the level of landside access performance that is provided to air passengers is not possible under current practices. They state that there is a lack of standardised evaluation practices that can compare the performance provided. They conclude by: "*An objective and consistent methodology is needed to evaluate existing conditions and determine the most appropriate option from a passenger perspective*" (Shriner and Hoel, 1999)

This chapter will introduce such a measurement methodology, based on literature and expert interviews on airport transportation process, that is able to quantify the considered performance and create indicators.

The performance measures have to be interpreted and transformed into performance indicators to be of value to state performance.

Starting point in the design of a performance measurement method is that we now know:

- what criteria reveal performance on the quality of airport accessibility
- what the relative importance of these criteria is to the clients through their demand profile
- performance is considered the amount in which the demand profile of a client group is met by modalities performance

Our measurement method has to use performance data on the criteria and weight the measurements according to the demand profile of the considered client groups. Improvement of performance on criteria that are found to be of high importance to a client group, should render a higher value on the resulting overall performance indicator and vice versa.

9.1 Level of Service

A well-known definition of service quality within the transportation literature is Level Of Service (LOS) (Correia et al., 2008, Waidringer, 2001). LOS states the amount of service that is offered to clients.

Several studies are undertaken to develop methods to measure the LOS of airports taking into account user demand (Correia et al., 2008). However most of these studies focus on terminal processes. Accessibility is only captures by these studies by looking at curb side processes only, which is very limited.

A broad measure reflecting the LOS of the accessibility as a whole of an airport terminal for a given type of passenger is non-existent but would be useful for planning, design and management levels. It would make it possible to it to identify the level of importance attributed to individual components by the different groups of clients and a such prioritise current deficiencies. Also it could provide a method to benchmark different airports on their accessibility (Correia et al., 2008).

9.1.1 DATA REQUIREMENT

The factors and criteria that can state relevant performance are known. But how can the values of these criteria be measured and expressed in a representative value? After all we want to know performance and as such a figure has to be constructed. There is a requirement for is a data that represents performance for each criteria.

Table 9-1 is an example of how Shriner and Hoel see the data requirements and corresponding data sources needed for their performance measures (Shriner and Hoel, 1999)

TABLE 9-1: SHRINER AND HOEL STATING DATA REQUIREMENTS AND SOURCES FOR ACCESSIBILITY FACTORS

Performance Measure	Data Requirement	Data Source
Cost	1. Toll costs 2. Parking rates 3. For-hire mode fares 5. Service gratuities	1. Facility inventory 2. Facility inventory 3. Mode inventory 5. Passenger surveys
Time	1. Total one-way trip time 2. Base case travel time 3. % waiting time of total trip time	1. Passenger surveys, Mode operators 2. Mode observation 3. Mode observation
Reliability	1. Mode arrival patterns 2. Mode vehicle breakdown history	1. Mode observation 2. Mode operators
Convenience	1. Walking distances 2. Number of level changes 3. Mode characteristics	1. Airport plans, Facility visits 2. Airport plans, Facility visits 3. Mode operators
Quality	1. Mode characteristics	1. Mode operators, Mode observation

However the situation at SPL is more complex for two reason:

(1) We have appointed many more criteria
(2) The data requirement for each criteria defers per modality.

As such there is a need for a combined list that mentions all needed data for each criteria, per modality. This list is constructed by interviewing data specialists at T&T and reviewing SPL literature.

Data requirement, unity and source for selected criteria

The starting point of the selection of data sources is the set of 34 criteria that were related to factors of influence on the quality perception of accessibility.

The criteria have to be measured for each modality, as the performance of each modality individually has to be known, and there are no sources for overall performance on all modalities.

The volume analysis from paragraph 6.2 provides the most used modalities by the different client groups. Combining the criteria with the most used modalities gives a table (Table 9-2) for which each crossing needs a data source to be measured according to the developed method.

For each crossing three element have been analysed:

- *Data requirement* ***(D)***
- *Unit of data* ***(U)***
- *Source of data* ***(S)***

The information needed to fill in the three elements for each crossings was received by analysing literature on accessibility measurements (Koster et al., 2010, Jehanfo and Dissanayake, 2009, Ji and Gao, 2010) and information received from interviews with the modality managers (Interview mr. A.J.C. Lensvelt, 2010, Interview F. Jongkind, 2010, Interview H.J. Duursma, 2010)

The full result of this analysis is presented in Annex 0. Table 9-2 presents a selection of criteria combined with the modalities used by Passengers to give an indication of the insight gained from the data need analysis.

TABLE 9-2: EXAMPLE OF DATA NEED ON SELECTED CRITERIA FOR PASSENGERS

PASSENGER						
Criterion (C)		**TRAIN**	**CAR DROP/PICK**	**CAR PARKED**	**TAXI**	**BUS**
Price per trip	d	**compar. index**	**compar. index**	**compar. index**	**compar. index**	**compar. index**
	u	euro/total trip	euro/total trip	euro/total trip	euro/total trip	euro/total trip
	s	transporter	avg price/km	avg price/km	transporter	transporter
Price trans-parancy	d	**stating/comp prices**	**NA**	**stating/comp**	**stating/comp**	**stating/comp**
	u	# yes/no		# yes/no	# yes/no	# yes/no
	s	transporter/T&T		transporter/T&T	transporter/T&T	transporter/T&T
Parking costs	d	**NA**	**access price (fut)**	**price short/long**	**NA**	**NA**
	u		euro/min	euro/hour		
	s		SPL parking	SPL parking		
Actual time to randweg	d	**time to reach SPL**	**time to reach SPL**	**time to reach SPL**	**time to reach SPL**	**time to reach**
	u	min	min	min	min	min
	s	NS planner	ANWB planner	ANWB + SPL	ANWB + taxikwal	transporter plan-
Waitingtime on trans-fers/stops/fil	d	**time trans + stops**	**time file**	**time file**	**time file**	**time trans +**
	u	min	min	min	min	min
	s	NS planner	ANWB file data	ANWB file data	ANWB file data	transporter plan-
Real time information on alterna-	d	**Scherm + pres inf**	**Scherm + pres inf**	**Scherm + pres inf**	**Scherm + pres inf**	**Scherm + pres**
	u	Yes/No %	Yes/No %	Yes/No %	Yes/No %	Yes/No %
	s	Allart/NS	RWS	RWS	Ferry	Allart/SR
Delay onsite reaching	d	**Delay time tunnel**	**Delay t. RW+CRT**	**Delay t. RW+CRT**	**Delay t. RW+CRT**	**Delay t.**
	u	% & min	% & min	% & min	% & min	% & min
	s	NS measurem.	TO & tbd	TO & tbd	TO & tbd	TO & tbd
Baggage storage	d	**compar. index**	**compar. index**	**compar. index**	**compar. index**	**compar. index**
	u	piec/pssgr	piec/pssgr	piec/pssgr	piec/pssgr	piec/pssgr
	s	NS/percep.	100	100	taxikwal	GVB en Connexion
Safety travel	d	**tot. accid. route**	**tot. accid. route**	**tot. accid. route**	**tot. accid. route**	**tot. accid. route**
	u	# accidents/death	# accidents/death	# accidents/death	# accidents/death	# accidents/death
	s	NS	RWS	RWS	RWS & research	GVB en Connexion

9.2 MEASUREMENT METHOD

The goal is to have a system that is able to compare all the different forms and units of data. The different unities currently make comparing the values impossible. To overcome this problem and alternative measurement method is proposed.

Also mentioned in Table 9-2 is the unity (u) in which the data is presented. As can be seen these unities defer very much among the different criteria. Even when looking at the same criterion the unity may defer between modalities as the used data source depends on the modality considered.

The inequality between the units and sources makes a direct comparison not possible. Therefore an alternative method has to be proposed.

9.2.1 INDEX RATING

As could be seen from the introduction and the chapter on relevant performance (Chapter 0), T&T aims at improving the delivered accessibility quality. As such they are interested in (positive) changes of the accessibility criteria. There is a need to know if and how much the accessibility has improved (or decreased). The resulting Performance Measurement System has to show what quality aspects are increasing and decreasing and what the influence is on the overall Accessibility Quality.

The result is a method to measure the change on the different data sources and to express this change as a percentage of the original value. A positive change will result in a higher value, and vice versa. An *index* (I) is used to represent the current performance on a criterion (C) in comparison with past performance. The calculation is done according to:

$$(1)\ {I^m}_{xy}(t_1) = \frac{{C^m}_{xy}(t_1)}{{C^m}_{xy}(t_0)} * {I^m}_{xy}(t_0),$$

Where ${C^m}_{xy}$ is the *measured value* of modality (m) of criteria y that is related to parent factor x.

$I^m{}_{xy}$ is the index that is calculated, for a given moment (t), on modality (m) for criteria y that is related to parent factor x

As a base line the values measured on the criteria on 1/1/11 are taken. The measured state of all criteria is taken by measuring the data sources and valued at index 100.

On t_1 all criteria are measured again and its values are compared with the original t_0 values according to formula (1). This provides indices for all criteria on t_1 that represents the changes in performance in comparison to t_0.

9.2.2 Weighting influence based on the demand profiles

Formula (1) has provided an index on the increase or decrease of each criterion. However the criteria are not of equal influence to their parent factors on accessibility quality as determined in Chapter 8. The amount of influence a criterion has on the perception of accessibility defers between the different client groups as could be seen from the differentiated demand profiles.

The six calculated factors are also not of equal influence on the overall LOS of accessibility. They are again of influence according to the stated importance of the client group considered (the demand profile). When calculating the Level of Service for T&T, the indices of the criteria have therefore be valued against the demand profiles of the client groups by assigning weights to each criteria.

The assigned weights are of importance to managers and designers, because they will allow them to focus their attention on the most important components of accessibility. Based on the concept of weighting the different criteria into an overall perception of accessibility quality, a bad passenger experience on two criteria of little importance according to the demand profile can be counterbalanced by a good experience on an important criterion.

Weighting functions

By using the demand profiles of a client group as weights on the measurements done on the selected criteria, the criteria of importance are valued higher than unimportant criteria. As such the more the important demands criteria of the client group are met, the exponential higher the resulting score will be.

Different demand profiles

In this thesis two client groups are considered (Passengers and Schiphol Workers) and their demand profiles are known through an experiment. As such, two sets of weights are available that can be used to rate the indices.

The appointed weight is dependent on the criterion or factor it is weighting and on the client group that is considered. We can define a considered weight (w) as:

$$(2)\quad w^g{}_{xy}$$

Where the considered weight (w) depends on the client group (g) and the associated index (xy) (index xy depends on criterion xy).

The experiment of paragraph 7.4 has given all the weights for the criteria for the groups Passengers and Clients. The numerical values of all used weights can be found in the resulting tables of the experiment that state the appointed weights to the criteria and factors.

Figure 9-1 shows how constructed indices of the measured criteria ($I^m{}_{xy}$ are connected to the index of its parent factors ($FI^m{}_x$) through weights ($w^g{}_{xy}$) that are based on a demand profile of a client group (g)

The calculated indices of the different factors (based on the weights) are connected to the resulting value of interest: the combined index on the perceived LOS of accessibility

(for a certain client group and modality). This amount of influence is also determined by (client group specific) weight ($w^g{}_x$)

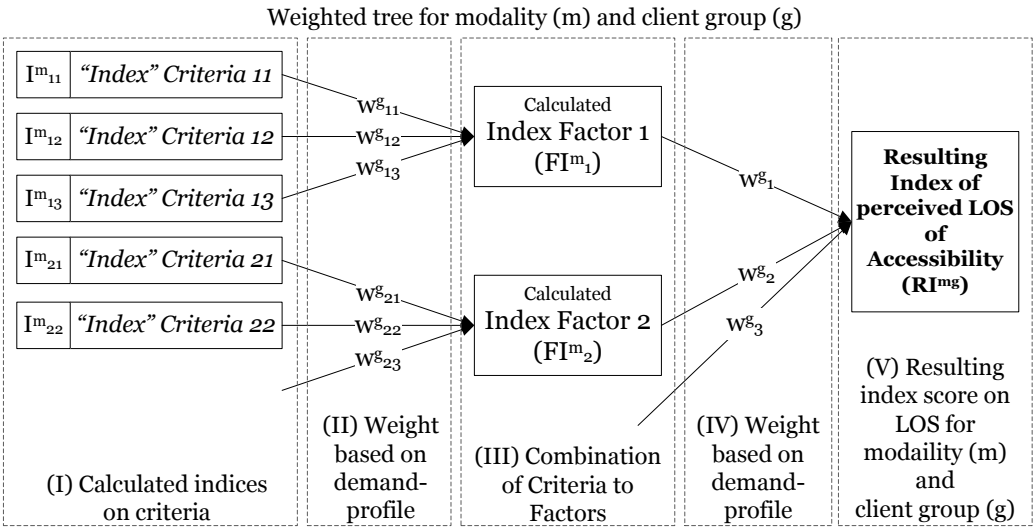

FIGURE 9-1: METHOD FOR CALCULATING PERCEIVED LOS ACCESSIBILITY

The index is multiplied by the associated weight (w) to give a greater influence to criteria that are, according to the demand profile, of higher importance to the overall quality perception of accessibility.

After the multiplication of the index criteria and the weight, the results of all criteria related to a single factor are summed. This figure has to be divided by the sum of the weights to come to a weighted average index on the considered factor (FI). The calculated weighted average ($FI^m{}_x$) can be expressed as:

$$(3)\quad (FI^m{}_x) = \frac{w^g{}_{x1} * (I^m{}_{x1}) + w^g{}_{x2} * (I^m{}_{x2}) + \ldots + w^g{}_{xy} * (I^m{}_{xy})}{w^g{}_{x1} + w^g{}_{x2} + \ldots + w^g{}_{xy}},$$

Where $w^g{}_{x1}$ is the weight put on the first criterion index Index $I^m{}_{x1}$). $w^g{}_{xy}$ is the weight on the last criterion index ($I^m{}_{xy}$). m is the modality considered and g the client group.

Given the fact that the amount of influence each factor index (FI) has on the resulting LOS index on accessibility (RI) is also based on weights, the formula for the resulting index (RI) is defined as:

$$(4)\quad RI^{mg} = \frac{w^g{}_1 * (FI^m{}_1) + w^g{}_2 * (FI^m{}_2) + \ldots + w^g{}_6 * (FI^m{}_6)}{w^g{}_1 + w^g{}_2 + \ldots + w^g{}_y},$$

where $w^g{}_1$ is the weight appointed to factor index 1 ($FI^m{}_1$). m is the modality considered and g the client group.

Using this approach, the composite equation for the resulting index can be developed as follows:

$$(4)\quad RI^{mg} = \frac{\sum(w^g{}_{xy} * (I^m{}_{xy}))}{\sum(w^g{}_{xy})},$$

Formula (5) states that the resulting index for a certain modality (m) and client group (g) is the sum of the weight and index multiplications for all criteria xy

This developed method of weighted contribution per criterion allows us to add the separate contributions of the different attributes to obtain the total level of service measure. It is the best known as the multi-attribute functions, and it is important both because of its relevance to some real problems and its relative simplicity (Keeney and Raiffa, 1976).

Using this method to calculate the resulting LOS, we can fill in the selected criteria and factors. This gives a full tree with all considered criteria. Figure 9-2 presents this tree with all recognised criteria and factors (this tree is simplified as the variables for a certain modality or client group are omitted)

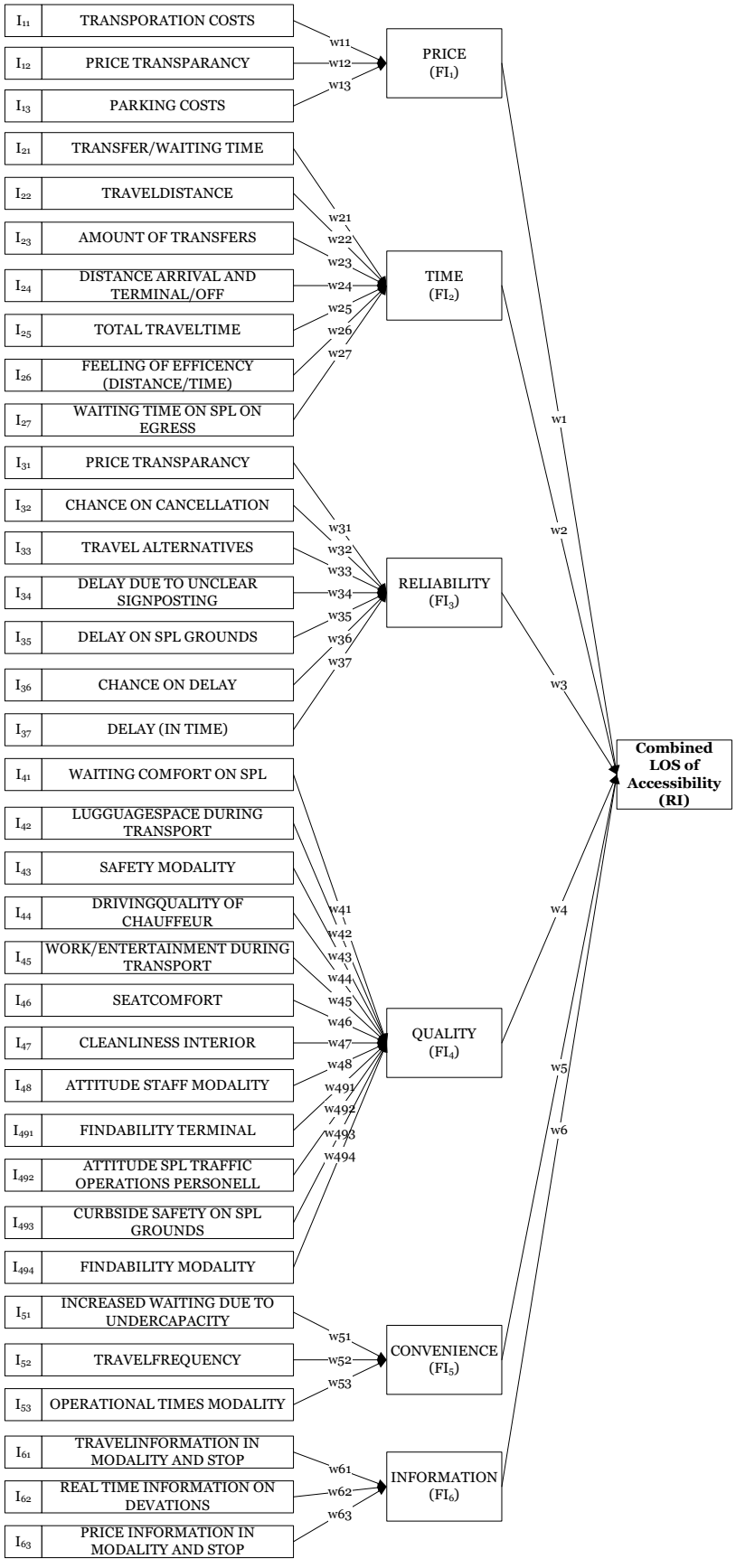

Figure 9-2: Criteria of influence on Accessibility factors

9.2.3 Combining modality and client group indices

The measurement method gives the possibility to state a resulting index score for each client group and modality considered. To present an index score for all modalities and all client groups, these individual scores have to be combined.

According formula (5), RI^{mg} presents the resulting accessibility quality index for modality m and client group g. The volume analysis done in paragraph 6.2 showed that the client groups and modalities are not equal in size, therefore it is not possible to simply take the average of all resulting indices. It can be assumed that the bigger a client group or modality use is, the bigger its influence of the overall accessibility quality index should be.

To come to a combined index score for the accessibility quality, a weighted average of all resulting indices (RI^{mg}) has to be taken according to the found volumes. As the use of the volumes might change over the time, current volumes have to be used.

The conducted volume analysis in paragraph 6.2 on modalities and the client groups gave the following volume split over the groups and modalities was found (average daily one way volumes):

Table 9-3: Absolute daily modality volumes (one-way)

	Train (m1)	Bus (m2)	Car (m3)	Taxi (m4)	Ordered (m5)	Motorcycle (m6)	Moped (m7)	Bicycle (m8)
Schiphol Workers (g1)	7.304	3.407	23.540	0	0	1.178	1.134	1.218
Passengers (g2)	13.458	685	14.337	5.117	1.149	0	0	0

If an overall index on accessibility is wanted, the RI^{mg} scores have to multiplied by the volumes in Table 9-3: Absolute daily modality volumes (one-way). An overall index score on the quality of accessibility, can therefore be calculated according:

$$(5)\ RI = \frac{RI^{m1g1} * (\text{"volume of m1g1"}). \ldots + \text{RI}^{m8g2} * (\text{"volume of m8g2"})}{(\text{"volume of m1g1"} + \ldots + \text{"volume of m8g2"})}$$

Where m1g1 is the combination of modality 1 (ie. train) and group 1 (ie. Schiphol workers)

It is also possible to calculate a resulting index on a single modality (for all client groups) or a single client group (for all modalities). The different RI^{mg} have to be averaged according to the

A resulting score for a specific modality m for all client groups is calculated according:

$$(6)\ RI^{m} = \frac{RI^{mg1} * (\text{"volume of g1"}) + RI^{mg2} * (\text{"volume of g2"})}{(\text{"volume of g1"} + \text{"volume of g2"})}$$

where g1 is client group 1 (ie Schiphol workers) and g2 is client group 2 (ie. Passengers)

A resulting score for a specific client group for all modalities is calculated according:

$$(7)\ RI^{g} = \frac{RI^{m1g} * (\text{"volume of m1"}). \ldots + \text{RI}^{m8g} * (\text{"volume of m8"})}{(\text{"volume of m1"} + \ldots + \text{"volume of m8"})}$$

Where m1 is modality 1 (ie. the train) until the final modality m8 (ie. the bicycle)

9.3 Measuring Example

To make the design measurement method more insightful, an example is given how a change on one criteria will result in a lower indices. The assumption in the given example is that all other indices remain constant (100).

Example:

On 1/1/11 the average travel time (criteria 25) of the car (modality 3) is 20 minutes, thus $(C^3{}_{25})(t_0) = 20$. This is set at index 100 ($I^3{}_{25}(t_0)$). On 1/2/11 this average time is increased to 28 minutes, thus $(C^3{}_{25})(t_1) = 28$. This increase has a negative (!) effect on the index as an increase in time results in a lower appreciation of the clients of the quality of accessibility. Following formula (1) the 8 minute increase is equal with a 40 point decrease on the index (28/20). As such the new index figure is 60, thus $I^3{}_{25}(t_1) = 60$

In this example we consider that we want to know the effect of the lower index on the perception of passengers (g=2). The demand profile of Schiphol Workers is therefore used to get the weight put on the travel time criterion. The weight is 4,1 (Table 7-8), thus $w^2{}_{25} = 4{,}1$. Given that all the other indices remain the same, we calculate the effect of the lowered travel time index on the index of parent factor Time ($FI^3{}_2$) according to formula (3). This result is a reduction of the index of factor time from 100 to 93,4, thus $FI^3{}_2\ (t_1) = 93{,}4$

As there is a decrease on the factor time, this will have an influence on the total LOS for Passengers using the car. Formula (4) is used to state the effect on the overall index of LOS. The result is a reduction of the overall index for passengers on modality car from 100 to 98,9, thus $RI^3{}_2\ (t_1) = 98{,}9$

As this index is only applicable to passengers coming by car, formula 5 has to be used to get the effect on the perception of accessibility quality among all clients and all modalities. The volume share of passengers by car on the total volume is 19,8 % (table xx). Using formula (5), the overall reduction on the index of perception of accessibility can be calculated. The result is a reduction of the resulting overall index for all clients and all modalities from 100 to 99,8, thus $RI(t_1) = 99{,}8$

10 Verification of Design Track I

This chapter aims at pointing at weaknesses in the design, due to knowledge limitations, simplifications or assumptions. A verification analysis is done by critically looking at the design process and state possible weaknesses and considerations for improvements.

Design Track 1 has delivered the a method on how performance in airport access can be measured. This done through several analysis under limited time and resources. Furthermore the body of literature on the measurement of airport accessibility is limited, making this a first draft design.

This first draft is based on a combination of findings and assumptions. As such there are limitations to the reliability of the designed method: its representation of reality is not ensured.

To state vulnerabilities in the design and needed future improvements, a verification is done. By critically looking at the design steps, the incompleteness in the processes is mentioned and the (possible) consequences are discussed. This is done per design step.

Defining Performance

In setting relevant performance a selection has been made. The analysis on T&T goals & objectives (Annex B) showed that T&T also has objectives on spending (€) and employee satisfaction. These objectives are not covered by the measurement system.

In assessing the amount of high quality accessibility offered, T&T is also interested in the catchment area (amount of people in reach of the airport) and sustainability of transportation. These factors of the accessibility quality are also not measured by the developed method.

The quality perceptions of clients is seen as the most important objective of T&T and the most challenging to design. Therefore this objective is the considered performance.

In using the designed method, it is critical to be aware of the limited relevance to all T&T objectives. The system is aimed at only stating part of the relevant performance spectrum. The given information by the PMS (indicators), are therefore descriptive of only a part of the whole performance. In assessing where to focus on to improve future performance, the developed method can provide an indication, but cannot be seen as prescribing.

For instance the employee satisfaction may be very low and therefor needs the highest attention and improvement. The developed method is not able to indicate this and can therefore not weight the importance of the low employee satisfaction against a (possible) decrease in client quality perception of accessibility.

Airport Accessibility Offered

Figures on modality split and volumes on the client group Passengers and are constantly being surveyed and updated. However figures on Schiphol Workers are based on a survey conducted only twice a year. To compare both volumes and create percentages based on the combined volumes, data has to be taken on the same moment. At the time of the volume analysis, the latest figures on Schiphol workers were from a 2008 research. Currently the 2010 figures are available (this research is conducted every two years)

The conducted volume analysis is used in the measurement method for constructing an overall index figure. It enables to see the effect of a decrease on a single modality or client group on the overall accessibility perception. To get a correct figure, the volumes have to be accurate and current. As the used figures are two years old and many volume changes could be seen the past two years (due to economic situation, region growth, volcanic eruptions, etc) these figures have to be (regularly) updated.

It is important to use the latest figures on all client groups, which currently isn't the case. For Passengers this is no problem as its figures are updated frequently. To get more frequent updates on the volumes and split of Schiphol Workers an estimation method has to be implemented that uses the survey outcomes but alters these figures based on data on amount of workers, region increase/decrease, new public service routes, etc.

Client accessibility demand

The set factors and criteria are based on literature, Schiphol documentation and expert interviews. As such it is assumed these criteria can be linked to the factors and are of influence to the quality perception of accessibility, but their validity is not checked with the client groups.

In this design the set of criteria is developed by the designer. It would be better to have the client groups themselves create a set of relevant criteria. Thus a rating would be given on criteria that are already of stated relevance.

It is advisable to improve the set of factors and criteria based on an experiment that allows representatives of client groups to create criteria of importance to their perception of the quality of airport accessibility

The client separation (creation of client groups) showed that many homogeneous client groups can be distinguished (total of 14 are recognised) that have a unique demand towards client accessibility. Due to limited time, only the two biggest groups (Passengers and Schiphol Workers) are used to create a demand profile through an experiment.

This simplification of all client groups has consequences on the relevance of the resulting index figures. It is now assumed that all clients are either passenger or Schiphol worker, which isn´t the case. As a result the demand profiles of visitors and cargo are not taken into consideration.

Also Passengers and Schiphol Workers are not split in different underlying homogeneous groups (business/leisure, durch/nin-dutch, etc) as proposed in the client separation. This unables T&T management to be aware of how performance is on these specific groups. As the goal is to offer all client the quality demanded, it is valuable to develop demand profiles for all underlying subgroups.

Experiment

An experiment is used to create demand profiles on Passengers and Schiphol Workers. This experiment is based on the criteria selected on relevance. The interviewee (people conducting the experiment) were asked to rate the criteria along an axis. This axis did have a positive and negative direction, but not a scale. As such the relation between the criteria was not based on a rating, but rather on a ranking method ("I find this criteria more important than the other").

This does give an indication on the (most) important criteria, but it makes quantifying the criteria difficult. The used method does not able the interviewee to state "I find that criteria twice as important as the other".

The quantification is based on the position of the post-it. An interval scale is superimposed on the positions of the post-it's to value the criterion. It is highly questionable whether the used intervals (1-5) can represent the actual value the interviewee wants to give the criteria. I.e.: is the value of a criterion placed as highly positive 5 times that of a criteria placed as very limited influence? As the interviewees are unaware of the used scale (they only see the axis) the quantification is fully based on the designers technique instead of an actual stated quantified difference by interviewees.

It is advisable to either improve on the method of experiment (to get a more direct quantitative result on the preferences) or to do additional research on how the ranking

along the axis can be transformed into a quantitative interpretation.

Only 16 iterations on the experiment are conducted (8 groups of passengers and 8 groups of Schiphol workers). Time limitations made it impossible to conduct the experiment with more people. This amount is too limited to impute high value to the resulting averages. Many more iterations (minimum of 20 per client group) are needed to create demand profiles with higher certainty and thus put higher value to their influence.

Design of a Performance Measurement Method

The assumption is that a positive or negative change of a quality criteria will have a linear effect on the resulting index. If the measured criteria increases with 10% of the original value, the index will also increase with 10%.

In reality a 10% increase might have a much stronger or weaker result on the perception of that criterion by the clients. For instance a 10% increase in costs might result in a much higher decrease of perceived accessibility.

The assumption of linearity between the measured performance and an index figure, makes it possible to develop a fully functional method within the limitations of this thesis. However it is a simplification of reality, thus has effect on the validity of the method.

The elasticity between the measured change from on a criterion and its index has to be researched to come to a higher validity of the method. This is expected to be quite difficult. For instance if parking cost increase from €2 to €3 per hour the index would go from 100 to 66. However the perception on parking cost might become much worse as changes in parking cost might have a quadratic effect on the resulting perception index.

As it is unknown what the quality perception of the clients on the current accessibility of Schiphol is, it is not possible to put a starting value on the index. All indices are therefor started on 100 and the change thereof is appointed.

Giving all criteria a staring index of 100 also means that none of them is rated as doing good or bad. However it is very much possible that one or more accessibility criteria are, in the perception of the client, scoring very well or very badly when starting the performance measurement method. As a result the system is not capable to give an indicator on where to direct attention to at the start of the measurement period as only change is registered.

Over time an index of 100 should be directly related to a certain accessibility perception level. For instance if clients would rate a parking price of € 2,- per hour as reasonable, this should be given an index of 100. Thus the indices would not only communicate change in accessibility perception but also valuation of the current level of accessibility on that criterion.

Additional and on-going research on acceptable values on all criteria are needed to set a substantiated standard value that is given an index of 100.

Not all data sources for the criteria are easily divided upon each other to get an index figure. This is due to the unity of the measurement, especially when survey data is used. For instance for the criterion seat comfort is hard to explicate in operational data. Therefore often survey data is used to value this criterion. However the unity of the survey data is expressed on an interval scale (excellent/good/average/etc) which makes a division to get an index score difficult. It is therefore advisable to construct a method to value changes in resulting survey data. This will improve the validity of the index scores.

- DESIGN TRACK II -

Creation of a Performance Measurement System

11 Introduction & Framework for Design Track II

Design Track I delivered a method on how to measure relevant performance on airport accessibility. Design track II is aimed at implementing the designed measurement method and create an actual Performance Measurement System for T&T, answering the fourth design question.

It should be noted that the focus of this thesis is on the design of a measurement method. The creation and implementation of the specific measurement system for T&T is operationally important, but academically of lower interest.

This thesis will therefore focus on the major findings and results of Design Track II and not describe every operational step taken in the creation and implementation process.

11.1 Combining theory and practice

The method of Performance Measurement as developed in Phase 1 has been a theoretical top down approach. The developed method would be able to present very clear and related indicators on performance. However it also requires many reliable data sources and advance hard and software to be implemented. As this thesis is limited by using only available data and systems, a theoretical optimal system is not achievable. Design track II will therefore assess what is available and design a PMS that is achievable given the limitations but also related to objectives as it is based on the method created in Design Track I.

As described in the objectives of this thesis, the goal is to create an actual operational PMS. A solely theoretical approach without notice of actual available performance data is there for inadequate. To come to an achievable and valuable PMS, theory has to meet practise, as depicted by Figure 11-1

The top down approach used in Design Track I was led by higher strategic goals and theory on setting representative measurements. As such not the practicality of setting and updating the measurements is key, but the theoretical perfect (optimal) informative indicators is guiding the creation of a PMS.

The risk of this top-down (Theory Driven) approach that there is no (operational) data available that is needed to create indicators and no alignment with the people who will use the system. The result is a theoretically perfect method, but impractical in actually creating performance indicators. As such the designed PMS is unachievable.

The development of the T&T PMS is limited by the currently available data sources and systems. As such it will not be possible to create the ideal PMS as developed by Design Track I.

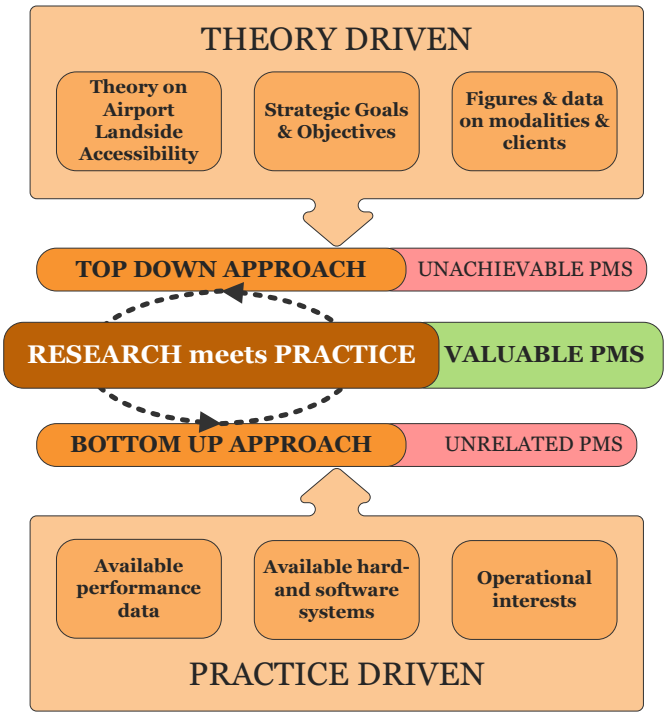

Figure 11-1: Combining approaches to create a PMS

Design Track II is aimed at acquiring what data, systems and methodology is available among T&T that can be used to develop a PMS.

Theory has to meet practise and a PMS is only valuable when they are both related to higher strategic goals and at same time practically realisable. Design Track II is therefore aimed at implementing the method Design Track I as far as possible, given the limitations on data, systems and interests and the limitations on this thesis.

11.2 Framework for developing a PMS

For the creation of a Performance Measurement System (PMS) a simplified framework of how such a system works is presented in Figure 11-2. This framework is based on the literature analysis on Performance Measurement (Annex 0) and leads the PMS design.

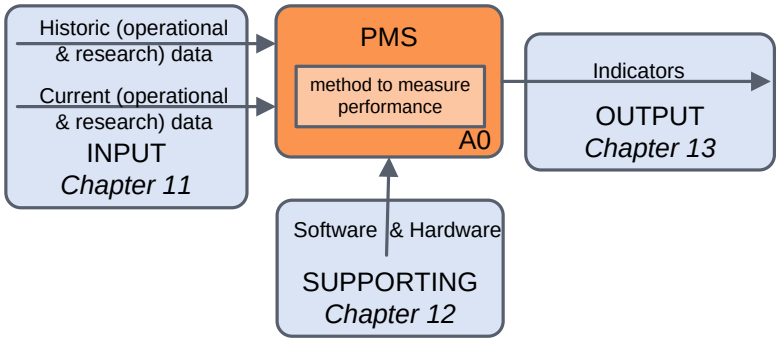

Figure 11-2: Framework for the creation of a PMS

Figure 11-2 shows that (operational) data is needed and that this data is transformed into information (indicators) by using the method from designed in Design Track I.

A first step is assessing what data sources are available to T&T and match this with the data requirements as stated in paragraph 9.1, Chapter 0 will assess the availability of data.

To use the data according to the Performance measurement method designed in Design track 1, support from soft- and hardware systems is needed. To know and select what systems to use, an analysis is done in Chapter 13.

The PMS has to present the measurements done by the measurement method in insightful and informative indicators. Design Track I showed that ideally indices are used that state improvement/decline in accessibility performance. By analysing what the current KPI within T&T are and how they are presented, the outlines for the indicators are presented. This is done in Chapter 0

Based on the finding from Chapter 12, 13 and 14, a PMS for T&T is designed. Chapter 15 presents the designed PMS.

11.2.1 Requirements & Recommendations

The interviews with the T&T managers have also provided several requirements on the PMS. These requirements have to be met by the resulting system and therefore shape the design:

1. **Ability to track and report the operational performance**

   T&T management is committed to define and start projects that are to improve operations in to adhere to Schiphol´s strategic goals. To ensure that these projects are indeed of value (to the strategic goals), advanced insight in the performance is required.

   Also it´s currently not possible to report on the department´s performance in a

substantiated manner. Answering the simple question: “How are we doing/improving?” can therefore currently not be answered in a quantified matter. There is a strong demand for a method to report, both internally as externally, relevantly and insightfully on the department´s performance. This should also enable the department to show how and in what amount is contributed to become Europe´s preferred airport.

2. **Ability to share information and insights between the mobility managers and the T&T department manager to get a broader view.**
Currently the insights and know-how on the T&T operation strongly resides in the specific function/role. Many possess data from their operation and insights from conducted research that is (or might be) relevant to others in the T&T organisation, leading to synergy. This is currently not automatically shared, as is not explicit what might be of relevance to others. There is an opportunity for a situation where insights are shared and combined to get greater intelligence on the operation. Also the department manger wants to get a greater insight on the operational performance of the different roles/functions. Figure 11-3 shows a representation of the information sharing (unlined) between the departments that should be supported by the system.

FIGURE 11-3: INFORMATION SHARING SUPPORTED BY SYSTEM

Recommendations on PMS

Following from the literature analysis on Performance Measurement Systems are several recommendations on the creation of a PMS. Below the most relevant recommendations are mentioned that will guide this phase during the different creation steps.

Data Input

- Data collection and methods of calculating should be made clear
- Data should be collected, where possible. By those whose performance is being evaluated
- Used data should be available for constant review

Presentation

- Feedback from PM systems should report at numerous levels of the organisation
- Performance measures should stimulate continuous improvement rather than just monitor
- Graphs should be the primary method of review
- Performance should be reported daily or weekly
- PM system information on the strategic objectives of the division must be shared across functional areas to provide organisational focus within divisions

12 INPUT: DATA AVAILABILITY

Design Track I has provided the data need to create a functional PMS based on the designed Performance Measurement method. As described in the limitations, there is no capital or time to create new data sources. Therefore an analysis on existing data sources is needed to comprehend what data is yet available and what data is unavailable. Unavailable data has an influence on the ability to create a PMS on the designed measurement method.

12.1 DATA SOURCES

Within the T&T organisation data is already used by all functions. Each participant within the department has its own selection of data sources that are used in an analytical or operational matter.

To get insight in the used data, a survey has been undertaken among all T&T employees. The survey asked to present all used data sources, its creator, its owner, the frequency, the format, the use and the value. The lay-out and results of the survey can be found in Annex G.

By combining all survey results it is possible to create a table with the used data sources, their informational value and usage by the different functions. A differentiation is made between internal survey data, external survey data and operational data. The result of the combination is mentioned in Table 12-1

TABLE 12-1: OVERVIEW OF EXISTING DATASOURCES AT T&T

Name of data	Type of data	Subject	Value	Frequency
Mobility research	External survey	SPL workers	Information on travel locations, characteristics and preferences	Once every 2 year
Quality monitor	Internal survey	Departing PAX	Information on client perception on seven qualitative T&T aspects	Once every 2 months
Sternet quality perception	Internal survey	Bus passengers sternet	Qualitative research in passenger perception on Schiphol sternet	Twice every year
Sternet monitoring report	External survey	Bus passengers sternet	Quantitative research on bus-transportation by Sternet (reliability, punctuality, etc)	Once every quarter
Customer complaints	Incoming messeges	Primarily PAX	Complaints on landsided accessibility of SPL	Weekly
TRS data	Operational data	Taxis	Quantitative information on amount of passing taxis and system errors	Monthly
Daily reports Taxi control	Operational data	Taxis	Service quality provided by taxi chauffeurs in front of SPL	Daily
Constant Traffic Countings SPL	Operational data	Passing vehicles	Quantitative information on the amount of vehicles that passed the counting devices on the access roads	On indication, average once every two months
Periodic Traffic Countings SPL	External survey	Passing vehicles specified	Specific countings on access-roads and modalities	Quarterly
Continuous Passenger Research	Internal Survey	PAX	Information on modality choice, nationality, background, etc.	Daily
Regionplan Research	External Survey	Schiphol Workers	Information on total employees, location, travel pattern and times	Yearly
Government Traffic Countings	External Survey	Passing vehicles	Countings on the main highway access roads to SPL	Quarterly
Probit Bus data	Operational	Buses	Details on bustimes, delays, failures, etc.	Continuously

12.2 Gaps between data demand and availability

When the Data need and Data availability are compared, it becomes clear that there is a great deficiency in the available data. Much of the currently used data is based on research and are lagging indicators (as described in paragraph 4.1.1). The amount of operational data that can be used for the design measurement method is limited. A comparison between the need and availability is made.

Rating

When the needed data is currently operationally (leading) available, the data need is marked positively (green). When the needed data is available, but only as lagging research data, the data need is marked neutral (orange). When the needed data is currently not available where the existence of dependable and representative data is positively marked. Where no (valuable) data is available this is marked negatively.

	DATA NOT AVAILABLE		LAGGING DATA AVAILABLE		LEADING DATA AVAILABLE

This rating on data availability is done for all needed data on Passengers and Schiphol Workers and results in a table with an oversight on the existence and lack of data. The full table can be found in Annex G. Table 12-2 present a selection of rated data sources on Passengers and Schiphol Workers.

Table 12-2: Selection of rated data sources on Passengers and Schiphol Workers

	Passenger					Schiphol Worker		
CRITERION	TRAIN	CAR DROP/PICK	CAR PARKED	TAXI	BUS	CAR PARKED	TRAIN	BUS
Actual time to courts	NA	time rand to court min tbd	time rand to court min tbd	time rand to court min tbd	time rand to court min tbd	time arr to off min tbd	NA	time rand to off min tbd
Walking distance on site	NA	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	NA	distance termin. m tbd
Waiting time	Avg time to cnnct min NSdatasource	NA	NA	Avg time to cnnct min taxikwal	Avg time to cnnct min Probit/SR	NA	Avg time to cnnct min NSdatasource	Avg time to cnnct min Probit/SR
Ratio unproductive waiting time	avail. entert/prod % allart	NA	NA	avail. entert/prod % ferry	avail. entert/prod % allart	NA	avail. entert/prod % allart	avail. entert/prod % allart
Chance on delay	Timeliness % UG kwal. monitor	Filefree roads % UG kwal. monitor	Filefree roads % UG kwal. monitor	Filefree roads % UG kwal. monitor	Timeliness % UG Probit	Filefree roads % UG kwal. monitor	Timeliness % UG kwal. monitor	Timeliness % UG Probit
Average delay time	Avg delay min NSdatasource	Avg delay min ANWB	Avg delay min ANWB	Avg delay min ANWB+taxikwal	Avg delay min Probit/SR	Avg delay min ANWB	Avg delay min NSdatasource	Avg delay min Probit/SR
Chance on cancellation	failure to transp % NSrapport	failure to transp % sneeuwval	failure to transp % sneeuwval	failure to transp % sneeuwval	failure to transp % GVB en Connexion	failure to transp % sneeuwval	failure to transp % NSrapport	failure to transp % GVB en Connexion

To get an impression of the total availability of data that allows the creation based on the performance measurement method developed in Design Track I, the amount of available leading data, available lagging data and non-available data sources are summed. As such the percentages of on the different types of data are attained.

Figure 12-1 and Figure 12-2 present the outcomes of the summed data availability rating for Passengers and Schiphol Workers.

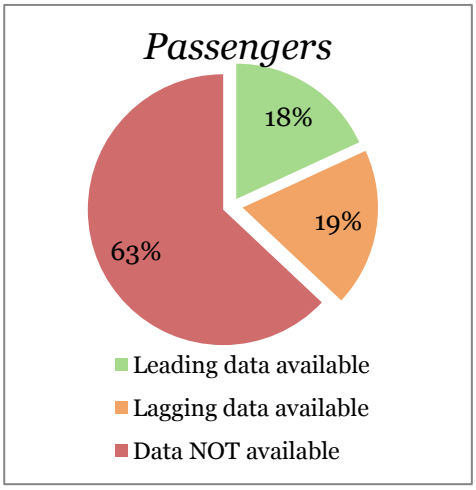

Figure 12-2: Data availability Passengers

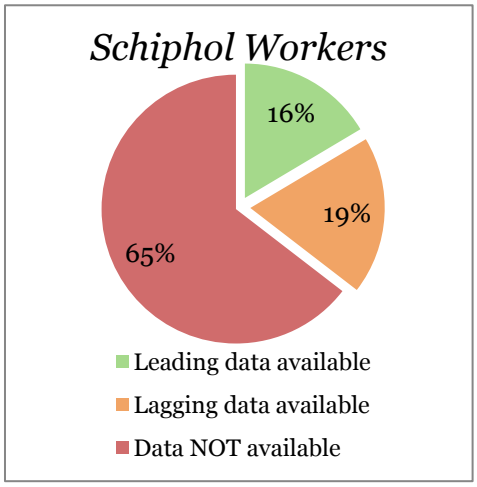

Figure 12-1: Data availability Schiphol Workers

It becomes clear that the vast majority of the needed data, both for Passengers and Schiphol Workers, is currently not available. This will have a profound impact on the ability to use the design measurement method in the PMS. To be able to have leading data on client perception of accessibility based on the designed measurement method, additional data sources will have to be created.

13 SUPPORTING: SOFT- & HARDWARE SYSTEMS

The PMS is depending on the availability of soft- and hardware systems. For the retrieval of data, the data storage, data alteration and indicator presentation soft- and hardware is necessary. At Schiphol several systems are currently used for Performance Measurement and Business Intelligence. A limitation in this design project is the use of currently available systems, as the implementation of a new system would be too time and resource demanding.

13.1 AVAILABLE SYSTEMS

An assessment of the available systems was done by interviewing the Schiphol ICT department and the Schiphol Data analyses department. There are three systems available that might be considered to support the T&T PMS. These are:

- *Oracle OBIEE v10*: The standard Business Intelligence (BI) programme used by the Schiphol Group.
- *Qlikview*: Since the Oracle program had some deficiencies in analytic possibilities by the end user, Passenger Services deployed Qlikview. A more visually able and user friendly Business Intelligence tool
- *MS Excel & MS Access:* Standard MS Office programs. Not able to do sophisticated data alterations or data retrieval. Widely spread and used by end-users. Limited presentation possibilities.

To decide on what supporting system will be used for the creation of the (first draft) PMS for T&T, information on the technology, deployment and end user possibilities was collected (Table 13-1). This information was but side by side for the three mentioned systems in a presentation for the T&T management to be able to select a supportive system. The main findings are:

TABLE 13-1: COMPARISON OF AVAILABLE SUPPORTING SYSTEMS

	Oracle OBIEE	Qlikview	Excel & Access
Technical differences	Many possibilities but difficult to implement (first results) Uses datawarehoue connection or logical connections for data-gathering	Intuitive in use but more difficult to scale Uses a "in-memory" database. Retrieves data from all connected database on each session and saves it compressed in a local database	Combination of Excel and Access able to unlock data from existing databases and simple presentation. Available on all desktop computers at SPL
End-user possibilities	More focussed on building standard reports More complex in use but has more possibilities in tailored reports an presentations.	More focussed on active analysing More intuitive in use, easier to do quick alterations in presentation. Not able to tailor to a high level	Limited possibilities in combining and analysing data. Very static on initial design Programs and interaction known by all end-users

Implementation	Process of about 3 to 6 months in combination with SPL ICT department Projects are supported by dedicated Oracle project team 11G version available in April 2011, before that introduction, no new implementations	No standardised implementation track Implementation down in cooperation with T&T Business Information Manager Qlikview server currently being implemented in datacentre Results of first SPL implementation not yet known	Creation of fill in possibility and basic dashboard functionality approximately one month Can be done in department internally with cooperation managers Update to Office 2010 expected in Q1 2011

Screenshots of Oracle OBIEE and Qlikview dashboards can be found in Annex I.

14 Output: Performance Indicators

14.1 Currently assessed KPI

This paragraph gives an oversight of the current key performance indicators (KPI) that are used within the AAS and T&T organisation to measure their performance. There are KPI on overall performance and detailed KPI on the performance of sub processes. Some of these KPI might be interesting to implement in the PMS. Furthermore the used presentation methods could influence the way the indicators of the developed PMS are configured

14.1.1 Overall performance

Passengers

To measure whether AAS is improving on its goal to become Europe´s most preferred airport, Schiphol has to be compared with Europe´s major airports. For this the International Airport Service Quality (ASQ) Benchmark from the Airport Council International (ACI) is used. This organisation presents, twice a year, a report on the quality perception of passengers on 150 airports worldwide (Airports Council International, 2009).

Schiphol compares itself with 9 other major European airports on Transfer quality and 11 airports for OD quality perception. For Traffic & Transportation only the O/D passengers are part of the clientele, therefore we will focus on the current state of the quality (according to the ASQ report) of O/D as a whole and zoom in on the finding on accessibility.

The compared O/D airports are: München (MUC), Dusseldorf (DUS), Copenhagen (CPH), London Heathrow (LHR). Manchester (MAN), London Gatwick (LGW), London Stansted (STN), Madrid (MAD), Frankfurt (FRA), Rome Fiumicino (FCO) and Paris Charles de Gaulle (CDG).

The ultimate long term goal is to hold the number 1 position in both the Transfer and OD category. The short-term goal is to be in the top 2 positions on Transfer and top 3 positions O/D.

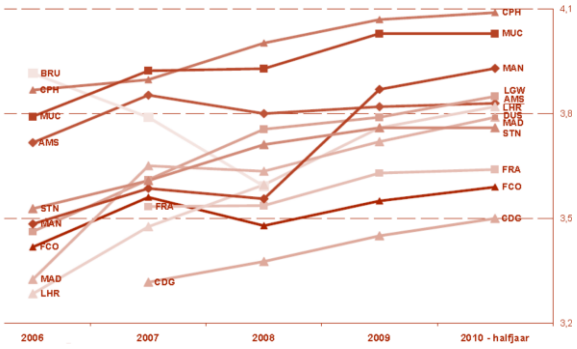

Figure 14-1: Quality position of SPL in Europe

The latest report is the 2010 halfway report, published by the Schiphol MRI department by the end of October 2010. The report shows that AAS currently not meets its goal to be in the top 3. In fact the past half year AAS lost its number 4 position to London Gatwick and is currently in the fifth position (of the 11 major European O/D airports), please see Figure 14-1.

The ASQ also mentions a sub indicator on the customer satisfaction on ground transportation to and from the airport. This indicator is very important to T&T as it provides a KPI every half year that clearly states how passengers perceive Schiphol´s accessibility. AAS is doing very well according to the ASQ research as thet are in the number 2 position, only CPH is in front of AAS.

Workers

Biennially Schiphol measures the accessibility perceptions among all working personnel at Schiphol grounds by the so called “Mobility Research” *(SOAB, 2009)*. The perception scores are high on all traffic & transportation modalities and in total 73,7% of all passengers are satisfied with the accessibility.

14.1.2 Performance Sub processes

Besides the major performance indicators, T&T also has KPI on several sub processes in their operation. In the research on existing data within the organisation many figures that reported on performance were found. In this paragraph the focus will be on the performance indicators that are regularly used in the T&T organisation, reported on with intervals and steered on by management.

Quality monitor

The currently only used KPIs are those that are produced by the **Schiphol Quality monitor**. This is a monitor that reports monthly on the passenger perception on multiple passenger processes. Continually passengers are questioned on their finding on Schiphol. They are asked to state their perception on airport processes by mentioning whether they perceive this process as excellent (E), good (G), average (A) or insufficient (I). Each month all findings are summed. The Quality monitor combines all excellent and good scores and report on the percentage of these in comparison of the total.

There is a specific report on ground transportation. This report mentions several indicators. A graph is presented on each indicator that shows the period result, the average result over the past time and the set target.

The ground transportation indicators are:

- **Traffic free roads**. States how passengers perceive the traffic on the highway roads (A4, A9, etc) towards Schiphol. (Current target 70%)
- **Number of train connections to SPL**. States how passengers perceive the amount of train connections that arrive at SPL. (Current target 87%)
- **Number of train connections from SPL**. States how passengers perceive the amount of train connections that depart from SPL. (Current target 82%)
- **Number of trains arrived on time**. States how passengers perceive the timeliness of the trains. (Current target 88%)
- **Total findability of SPL from transportation.** States how easy people can find the Schiphol coming from their transportation towards the airport. (Current target 88%)
    - **Total findability of terminal from transportation** (Current target 90%)
- **Total findability of transportation from terminal.** States how easy people can find their method of transportation coming from the terminal (Current target 87%)
- **Waitingtime NS counters.** States how people perceive the amount of time they have to wait to be served at the NS counters. (Current target 84%)
- **Waitingtime NS ticketmachines.** States how people perceive the amount of time they have to wait to be served by a NS ticketmachine. (Current target 84%)

Each month the combined results are presented on the Schiphol intranet webpage to be viewed by all personnel. Below (Figure 14-2) is an example of the graphs as showed by the Quality monitor.

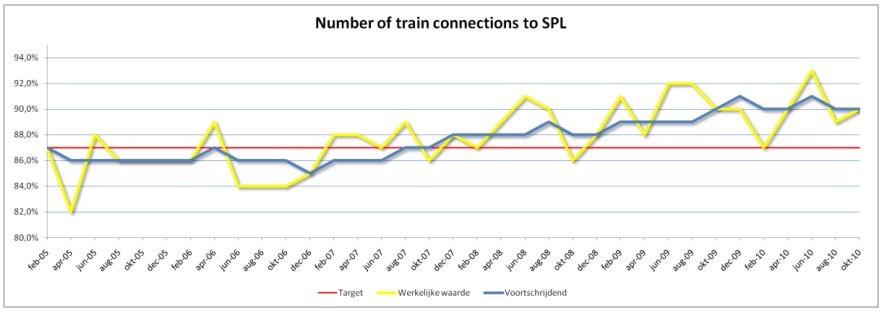

Figure 14-2: Current Performance indicator on Number of train connections

15 Design of a PMS

15.1 Design elements

Data sources

The analysis of the data sources showed that the currently available sourced are limited. Less than 40% of the needed data sources are available.

This posed a difficult obstacle in the development of an operational PMS. The main obstacle is that the developed method is only of value when a high amount of data sources is available.

If many needed data sources are not available, the risk is that the influence of the available data sources is awarded too much value by managers. To prevent this the development method gives a weight on the criteria based on the demand profile.

However if data is only available on only a selection of the criteria, the remaining indices on the criteria will remain 100. As such the influence on the resulting overall accessibility quality is only given by criteria that have a data input. With less than 40% of the data sources available, the resulting total indices will show limited variation. This limited variation might falsely indicate that the quality perception remains relatively constant, which isn´t necessarily true.

As a result the decision was made not to implement the designed measurement method in this first PMS. Instead a scaled down PMS is proposed that insightfully presents criteria that have data sources and were appointed as relevant based on the demand profiles.

The selected data sources that are implemented in the PMS can be found in Annex H. All data sources, both leading and lagging, that matched with the selected criteria are used in the PMS

Supporting hard- and software

Based on the findings mentioned in table Table 13-1, combined with limitations on time and capital, the decision was made to create the first version of the PMS in Excel & Access. The main consideration was that the implementation of the PMS had a short operational lead-time and the system could be quickly used by the T&T employees.

When more advanced functions are needed and more data sources are available, a transformation to Qlikview is planned. Qlikview is more capable of capturing and combining data from multiple sources.

Indicators

The indicators that are already available are matched with the demand profiles to make a division in importance. Those considered of high relevance are used in the PMS. Also KPI used by the MRI department (data research department) that are of relevance to the T&T processes are also captured and used by the T&T PMS.

In consultation with T&T management it was decided that the indicators had to be tailored to the roles within T&T. As the roles are mainly divided over the different modalities, the PMS had to provide relevant indicators per modality.

Throughout this thesis a separation was made between Passengers and Schiphol Workers as these were considered the two major client groups. This separation is also upheld for the PMS. It should be possible to select the client groups of interest and can indicators relevant to that client group.

Lastly the presentation of the KPI was discussed with management. The current presentations were used as reference point. It was decided that a graph had to be presented for each indicator which was in style with the graphs currently used. Furthermore a difference with the preceding measurement and with the same time frame a year ago had to be given. This difference had to be expressed in an absolute value and a percentage

change. The interval level on which all figures had to be updated was set at one month. The PMS had to give the possibility to quickly look up past periods.

15.2 Resulting Design

Based on the findings of the preceding paragraph a first version of the PMS for T&T was developed. Excel was used to create and operate the dashboard. Excel has limited capabilities to automatically extract (or stream) data from different databases. Therefor Access is used to enter data into the database (much has to be done manually).

All data sources that are coloured green or orange in Annex H are used and presented in the PMS. Furthermore the top frame gives the possibility to select a client group (passengers or Schiphol Workers) and a period (the current period or one of the preceding 24 months).

In-line with the demands from the T&T management, numbers are presented on a monthly basis and a comparison is shown with the preceding month and the same month one year ago. To enhance the insightfulness, coloured arrows are used to show high, medium of no decrease/increase between the periods. Also a graph is presented in the same fashion graphs are currently presented, for each indicator.

The indicators are coupled for each modality. This gives modality managers the possibility to quickly look for the most relevant indicators.

Figure 15-1 presents a screenshot from the developed PMS

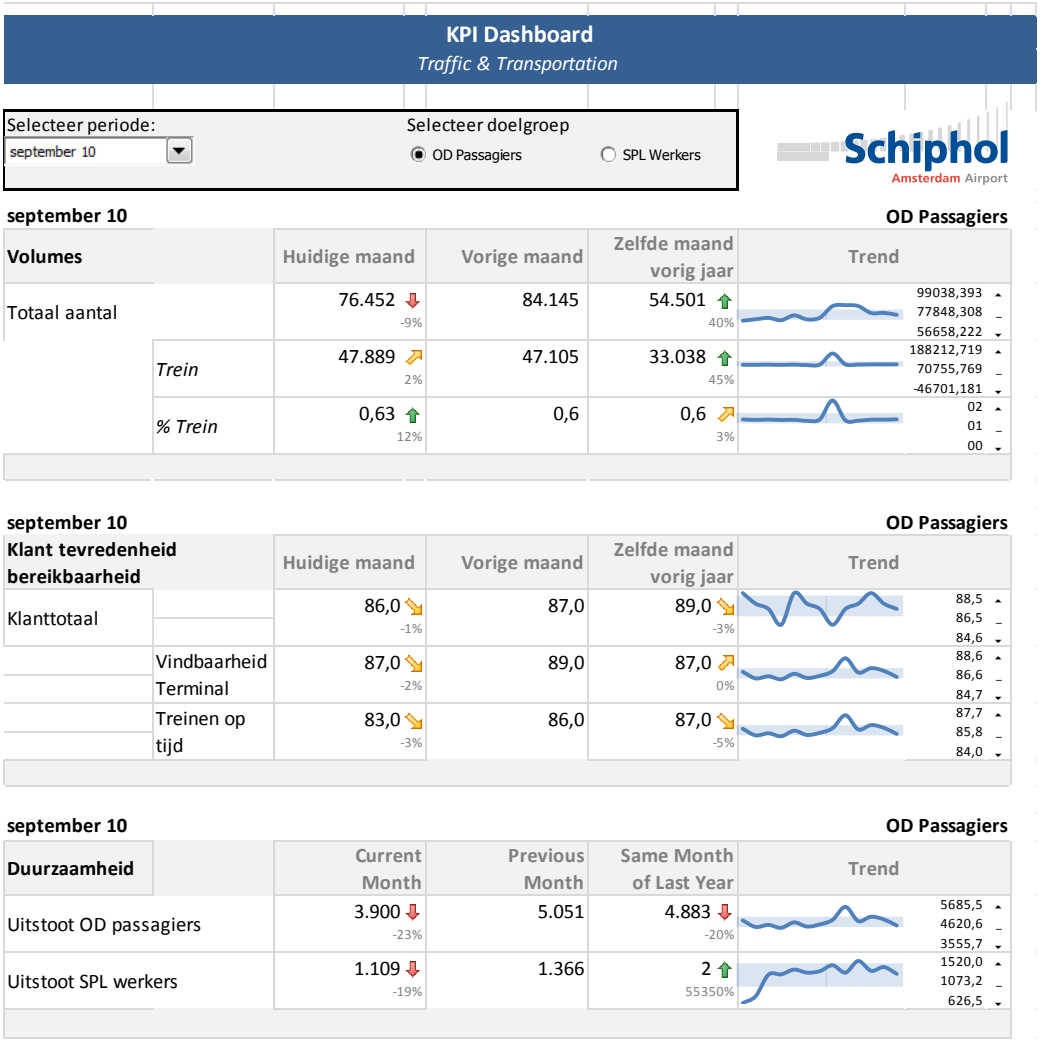

Figure 15-1: Screenshot of developed PMS

15.3 Social media scanner

Missing insight

The design measurement method from Design Track I is aimed at indicating the “voice of the customer”. The perception of the client on accessibility quality is what has to be reported by the PMS. As the decision was made not to implement the developed measurement method due to a lack of data sources, the ability to report on the client´s perception of accessibility was also greatly reduced.

The current used sources and KPI are not sufficiently able to capture and – consequently - report on user perception. As this was one of the main objectives of this design process, this inability was considered a major shortcoming.

The design elements described in paragraph 15.1 render an valuable PMS (Figure 15-1). but this PMS uses only existing data sources. As such the improvement is gained from the combination, valuation and presentation of existing data. To really improve the insight of relevant performance, to capture the “voice of the customer”, additional data is needed.

As long as the proposed measurement is not fully implemented an alternative method is required to capture – in some form – the perceived accessibility of Schiphol. After a brainstorming process several possibilities were discussed, of which a so-called Social-media scanner was considered the most valuable and realisable given the limitations.

The full design process is too extensive and to practical to be captured in this thesis. However as this social media scanner will be an integrated part of the resulting PMS, the essential design steps are covered and the result is explained.

15.3.1 Design steps

Concept

The past five years there has been a steady increase in the amount of messages people share by the use of social media. Especially Twitter has given people the possibility to share their opinions and activities with the rest of the world. This stream of opinions is interesting for businesses as they can express an appreciation or disappointment for a product or service.

There is a need for additional, real time, data on the client perception of the accessibility of Schiphol. The idea was developed that screening social media outings on messages on the accessibility of Schiphol, could give an indication of the client perception. Especially since the collection of this data is relatively simple and inexpensive, developing a method on screening the messages could provide an attractive solution to the need for client perception data.

Design

Research was conducted on how relevant public social media messages could be filtered. Several solutions were compared. At the end a connection with the service from Social-Mention.com was realised.

SocialMention offers an API connection (an interface connection that allows communication and sending requests). This API provides a single stream of real-time search data aggregated from numerous social media properties. An API call initialises live querying of each social media source and the data is sorted, processed, and normalised.

Based on the API, three syntax were developed that asks the SocialMention database to select and send all messages on all social media from the past 48 hours, based on the search words:

1. Schiphol & Trein (train)
2. Schiphol & Bus
3. Schiphol & Taxi

The results (messages) were collected in three local Excel databases and sorted on time of sending. The database is updated every 30 minutes with new messages.

After some testing it became clear that there were sufficient messages on each modality to do additional filtering. For Schiphol & train an average of 92 social media messages per 48 hours was measured, for Schiphol & Bus an average of 27 and Schiphol & taxi an average of 17. The vast majority (> 90%) of these messages originates from Twitter (tweets).

Sentiment

A second design objective was to filter the collected messages on sentiment. The goal is to be aware of the client perception. Therefore it is valuable to be aware of the sentiment of clients of the Schiphol modalities on the quality of the service.

For a couple of days all incoming messages on the selected search words were read. For each messages a sentiment was appointed (positive sentiment, neutral sentiment, negative sentiment). Then words were selected that signal the found sentiment. This was done based on the "bag of words method", where sentences are seen as non-connected words and each word can have a sentimental value.

Based on this method and the derived sentiments from each message, eight negative signal words (disruption, delay, coagulation, deviations, stuck, cancelation, busy, fail) and five positive signal words (cosy, nice, fun, pleasant, fast) were selected.

All three databases (train, bus, taxi) are searched on these signal words. The amount of messages containing these words are counted. As a result it is possible to calculate the percentage of positive, neutral and negative messages on the total amount of messages. This percentages captures (in some form) the perception of clients on the modalities over the past 48 hours.

DASHBOARD

The percentages on the positive, neutral or negative sentiments have to be insightfully presented for each modality. As the messages are collected through Excel, a dashboard is also designed by using Excel.

For each assigned positive and negative signal word, the absolute amount and relative percentage of found messages is presented in a table. The total amount per category (positive, neutral, negative) is also shown. To get a quick indication of the current ratio of the sentiments, a pie diagram is presented for each modality on the percentage of sentiments. This indicates how the current perception of the T&T client is on the different modalities.

Pie diagrams are also given to show the most used words in stating positive or negative sentiments.

Furthermore the amount of messages send in the past 48 hours is given and the timestamp of the first and last message is given for each modality.

Figure 15-2 shows a screenshot of the developed dashboard

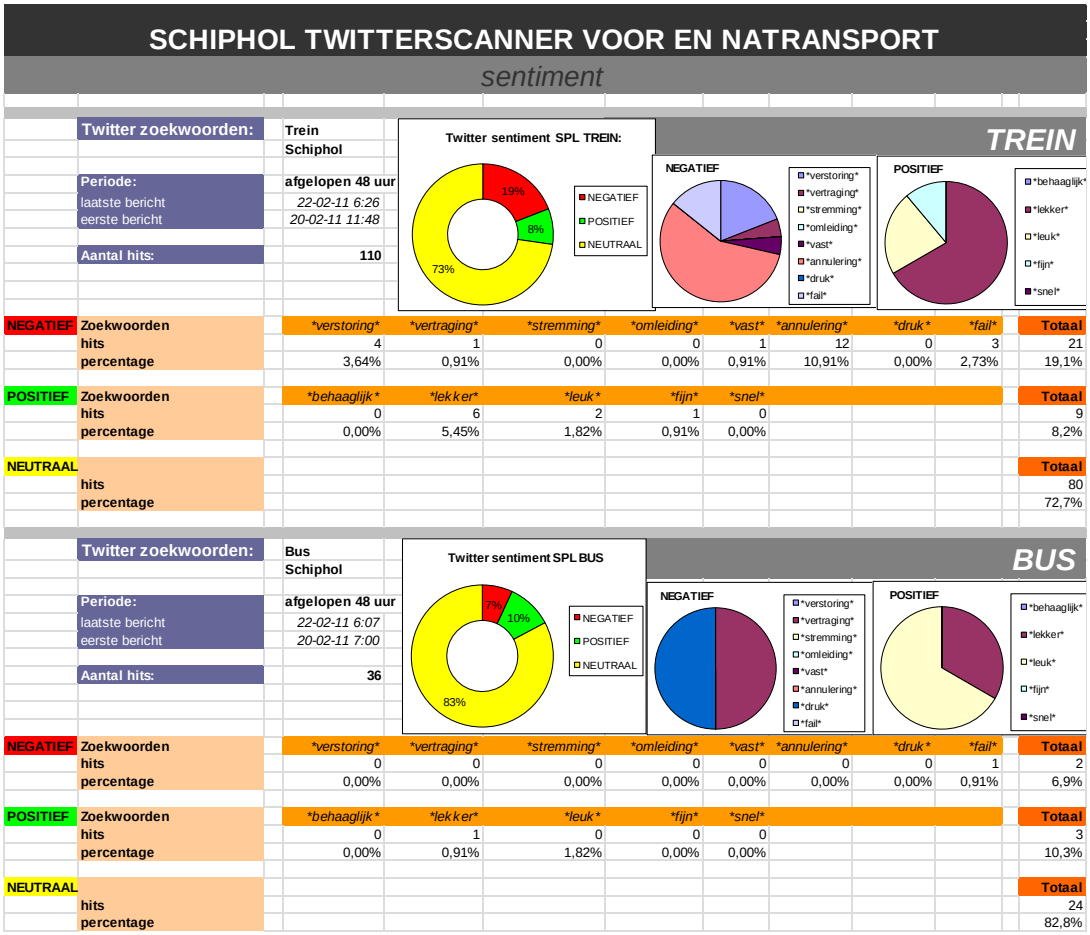

FIGURE 15-2: DASHBOARD OF SOCIAL MEDIA SCANNER

INFORMATIVE VALUE

As stated in the preceding paragraph, the developed PMS lacked sufficient ability to present the client perception of the quality of accessibility at Schiphol. The social media scanner is able to capture (some of) this perception.

The amount of messages is limited, the people sending the messages are not a single client group and catching all sentiments purely on signal word not faultless. However this method is able to notice sudden or long term trends in the perception of quality of the modalities. The two major insights gained from the scanner are:

1. The scanner is able to capture sudden changes in sentiment. For instance a disruption of service puts a spike on negative sentiments. As this is noticed almost real-time, the modality manager can react and look for a cause of the sudden change. It also provides leverage in negotiations with the stakeholders. When the modality manager notices spikes of negative sentiments more often, he had evidence to show that the amount of incidents on a certain modality is increasing.

2. The percentages of positive and negative sentiment are saved per modality. As time passes by, trends can be noticed in the percentages. Without looking at sudden spikes, it is possible to see whether the ratio of positive or negative messages is changing over a longer period of time. As such a trend can indicate whether the client perception on the modalities is improving or declining over time. It is proposed that the trend on each modality is evaluated monthly.

16 Verification of Design Track II

This chapter aims at pointing at weaknesses in the design, due to knowledge limitations, simplifications or assumptions. A verification analysis is done by critically looking at the design process and state possible weaknesses and considerations for improvement.

The developed PMS and social media scanner are both operational and being implemented at T&T. At the time of presentation of this thesis, the implementation of the PMS has not been fully completed, making a full verification impossible.

Design Track II has delivered a functional Performance Measurement System that T&T can actually use to gain insight on their performance. However the system is a first draft and is developed with limited time and resources at hand. It also proofed impossible to implement the designed measurement method from Design Track I as not enough data sources are available.

The taken design steps are verified and the remarks on improvement should be considered when improving the PMS.

Data sources

The limited amount of data sources motivated the decision to not implement the developed measurement method. It was decided that all sources that are related to one of the selected criteria, would be used in the PMS. This is valid as the criteria are selected on their relevance to the T&T goals and objectives. However it is also possible to give a rating on the reliance of each data source based on the demand profiles on the criteria.

In the first draft of the PMS this distinction is not made: all data sources are considered equal. Although the objective is to create new data sources to implement the designed measurement method, for the time being it is possible to rate and sort the criteria (and relating data sources) based on the created demand profiles.

Furthermore no research is conducted on the timeliness of the data. The objective is to have a full new dataset every month to use in management meetings. The data sources are evaluated on their update frequency, but is unknown what the chance on delay or unavailability is. Additional research on the timeliness of that data sources would be valuable.

Supporting

A main motivation for implementing an PMS based on Excel was the lead time on implementing one of the other Business Intelligence systems. Both Cliqview and OBIEE required a Schiphol specialist to be involved and a team to support the development. These processes are standardised by Schiphol and as a result are bound by guidelines.

The minimal lead time is three months, which was too long to be considered for this thesis. However the findings of this thesis and the functions of the first draft of the PMS can be very useful for a second version of the PMS.

The Schiphol IT department has extensive knowledge of implementing performance measurement systems. This thesis combined with the delivered product can be used by the IT department as a guideline for developing and implementing a second version of the PMS that, preferably, incorporates the method from Design Track I. Especially the possibilities Cliqview offers on connecting to different databases and conduct analysis on the datasets could greatly improve the PMS.

Many of the KPI that were used until know are constructed by the MRI (market research & intelligence) department at Schiphol. They construct these KPI on the bases of (continuously) conducted interviews with Passengers. The motivation for using the indicators currently researched by MRI is given by an evaluation of many years ago, This thesis has provided an insight in what could be valuable data for improving the insight of performance. It also showed which data is not available. This insight can form the basis

of appointing other indicators that are researched by MRI. It appears that other indicators (instead of the ones use now) could have a higher informative value with the same effort. It does demand MRI to change the questions asked to the passengers.

Design of the PMS

The design is a first draft design. It provides much more insight than was available up to now, but is also a basis for improvement. The first experience of usages showed that the input of data into the system is quite labour intensive. Only a limited amount of data sources are uploaded automatically. Many of the data has to be taken from other systems and manually entered in the PMS or copied from hard-copy documents.

As this demand multiple manual acts, the system is highly dependent on the willingness of those entering/uploading the data. This is a weakness in the design as without data the PMS will become useless. Therefore the value of the system has to be proven to ensure willingness of employees to enter data. A process of improvement has to be started that is aimed at connecting databases to limit manual intervention.

The PMS currently has no capability to set targets, however this is highly desirable. T&T management want to push the employees to improve on relevant performance indicators. Therefore targets have to be set. After implementation of the PMS it is advisable to look for reasonable targets and implement them in the PMS. This can provide then provide a motivation to focus efforts on improving certain indicators.

Social media scanner

The signal words used on the social media scanner are the result of limited research on the sentiment of messages. To get more valid results on the sentiment of the messages, the amount of words have to be extended, possibly even rated (very negative, moderately negative, etc.).

Furthermore the currently designed system looks for the amount of time a word is used in all social media messages of the last 48 hours. I someone sends a message “Schiphol train is fun, fun, fun, fun) the system would indicate 4 time the word fun in the total. This is of course incorrect. The system should be improved so it only gives one sentiment valuation per message.

The licences used to get the required data from social media is a free-of-use licence. Although this ensures no costs, it is also put a strain of reliability as no SLA is concluded. It is therefore advisable to agree on a guaranteed delivery of the needed data with a provider.

The PMS and the social media scanner are currently two separated systems in different sheets as they are developed independently. To reduce complexity to the end-user it is advisable to integrate the two system and present the major findings in a single sheet.

- CONCLUSION -

17 Final Conclusions & Validation

17.1 Final conclusions

The two created designs are the deliverables of this design thesis and can be seen as the conclusions of this design project. However by answering the design questions that were stated at the beginning of this thesis, a conclusion can be presented on the most important findings.

Question 1: *What is Performance Measurement and how is a performance measurement method designed?*

Performance measurement is used to assess the impact of actions on the objectives of the organisation whose performance is being measured. This could be considered 'as quantifying the effectiveness of action'. In the case of measuring the impact of the organisation's performance on customer satisfaction, the client´s perception and uptake on relevant performance has to be implemented in the valuation of the measurements.

Performance measurement has a considerable impact on the environment in which it operates. Starting to measure, deciding what to measure, how to measure and what the targets will be, are all acts which influence individuals and groups within the organisation. Once measurement has started, the indicators on performance will have consequences, as will the actions agreed upon as a result of that review. Therefor deciding upon what is relevant performance and how it is measured, is a process that has to be done in a thorough and analytical manner. The used method, measures and indicators have to be agreed upon as otherwise the relevance of the resulting indicators will be questioned.

In designing a method for measuring performance a framework is created (based on existing literature) that guides the process steps to be taken. Combining the insights gained from these analyses will result in a performance measurement method that is in line with companies goals and objectives, the client´s demands and the accessibility services offered. The outcome of filling in this framework will be the ability to state and set relevant Performance measurements and translate these into Performance indicators. Figure 17-1 shows the constructed framework that guided the performance measurement method design process.

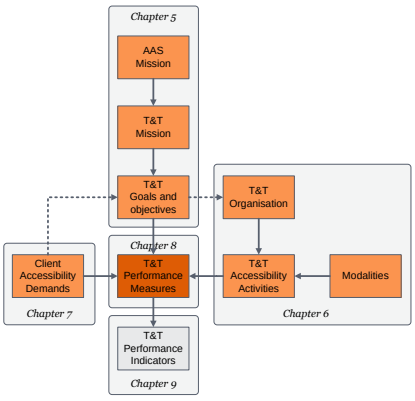

Figure 17-1: Developed framework for performance measures

Question 2: *What is considered to be Performance according to T&T?*

At the start of this thesis project the assumption was that the development of the Performance Measurement System would mainly be an ICT challenge of aligning data sources and implementing a Business Intelligence Solution. However quickly it became clear that several essential steps had to be taken first to create a PMS that would be of value to Traffic & Transportation.

Essential to the development of a Performance Measurement System is a very clear view on what is considered relevant performance. This initial step proofed to be challenging. There are many internal documents on which multiple goals and sub goals for T&T are formulated, but a single major objective they could be operationalized (measured) had yet to be declared.

The main reason for this is the major difference between T&T and other Schiphol departments. This difference is based on two aspects:

- *Differing clients:* Almost all Schiphol departments consider Passengers their sole client group. As a result all their objectives are related on optimising processes on the demand of Passengers,. However T&T also considers Schiphol Workers, Visitors and Cargo their clients. In volume Schiphol Workers is even a bigger group than Passengers.
- *Differing processes*: The majority of the Schiphol processes are so-called terminal processes. Meaning that they are located on the terminal and within the boundaries of control of Schiphol. T&T however deals with accessibility processes. The way these are managed differs greatly from terminal processes and secondly are done with stakeholders that are not under the direct control of Schiphol.

Both the differing clients and processes make it difficult to use the goals & objectives of the parent departments directly on the T&T situation. The companies goals had to be matched with the T&T differing client groups and processes to come to relevant performance objectives.

Eventually three major performance objectives for T&T were agreed upon and set that could be operationalized: Quality of accessibility delivered to the clients, catchment area and sustainability (CO_2 profile).

For this thesis the quality of accessibility delivered to the clients is used as relevant performance that has to be measured. The motivation for choosing this objective, is that this is considered most difficult to measure and other objectives might be possible to derived using the measurements created by a PMS on this objective.

Before measurement on this objective can start, a statement is developed on how performance on this objective be seen. In other words: what has to be measured/known to get insight in the performance on this objective. Matching the selected major objectives of T&T with the accessibility processes at Schiphol resulted in the following definition on considered performance:

Performance on quality of accessibility delivered to the client =

the amount in which the demands of a client group on the quality of accessibility are met by the characteristics of a modality

QUESTION 3: *How should the considered Performance be measured?*

A method is developed that is able to measure the quality of accessibility offered to the clients of T&T. To come to this method first a theoretical view on how the considered performance is delivered and measured was created. Based on several analyses a view on the position of T&T within the offering of accessibility to clients was gained. T&T is seen as being of influence (by controlling, guiding or influencing the different offered modalities) on the quality characteristics of the different offered accessibility solutions offered (types of modalities).

The demands of the clients on airport accessibility can be expressed (based on literature research and expert opinions) on six factors (cost, time, reliability, quality, convenience)

Based on an experiment conducted on Passengers and Schiphol Workers it was found that the demand characteristics on airport accessibility differ between client groups. Table 17-1 shows how the factors are awarded by the client groups, by a rating (from 1 to 5, 5 being higher).

TABLE 17-1: AWARDED RATINGS ON ACCESSIBILITY FACTORS

FACTOR	COST	TIME	RELIABILITY	QUALITY	CONVENIENCE	INFO
PASSENGER	**4**	**4**	**5**	**3**	**4**	**1**
SPL WORKERS	**2**	**4**	**3**	**2**	**4**	**3**

Such a rating is constructed not only for the factors but also on all underlying criteria. These rating give a weight on each criteria that shows how the two client groups perceive the importance of the accessibility characteristic. The weights together construct a demand profile. As such two demand profiles (one for Passengers and one for Schiphol Workers) are constructed.

The analyses of service offering and client demand gave the possibility to fill in the created framework and set relevant performance measures. This filled in framework provides an insight on where measurements have to be taken to capture relevant performance. Figure 17-2 provides a small depiction of the framework. A full size picture can be found by Figure 8-2,

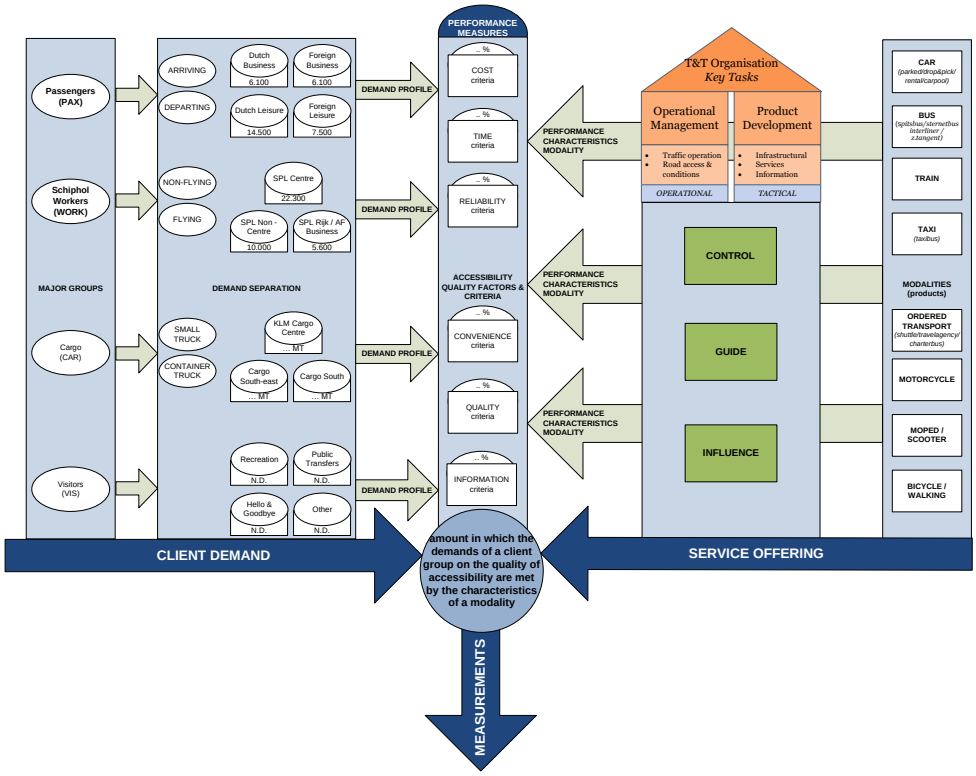

FIGURE 17-2: SMALL VERSION OF FILLED IN FRAMEWORK

The client groups Passengers and Schiphol Workers are highlighted bold as they are considered the most important client groups and were therefore additionally researched.

Measuring performance

For measuring performance, data points and sources are needed for all of the 34 accessibility criteria. Not every criteria can be directly measured, as such measurements have to be appointed that are best able at providing (some) information on the performance on a certain criterion. A table is created that states the needed data sources on their name, source and unity Table 9-2. This table made clear that the unities between the data differ greatly.

The inequality between the units and sources makes a direct comparison not possible. Furthermore it is currently not known what appreciation can be given on the scores on the data point (is a certain score sufficient, inadequate, etc.).

Therefore indices are used that are able to indicate a positive or negative change over time for each criterion. To construct an index, formula (1) is used

$$(1)\ I^{m}{}_{xy}(t_1) = \frac{C^{m}{}_{xy}(t_1)}{C^{m}{}_{xy}(t_0)} * I^{m}{}_{xy}(t_0),$$

Where $C^{m}{}_{xy}$ is the *measured value* of modality (m) of criteria y that is related to parent factor x.

The constructed demand profiles gave the ability to appoint weights on the indices. Weighting these indices ensured that those criteria that are of higher importance to a certain client group, have a greater influence on an overall figure (index) on the delivered airport accessibility. Figure 17-3 shows how weights influence criteria and factors. The weights are unique for each client group and are constructed based on de demand profile.

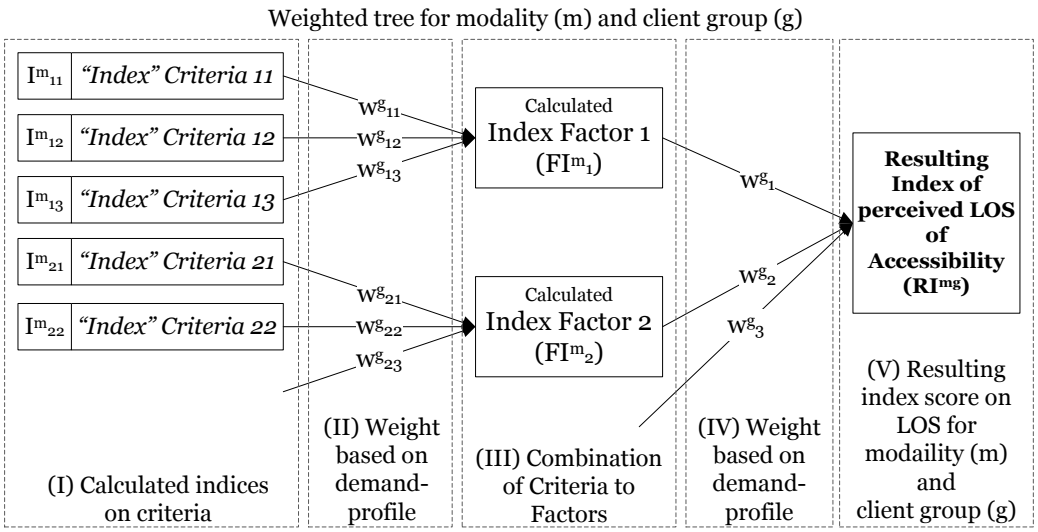

FIGURE 17-3: DEVELOPED WEIGHTED TREE ON MEASURING ACCESSIBILITY PERFORMANCE

The resulting index on accessibility can be constructed by multiplying all calculated indices with the appointed weights, as shown by formula (4)

$$(4)\ RI^{mg} = \frac{\sum(w^{g}{}_{xy} * (I^{m}{}_{xy}))}{\sum(w^{g}{}_{xy})},$$

This formula gives the resulting accessibility index for a certain modality (m) and client group (g).

To get an overall index, independent of modality or client group, a weight is appointed based on the volume percentage of the client group and modality (figures are known from the volume analysis) to each resulting index score.

Formula (5) shows how the overall resulting index on accessibility (RI) can be constructed based on the volumes of a modality combined with a client group.

$$(5)\ RI = \frac{RI^{m1g1} * ("volume\ of\ m1g1"). \ldots + RI^{m8g2} * ("volume\ of\ m8g2")}{("volume\ of\ m1g1" + \ldots + "volume\ of\ m8g2")}$$

Where m1g1 is the combination of modality 1 (ie. train) and group 1 (ie. Schiphol workers)

QUESTION 4: *What is an achievable Performance Measurement System for T&T given the limitations?*

A analysis on available data sources showed that there is insufficient (< 40%) data available to implement the proposed method to measure performance. Therefore it was decided to delay implementation until sufficient data as available and for the time being develop an alternative PMS.

Excel was used to create and operate the dashboard. Access was used to enter data into the database.

The PMS gives the possibility to select a client group (passengers or Schiphol Workers) and a period (the current period or one of the preceding 24 months).

Numbers are presented on a monthly basis and a comparison is shown with the preceding month and the same month one year ago. To enhance the insightfulness, coloured arrows are used to show high, medium of no decrease/increase between the periods. Also a graph is presented in the same fashion graphs are currently presented, for each indicator.

The indicators are coupled for each modality. This gives modality managers the possibility to quickly look for the most relevant indicators. Figure 15-1 shows a screenshot of the constructed system.

Although this constructed PMS is valuable in providing a clear insight in performance, it is not sufficiently able to capture the client perception on the quality of Schiphol´s accessibility. An alternative, complimentary, system was therefore created to capture – in some form – the perceived accessibility of Schiphol. This system (a social media scanner) collects all social media messages (mainly twitter messages) that contain outings on the Schiphol modalities for the past 48 hours.

Based on signal words the sentiment of each message is analysed (positive, neutral or negative). A dashboard insightfully presents the percentages of each sentiment for three different modalities (train, bus and taxi). This dashboard enables the T&T managers to see sudden spikes (declines or raises) in the perception of modalities, but also to follow the quality perception over time. These trends can indicate whether the perceived accessibility quality of Schiphol is changing over time.

17.2 Validation

The results of the design tracks are validated by matching the original design objectives with the achieved results

Objective 1: *To design a method to measure the performance of T&T*

A method is indeed designed. This method is able to capture performance that is directly related to the objectives of T&T. In the opinion of the author, such a system (capable of measuring the perceived quality of airport accessibility) had not yet been developed. As such this method is a first draft design that can be improved on many aspects. However it can already provide, given sufficient data sources, indices on delivered performance that allow mangers to quickly notice a decline or raise in quality criteria and the effects on the overall accessibility perception of different client groups.

As this is a draft design and many assumptions have to be verified over time, the informative value is limited. The certainty on the given indicators is not sufficient to make high impact management decisions based the resulting figures. As the proposed improvements are implemented, the informative value of the method will increase and thus the ability to steer and hold employees accountable for the resulting indicators.

Objective 2: *To create a system that is able to use the method and present the measured performance*

This objective could not be achieved due to the limitations. To use the developed method many additional data sources were needed to feed the system. Less than 40 % of the needed data is available at T&T. As such it was decided to create an alternative PMS and to recommend future implementation of the developed method (when sufficient data sources are available).

By combining the data available on relevant performance indicators in a single database and giving the ability to compare different time periods on performance, a PMS was created that gives valuable additional insight to T&T management.

As this PMS does not yet measure the perceived accessibility from a client perspective, the PMS is supplemented by a developed social media scanner. This scanner can measure the sentiment of social media messages on the accessibility of Schiphol. As such it provides an indication on the (trend in) quality of Schiphol´s accessibility as stated by the clients.

Although the design performance measurement method is not implemented, the resulting combination of the simplified PMS and social media scanner does provide a significant increase in the possibility to measure and show T&T´s performance.

18 RECOMMENDATIONS

Many recommendations are made during the verification analyses on Design Track I (Chapter 10) and Design Track II (Chapter 0). It is advised to consult these chapter to get a full oversight of all (improvement) recommendations. This chapter will use the findings from the two verification steps and the conclusions from the previous chapter to present the major recommendations.

18.1 MEASUREMENT METHOD

- The measurement method depends on correct figures on the modality split of the different client groups (usage of the modalities per group). The volumes on Schiphol workers are currently updated once every two years. This is insufficient. To get more frequent updates on the volumes and split of Schiphol Workers an estimation method has to be implemented that uses the survey outcomes on Passengers but alters these figures based on data on amount of workers, region increase/decrease, new public service routes, etc.
- It is advisable to improve the set of factors and criteria based on an experiment that allows representatives of client groups to create criteria of importance to their perception of the quality of airport accessibility
- It is now assumed that all clients are either Passenger or Schiphol worker, which isn´t the case. As a result the demand profiles of visitors and cargo are not taken into consideration. Also Passengers and Schiphol Workers are not split in different underlying homogeneous groups (business/leisure, Dutch/non-Dutch, etc) as proposed in the client separation. As the goal is to offer all client the quality demanded, it is valuable to develop demand profiles for all client groups and underlying subgroups.
- The created demand profile is based on the position of the post-it. An interval scale is superimposed on the positions of the post-it's to value the criteria. This quantification is fully based on the technique chosen by the designer instead of an actual stated quantified difference by interviewees. It is advisable improve on the method of experiment so that the interviewees themselves state a quantified valuation of the different criteria. Another possibility is to do additional research on how the ranking along the axis can be transformed into a quantitative interpretation.
- Only 16 iterations of the experiment are conducted (8 groups of passengers and 8 groups of Schiphol workers). This amount is too limited to impute high value to the resulting averages. Many more iterations (minimum of 20 per client group) are needed to create demand profiles with higher certainty and thus put higher value to their influence.
- Currently a linear relation between a measured increase or decrease of a criterion and a resulting perception index is assumed. In reality the relation between absolute numeric changes and the percentage change in perception will be unique to each criterion. The elasticity between the measured change on a criterion and its index has to be researched to come to a higher validity of the method. This is expected to be quite difficult. For instance if parking cost increase from €2 to €3 per hour the index would go from 100 to 66. However the perception on parking cost might become much worse as changes in parking cost might have a quadratic effect on the resulting perception index.

- Over time an index of 100 should be directly related to a certain accessibility perception level (sufficient). For instance if clients would rate a parking price of € 2,- per hour as reasonable, this should be given an index of 100. Additional and on-going research on acceptable values on all criteria are needed to set a substantiated standard value that is given an index of 100.

- The resulting overall perception of Schiphol´s quality of accessibility is calculated by the design measurement method. Interestingly this indicator is also given by the International Airport Service Quality (ASQ) Benchmark from the Airport Council International (ACI).
  This organisation presents, twice a year, a report on the quality perception of passengers on 150 airports worldwide (Airports Council International, 2009). One figure given is the customer satisfaction on ground transportation to and from the airport.
  The calculated index figure from the measurement method can be compared with the figure from ASQ on customer satisfaction on ground transportation. As the both indicate performance on the same aspect, the ASQ figure can be used the validate the predicting value of the measurement method.
  A big difference in the expected value and the resulting value from the survey, shows that the calculation of the index has to be improved. Comparing and validating the designed measurement method with the ASQ figures is highly recommended

18.2 Performance Measurement System

- The primary recommendation is to aim for implementing the designed measurement method in the PMS. For this additional data sources are needed. When more than 60% of the needed data sources is available, the measurement method can be implemented. Therefore it is recommended to start developing data sources for the indicators. The indicators that are given the highest weight by the demand profile should be given priority.

- The objective is to have a full new set of indicators every month to use in management meetings. The data sources are evaluated on their update frequency, but it is unknown what the chance on delay or unavailability is. Additional research on the timeliness of that data sources would therefore be valuable.

- Cliqview offers advanced possibilities on connecting to different databases and conduct analyses on the datasets. Furthermore the Schiphol IT department has extensive knowledge on implementing such BI systems. For a second version it is therefore recommended to use Cliqview and be assisted by the Schiphol IT department. The findings of this thesis can be valuable to guide the development of the second version of the PMS

- Many of the KPI that were used until know are constructed by the MRI (market research & intelligence) department at Schiphol. They construct these KPI on the bases of (continuously) conducted interviews with Passengers. It appears that other indicators instead of the ones use now) could have a higher informative value with the same effort. It does demand MRI to change the questions asked to the passengers. It is recommended to evaluate the currently constructed KPI by MRI and possibility suggest KPI to be researched that are of higher relevance and informative value.

- The developed PMS is highly dependent on the willingness of those entering/uploading the data. This is seen as a weakness as not entering data would render the PMS worthless. It is therefore recommended to gradually automate

the uploading and entering of the needed data into the PMS.

- The PMS currently has no capability to set targets. However this is highly desirable. T&T management want to push the employees to improve on relevant performance indicators. Therefore targets have to be set. After implementation of the PMS it is advisable to look for reasonable targets and implement them in the PMS.
- To get more valid results on the sentiment of the messages found by the social media scanner, the amount of signal words has to be extended, possibly even rated (very negative, moderately negative, etc.). Furthermore the current designed system looks for the amount of times a word is used in all social media messages of the last 48 hours. If someone sends the message "Schiphol train is fun, fun, fun, fun" the system would indicate 4 time the word fun in the total. This is of course incorrect. The system should be improved so it only gives one sentiment valuation per message.
- The licences used to get the required data from social media is a free-of-use licence. Although this ensures no costs, it is also put a strain of reliability as no SLA is concluded. It is therefore advisable to find a trustworthy provider of the social media messages and construct a SLA.
- The PMS and the social media scanner are currently two separated systems in different sheets as they are developed independently. To reduce complexity to the end-user it is advisable to integrate the two system and present the major findings in a single sheet.

18.3 Organisational

- An interesting passage was found when doing literature on Performance Measurement system This passage, by Neely et al., shows the challenges in starting the use of a PMS in an organisation. As it expected to be of high relevance the passage is quoted here:

  "The process of designing a measurement system is intellectually challenging, fulfilling and immensely valuable to those managers who participate fully in it. There is increasing anecdotal evidence, however, that the process of designing the measurement system is not the most difficult task. The real challenges for managers come once they have developed their robust measurement system, for then they must implement the measures. As soon as they seek to do so they encounter fear, politics and subversion. Individuals begin to worry that the measures might expose their shortcomings. Different people seek to undermine the credibility of the measures in different ways. Some seek to game the system. Others seek to prevent it ever being implemented". (Neely et al., 2000)
- The adoption and further development of the PMS requires a PM manager who is a accepted member of the management team that responsible for the supply chain. The PM manager is responsible for the whole reporting and improvement process, not just as an analyst or accountant, but as a manager in charge of concrete follow-ups and monitoring the effects of actions, as well as being responsible for improving the PMS itself.

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-ANNEXES-

A. Theory on Performance Measurement Systems

A.1 Creating Performance Measurements

"The process of deciding which measures of business performance to adopt is a valuable one, not least because it forces management teams to be very explicit about their performance priorities and the relationship between them, thereby exposing, and offering an opportunity to resolve, any hidden differences of opinion". (Neely et al., 2000)

The goal of this thesis is to design a Performance Measurement System (PMS) relevant to the T&T activities. To come to a thorough and relevant design it is wise to use a guide that prescribes the steps to achieve a PMS and to have a broader understanding how PMS work and compose relevant KPI. There is an extensive body of literature on PMS design requirements, steps, frameworks and recommendations. This paragraph will present the findings that are relevant to the T&T situation and surrounding. This will result in combining the findings most applicable into a framework that is used for the creation of the T&T PMS.

According to Folan and Browne the initial building blocks of all Performance Measurement (PM) initiatives may be termed PM recommendations. PM begins with a recommendation, which is a piece of advice related to the discipline of PM—its measures or its structure, for example. When a series of these recommendations have been collected, a PM framework may be developed which use these recommendations as the basis for development.(Folan and Browne, 2005)

Recommendations concerning PM can be divided into two core areas:

- **recommendations for performance measures**: emphases upon the requirements of good performance measures
- **recommendations and issues for PM framework and system design:** examines the recommendations that have been made regarding the design and development of PM frameworks and systems

Neely, Mills et al have written an extensive paper on the review of Performance Measurement design concepts. They have focused on both types of recommendations. They have groups their findings into a table that has both desirable characteristics of PMS design as well as desirable characteristics for the output (performance measures). Table 19-1 shows their findings.

Table 19-1: Preferences of PMS design and output

Desirable characteristics of a performance measurement system design process	Desirable characteristics of the output of the process
Performance measures should be derived from the company's strategy.	Performance measures should enable/ facilitate benchmarking.
The purpose of each performance measure must be made explicit.	Ratio based performance measures are preferable to absolute numbers.
Data collection and methods of calculating the level of performance must be made clear.	Performance criteria should be directly under the control of the evaluated organizational unit.
Everyone (customers, employees and managers) should be involved in the selection of the measures.	Objective performance criteria are preferable to subjective ones.
The performance measures that are selected should take account of the organization.	Non-financial measures should be adopted.
The process should be easily revisitable – measures should change as circumstances change.	Performance measures should be simple and easy to use.
	Performance measures should provide fast feedback.
	Performance measures should stimulate continuous improvement rather than just monitor.

Recommendations for Performance Measures

A key article of Folan and Browne state that measuring organizational performance is an increasing important field of research for organizations and academics (Folan and Browne, 2005). In their article they try to review the current (article from 2005) rich body of literature on performance measurement. They refer to Neely (as described above) but complement these objectives with the following objectives for a performance measures:

- the measure should be kept physical (i.e. quantitative)
- the measure should be taken as close to the customer as possible.
- have top management support;
- involve employees in their development (particularly customer satisfaction measures);
- ensure that those measures used are relevant to managers and employees in performing their day-to-day jobs;
- be part of a feedback loop that links them to manager and employee performance appraisals.

Recommendations for PMS design

Folan and Browne have constructed a list of 32 recommendations for the design and development of performance measurement frameworks and systems based on the academic findings of many researchers (Folan and Browne, 2005). For our design at T&T we can make a selection of the 20 recommendations that are most relevant to our performance measurement system.

1. Should be based upon the strategic role of the company
2. Specific goals must be established and revised when met
3. Measurements should be easy to understand by those being evaluated
4. Data should be collected, where possible, by those whose performance is being evaluated
5. Graphs should be the primary method of reporting performance data
6. Data should be available for constant review
7. Performance should be reported daily or weekly
8. PM systems should be mutually supportive and consistent with the business's goals, objectives, critical success factors and programmes
9. Should convey information through as few and as simple a set of measures as possible
10. PM systems should reveal how effectively customers' needs and expectations are satisfied
11. Focus upon measures that customers can see
12. Provide measures that allows all members of the organisation to understand how they affect the entire business
13. System consists of well-defined and measurable criteria for the organisation
14. Routines must be established so that measures can be measured
15. Feedback from PM systems should report at numerous levels of the organisation
16. Feedback from PM systems must be linked cross-functionally to ensure it supports and not inhibit strategy implementation
17. Should enable managers to view performance in several areas simultaneously
18. PM system information on the strategic objectives of the division must be shared across functional areas to provide organisational focus within divisions
19. PM system should be used to challenge strategic assumptions
20. PM system should be implemented in such a way that it does not induce fear, politics and subversion

Lohman et. al. have created a list of recommendations when creating a model. Those relevant to our design process are(Lohman et al., 2004):

1. Use a standard metric definition template that includes all relevant metric attributes needed to produce or reproduce metric values in a consistent way.
2. Postpone the selection of dedicated PM software until the basis of the PMS (the metric dictionary) is mature.
3. The adoption and further development of the PMS requires a PM manager who

is a accepted member of the management team that responsible for the supply chain. The PM manager is responsible for the whole reporting and improvement process, not just as an analyst or accountant, but as a manager in charge of concrete follow-ups and monitoring the effects of actions, as well as being responsible for improving the PMS itself.

POSSIBLE BARRIERS

Lohman, Fortuin et al. stress the limitations of a "green field" approach in the development of PMSs. The presence of existing measures and parallel PM initiatives may quite fundamentally change the development from a "design approach" to a "coordination approach" focused at aligning the future PMS with existing performance measures and parallel initiatives outside the operations function. (Lohman et al., 2004)

According to Lohman, Fortuin et al. many companies that want to improve their PMS have to face five problem areas that have to do with an existing infrastructure of measurements (Lohman et al., 2004), namely:

1. a decentralized, operational reporting history;
2. deficient insight in the cohesion between metrics;
3. uncertainty about what to measure;
4. poor communication between users and producers of PI
5. a dispersed IT infrastructure.

Kaplan and Norton identified 4 barriers to implementation of performance measurement systems. These were identified through individual cases but quantifiable supporting evidence is provided. These barriers are mentioned in the passage (Kaplan and Norton 1999):

Vision and strategy not actionable

This occurs when the senior management team have failed to achieve consensus as to how the vision should be achieved. This leads to different groups pursuing different agendas and effort is neither coherent nor linked to strategy in an integrated way.

Strategy is not linked to department, team and individual goals

When this happens, then those concerned continue to follow the old traditional performance criteria and thwart the introduction of the new strategy. This can be exacerbated by an unaligned incentive system.

Strategy is not linked to resource allocation

This often occurs when the long term strategic planning process and annual budgeting process are separated and may result in funding and capital allocations becoming unrelated to strategic priorities.

Feedback is tactical and not strategic

This occurs when feedback concentrates solely on short-term results (such as the financial measures) and little time is reserved for the review of indicators of strategy implementation and success.

A.2 PMS Steps

Azofra, Prieto et al. give an example of how the key variables, that determine the performance (in their case of a car factory in Spain), can be identified from the global mission. In this way the ultimate key factors that determine success on the strategic goals can be derived in five steps: Global Mission to Local Mission to Strategic Objectives to Key Succes Factors to Action Plans to Key Variables. Figure 19-1 provides an example of the steps filled in for their automotive case.

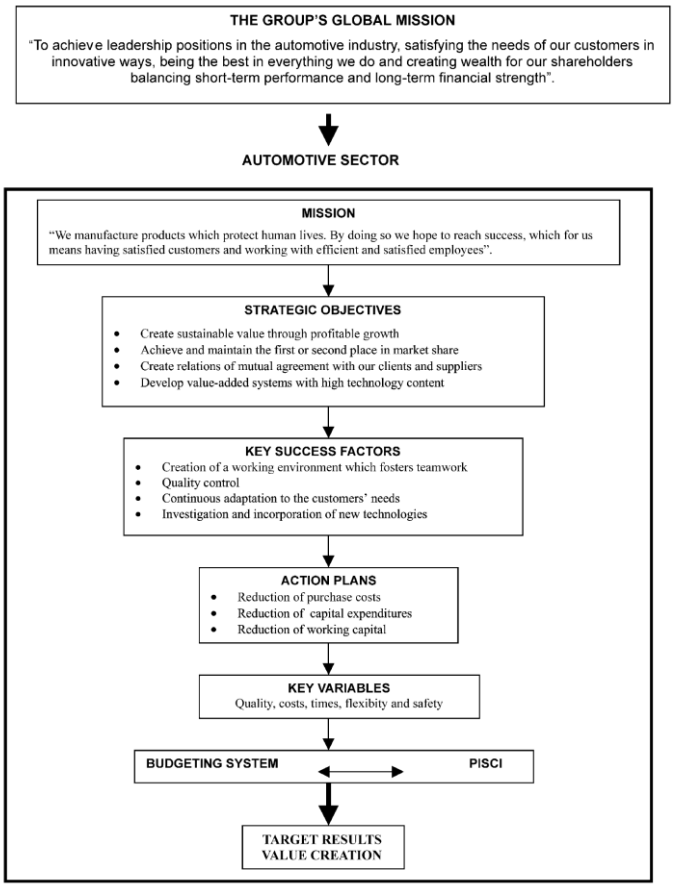

Figure 19-1: PMS steps according to Azorfa et al.

According to a report by Root Cause on building a performance measurement model there are five fundamental questions that should be thoroughly answered to create a valuable BPM (Wolk et al., 2009):

- *"How do we know how well our organization is progressing against our mission and goals?*
- *What should we measure in order to have critical information without becoming overwhelmed with data?*
- *How should we report and discuss our performance internally among staff and board members to maximize learning?*
- *Where should we focus our organization's limited resources in order to increase our effectiveness today and achieve sustainability over the longer term?*
- *How can we most effectively measure and communicate our performance and impact to external stakeholders? "* (Wolk et al., 2009)

In their report Wolk, Dholakia et al. Prescribe a five step approach to building a performance measurement system. These steps are:

1. Planning to measure
2. What to measure
3. Determining how to measure
4. Prepare to use the data

Table 19-2: Steps to develop a PMS

Nine steps to develop a **PMS** [36]

Step	Action
1	Clearly define the firm's mission statement
2	Identify the firm's strategic objectives using the mission statement as a guide (profitability, market share, quality, cost, flexibility, dependability, and innovation)
3	Develop an understanding of each functional area's role in achieving the various strategic objectives
4	For each functional area, develop global performance measures capable of defining the firm's overall competitive position to top management
5	Communicate strategic objectives and performance goals to lower levels in the organization. Establish more specific performance criteria at each level
6	Assure consistency with strategic objectives among the performance criteria used at each level
7	Assure the compatibility of performance measures used in all functional areas
8	Use the **PMS**
9	Periodically re-evaluate the appropriateness of the established **PMS** in view of the current competitive environment

Lohman and Fortuin have also created a list of nine steps to develop a PMS. Their steps are stated in Table 19-2 (Lohman et al., 2004)

A.3 Frameworks

Ferreira and Otley state that frameworks on their own are not a complete solution (Ferreira and Otley, 2009). Frameworks do not tell a company what to measure and there is no mechanism for specifying the objectives which should be met. However they can provide guidance into the creation of a valuable Performance Measurement System

Before venturing into the literature there is one basic differentiation on frameworks that has to be mentioned. Firstly there are *frameworks on measurement focus*. These describe how PMS can function within an organization and where and how in an organization it is possible to come to measurements.

Secondly there are *frameworks on the design of a PMS*. These prescribe which steps have to be taken, information/insight is necessary and pitfalls have to be avoided to create a PMS.

Frameworks on Measurement Focus

Brown's framework, shown in Figure 19-2, is useful because it highlights the difference between input, process, output and outcome measures. He uses the analogy of baking a cake to explain this more fully. Input measures would be concerned with volume of flour, quality of eggs, etc. Process measures would be concerned with oven temperature and length of baking time. Output measures would be concerned with the quality of the cake. Outcome measures would be concerned with the satisfaction of the cake eaters i.e. was the cake enjoyable?

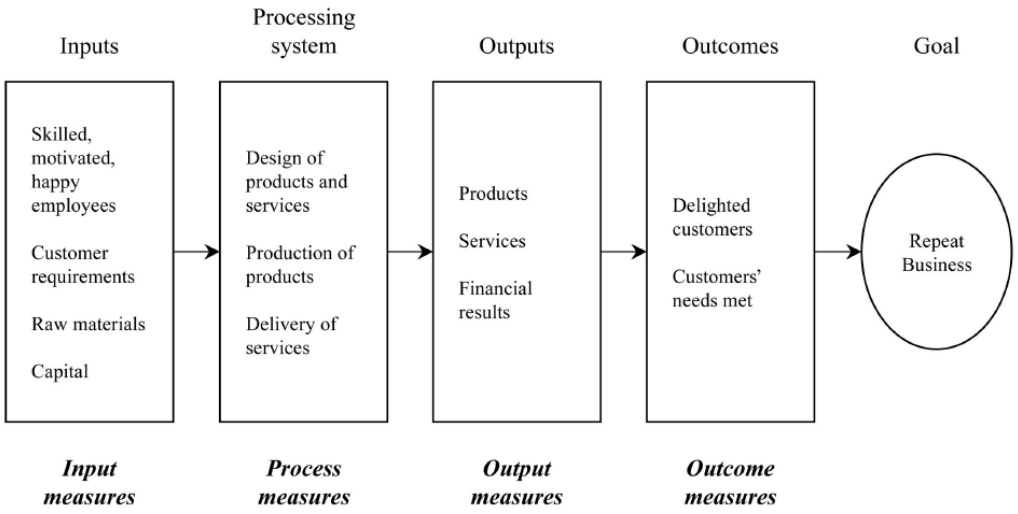

Figure 19-2: Brown´s Framework

Another wide ranging and currently popular measurement framework is the European Foundation for Quality Management's Business Excellence Model. This consists of two distinct subsets of performance factors, broadly classified as enablers and results. The theory underpinning the Business Excellence Model is that the enablers are the levers that management can pull to deliver future results (Figure 19-3).

The terms used in the framework are so open and can be interpreted in so many ways, that any single organization could decide to capture any one of several dozen different measures of performance under each of the headings. (Neely et al., 2000)

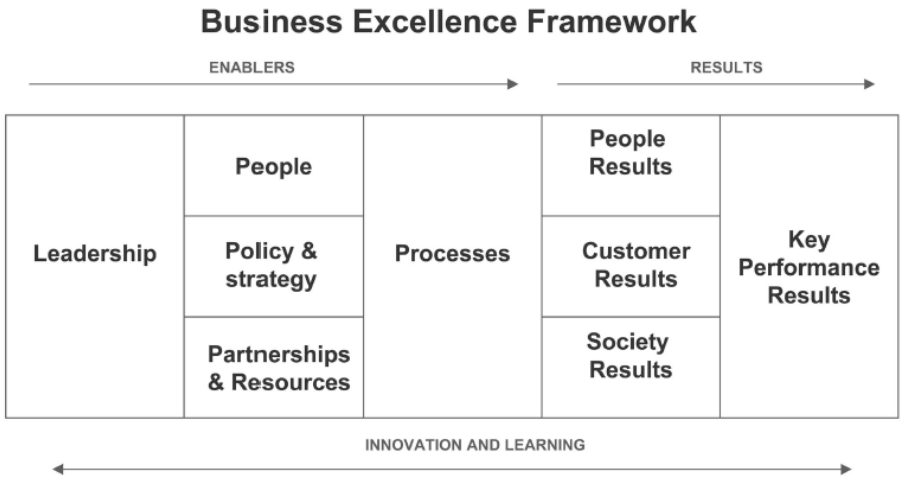

FIGURE 19-3: BUSINESS EXCELLENCE FRAMEWORK

FRAMEWORKS ON THE DESIGN OF PMS

Many frameworks on the design of PMS that have been developed are focused on producing companies and of limited relevance to the T&T situation.

A major influence on the choice of the performance measurement framework is the type of performance that is desired to measure. As is made clear in the paragraphs Introduction and Goals of T&T, AAS and T&T are very much focussed on delivering quality to the client. The selected framework for performance measurement must therefore be aimed at measuring the amount of quality that T&T offers to their clients.

Bourne and Neely recognize that there are wide differences between the published approaches to designing and implementing performance measurement systems. To create a better understanding of the alternative approaches, Bourne and Neely have categorized published approaches to PMS creation. (Bourne et al., 2003)

Bourne and Neely suggest that the PMS frameworks can be categorized on two aspects:

- **The underlying procedure**, which could be considered the 'hard' issues
  - *The 'needs led' procedure*: a top down procedure for developing performance measures, where the customer, business and stakeholder needs are severally or jointly identified and used as a basis for the development of performance measures. The measures are designed to monitor the business's progress towards achievement of these needs.
  - *The 'audit led' procedure*: a bottom up approach to the design of a performance measurement system, starting with an audit of the existing performance measures. The information collected is then used to challenge the status quo and as a basis for amending the existing performance measures.
  - *The 'model led' procedure:* a prescribed theoretical model of the organisation as a rationale for designing the performance measures that should be deployed.
- **The underlying approach**, in terms of the role of the process leader, change agent or consultant, which could be considered the 'soft' issues.
  - *The 'consultant led' approach:* the majority of work is undertaken by an individual (or group of individuals, usually consultants – hence the term used here) almost in isolation from the rest of the management team.
  - *The 'facilitator led' approach:* the majority of the work is undertaken by the management team together in facilitated workshops. Consequently, the management team's role is not restricted to critiquing work done by

others.

In the T&T case has clearly *a need led procedure* as our goal is to measure the quality to the customer and the customers voice is put central in evaluating performance. Looking at the underlying approach, this thesis and the followed steps are in line with the *consultant led approach* where the majority of the work is done in isolation from the rest of the management team. With this is not meant that the management is not involved in the whole process, but that the lead and steps are taken by the ´consultant´.

Our focus is therefore on the different Needs Led procedures that are Consultant approaches. We will focus on three frameworks that reside in this category: The client focused balanced scorecard by Kaplan and Norton, Neely & Mills´PMS design process and the Extended framework by Fereira and Otley

BALANCED SCORECARD

Many performance measurement systems are focused on multiple aspects within a company. A good example is the Balanced Scorecard approach by Kaplan and Norton, a very popular approach during the turn of the century. Multiple research have found that the balanced scorecard system as developed by Kaplan is valuable as performance measurement system. This system prescribes how a performance measurement system can be created. Although such a system cannot be used one on one for the T&T case due to the unique situation (no direct competitor, no real suppliers, etc), it does have interesting aspects

The balanced scorecard framework is based upon four perspectives surrounding the company's vision and strategy:

- financial perspective;
- customer perspective;
- internal business perspective;
- learning and growth perspective.

As stated above our PMS will be focused at the customer (client). Although we acknowledge that the other aspects are also of value and T&T does consider these aspects our research will be focussed on measuring the quality delivered to the customer.

Since Kaplan and Norton's initial article in Harvard Business Review, the application of the balanced scorecard has been developed and refined through consulting practice.

The initial process describes in outline the seven stages for developing and implementing a balanced scorecard. The process uses both consultant interviews and executive workshops in the development of a shared set of business objectives and measures. A graphical overview is depicted by Figure 19-4.

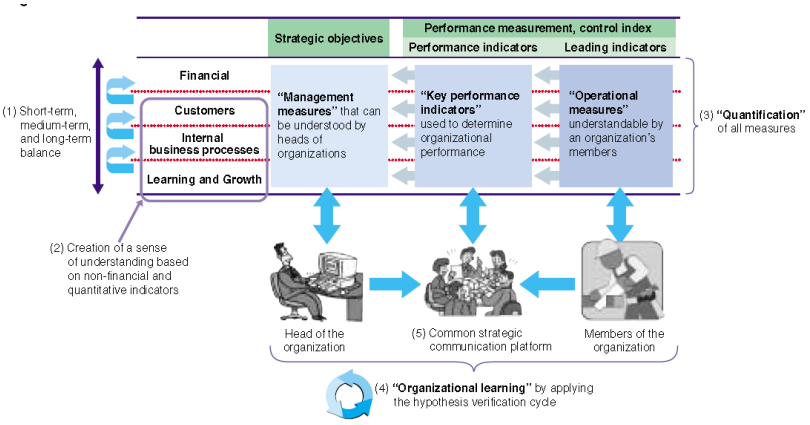

FIGURE 19-4: TECHNIQUES AND STEPS TO FIND PERFORMANCE MEASURES

This process has been developed by the introduction of tools to capture the customer perspective. Kaplan described how an external customer view was introduced into the scorecard development process in an example case. Here, customer interviews were recorded and analysed. This technique developed a new customer and allowed the company to segment its market and to develop strategies, actions and measures that underpinned the development of its chosen niche. (Bourne et al., 2003)

Neely and Mills PMS design process

Neely, Milles et al (Neely et al., 2000) developed a 12 phase system in 1991 that could be used for designing a performance measurement system. This was a very facilitated processes that demand a great deal of interaction with management. Over the years they have applied this framework many times and made alterations to it to get a more consultant led procedure. They have tested this system in multiple environments and made several alterations based on their findings. This led to the creation of a enhanced flowchart in 1994 that outlined the steps needed to come to a PMS. This model, consisting of six main phases, as depicted in Figure 19-5

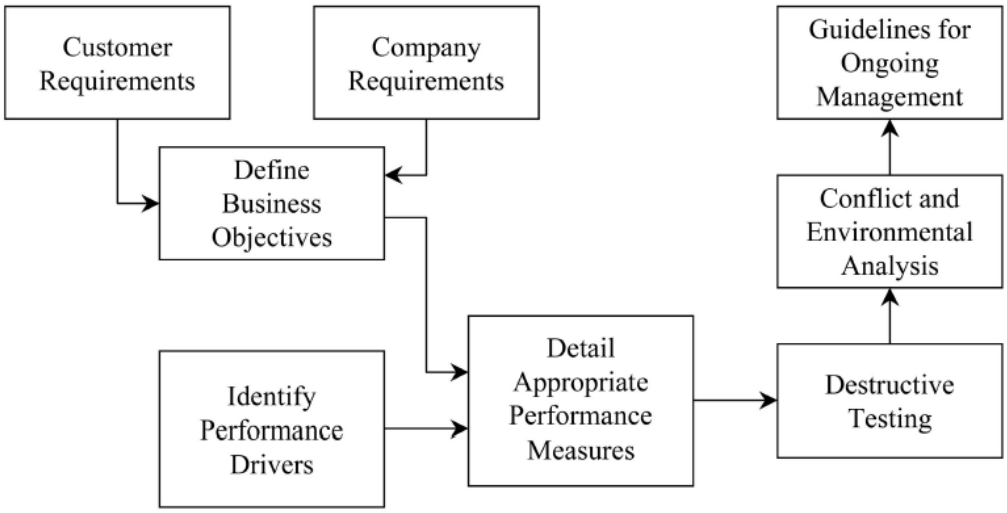

Figure 19-5: Enhanced six-step PMS flowchart

However after this, they've made several further alteration as could be understood from the Bourne and Neely article "Implementing PMS: a literature overview". They have altered their model and added the notion that PMS design alterations have to be done for each product group. The total framework comprehensives a 10 step process. The first five of these are focused on "*the tools and procedures for developing top level set of business objectives and designing performance measures for a business unit*" (Bourne et al., 2003), as also depicted by Figure 19-6*:*

- **Part 1 Grouping products**: by identifying groups of products (or markets) which have distinct competitive requirements. This is done as different products or markets may have differing customer needs
- **Part 2 Agreeing business objectives**: by developing business objectives from customer and stakeholder needs to create a coherent set of top-level business objectives
- **Part 3 Agreeing performance measures**: by designing individual performance measures for each of the business objectives agreed in part 2
- **Part 4 Signing off the top-level performance measures**: by reviewing the measures developed in part 3, testing them for comprehensiveness and coherence before obtaining agreement for implementation
- **Part 5 Embedding the top level performance measures**: by providing advice on implementation and performance reviews.

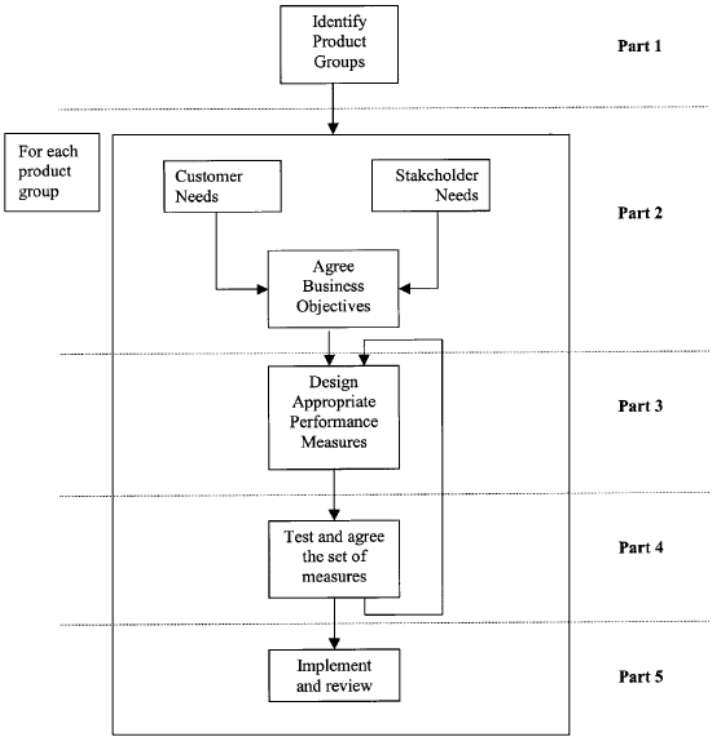

FIGURE 19-6: TOOLS AND PROCEDURES FOR DEVELOPING TOP LEVEL SET OF BUSINESS OBJECTIVES

EXTENDED FRAMEWORK BY FEREIRA AND OTLEY

Based on the frameworks of Otleys´s (1999) and Simmons (1995), Fereira and Otley propose an extended framework. This framework aims to provide a broad view on the key aspects of a PMS. (Ferreira and Otley, 2009). They put the measurement system into the management environment and is therefore more a performance management system.

The PMSs framework proposed in this paper draws on the extant literature, but also on personal observations of MCS design and use in a variety of organizations over the years. It represents the result of inductive reasoning applied to a variety of studies known to the authors. The PMSs framework is put forward as a research tool for examining the structure, operation and use of PMSs in an holistic manner.

The proposed questions should provide powerful means to *"relatively quickly outlining the main features of a PMS in a comprehensive manner, and the ways in which it is used in the context of a specific organization"*. (Ferreira and Otley, 2009).

The framework is a progression of Otleys earlier framework and 10 ´what´ and 2 ´how questions:

1. What is the vision and mission of the organization and how is this brought to the attention of managers and employees? What mechanisms, processes, and-networks are used to convey the organization's overarching purposes and objectives to its members?
2. What are the key factors that are believed to be central to the organization's overall future success and how are they brought to the attention of managers and employees?
3. What is the organization structure and what impact does it have on the design and use of performance management systems (PMSs)? How does it influence and how is it influenced by the strategic management process?
4. What strategies and plans has the organization adopted and what are the processes and activities that it has decided will be required for it to ensure its suc-

cess? How are strategies and plans adapted, generated and communicated to managers and employees?

5. What are the organization's key performance measures deriving from its objectives, key success factors, and strategies and plans? How are these specified and communicated and what role do they play in performance evaluation? Are there significant omissions?
6. What level of performance does the organization need to achieve for each of its key performance measures (identified in the above question), how does it go about setting appropriate performance targets for them, and how challenging are those performance targets?
7. What processes, if any, does the organization follow for evaluating individual, group, and organizational performance? Are performance evaluations primarily objective, subjective or mixed and how important are formal and informal information and controls in these processes?
8. What rewards — financial and/or non-financial — will managers and other employees gain by achieving performance targets or other assessed aspects of performance (or, conversely, what penalties will they suffer by failing to achieve them)?
9. What specific information flows — feedback and feedforward —, systems and networks has the organization in place to support the operation of its PMSs?
10. What type of use is made of information and of the various control mechanisms in place? Can these uses be characterised in terms of various typologies in the literature? How do controls and their uses differ at different hierarchical levels?
11. How have the PMSs altered in the light of the change dynamics of the organization and its environment? Have the changes in PMSs design or use been made in a proactive or reactive manner?
12. Howstrong and coherent are the links between the components of PMSs and the ways in which they are used (as denoted by the above 11 questions)?

These questions – or actually the answers - can be put into a graphical representation to present the relationship. Figure 19-7 shows the sequence of the questions and how they can be seen in a Performance Management System as a whole (Ferreira and Otley, 2009)

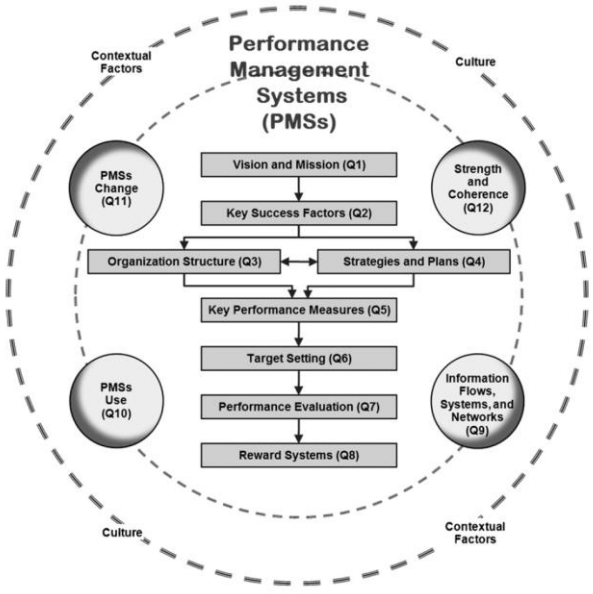

Figure 19-7: Questions and analyses needed to come to PMS

B. Full Objective analyses

B.1 Schiphol Group

Corporate vision

The Schiphol Group, parent to AAS, has created the AirportCity concept. It wants to develop airports that create added value on multiple levels and offers and inspiring environment to all travelling, working and visiting guests (Schiphol Group NV, 2010a).

The vision, mission and ambition as described by the Schiphol Group (Schiphol Group NV, 2010a) is depicted in Figure 19-8.

Figure 19-8: Vision, Mission and Ambition of the Schiphol Group

B.2 Amsterdam Airport Schiphol

Amsterdam Airport Schiphol is by far the most important airport to the Schiphol group and provides the vast majority of its income. AAS is the embodiment of the AirportCity concept.

Europe´s Most Preferred Airport

The goal of AAS is to become and stay *Europe´s most preferred airport*. With preferred is meant that the focus is on offering quality to the client.

AAS sees the AirportCity concept, developed by the Schiphol Group, as leading in becoming Europe´s preferred airport. The concept is built on two major pillars: the Socio-economic function and Entrepreneurial Management (Figure 19-9). These pillars should be seen as interactive. In thriving for optimisation of its socio-economic function, all business areas should adhere to conditions set by focusing on a healthy business (operation). But also the other way around: All entrepreneurial activities should contribute to the socio-economic function.

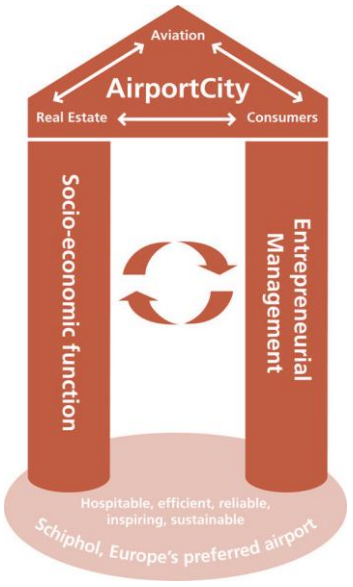

Figure 19-9: Airport City concept

Strategy Amsterdam Airport Schiphol

Becoming Europe´s preferred airports asks for a strong strategy. Schiphol´s board therefore pushes for a more *lean and competitive operation* throughout the whole AAS organisation. With outsourcing non-core activities, six sigma optimisation projects, increased management insight and steering capabilities and a solid company vision, Schiphol creates an environment where competitiveness is enforced.

At the same time there is an increased focus on sustainable and environmental responsibility. The social responsibility that AAS recognises, pushes to commit to a leading position in thriving for sustainability. In the end of 2007 Schiphol´s board presented a climate plan for Schiphol *(Schiphol Group NV, 2007)*. This plan set ambitious strategies to increase the companywide focus on sustainability and rigorous targets on the reduction of CO_2 and NO_x emissions.

Finally Schiphol recognises that it might out price itself out of the current market (Schiphol Group NV, 2010c). Especially if growth is not expected, following through on its AirportCity and sustainability goals becomes too expensive. Therefore higher management also focuses on a drastic reduction of its operating expenses.

QUALITY DRIVEN APPROACH

The vision and strategy have resulted in a quality driven approach: AAS aims to set itself apart from other airports by offering a true quality experience for the customer. This approach is communicated to all business areas through a core focus and five core values *(Schiphol Group NV, 2010c)*. The core focus is *"connecting"* and is combined with the core (brand) values: *Reliable – Efficient – Innovative – Hospitable - Sustainable*

In the current period (2009-2012) the brand values are used for getting the *"the basics right"*. AAS wants to be positioned for becoming Europe´s preferred airport by firstly eliminating the current perceived dissatisfies and aims for a top 2 position for transfer passengers and a top 3 for O&D passengers by 2012.

From 2012 to 2015 the *focus will be on the satisfiers*, offering more than expected to the passenger. Offering top quality should result in becoming the number 1 airport for transfer and top 2 position in the O&D market. Figure 19-10 depicts the AAS two-step process of becoming Europe´s Preferred Airport according to AAS.

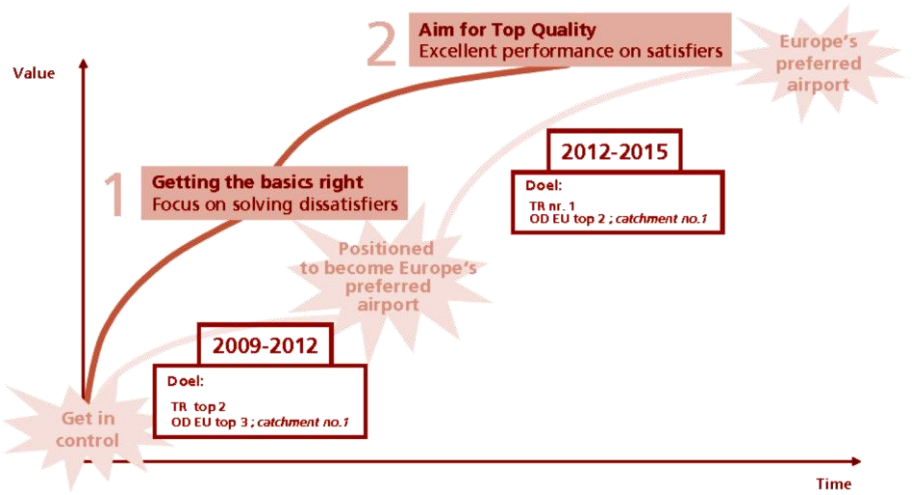

FIGURE 19-10: AAS GOALS IN BECOMING EUROPE´S PREFERRED AIRPORT

With these positions is meant the position that AAS gets in the European preferred airport rating. This is done by the International Airport Service Quality (ASQ) Benchmark from the Airport Council International (ACI). This organisation presents, twice a year, a report on the quality perception of passengers on 150 airports worldwide (Airports Council International, 2009). It provides insight in the quality perception of passengers on both the O/D and Transfer processes.

B.3 Passenger Services

As a result from the Quality driven approach as formulated by AAS, the Passenger Services department (parent to T&T) has developed, with input from underlying departments including T&T, the CTQ tree (Figure 19-11). CTQ stands for "Critical to Quality" and shows "the voice of the customer". The insight for this CTQ tree is attained from interviews with all departments in contact with the customer and in cooperation with the Marketing, Research & Intelligence (MRI) department at Schiphol *(Interview drs. ing. M.M.H. van Boxtel, 2010)*.

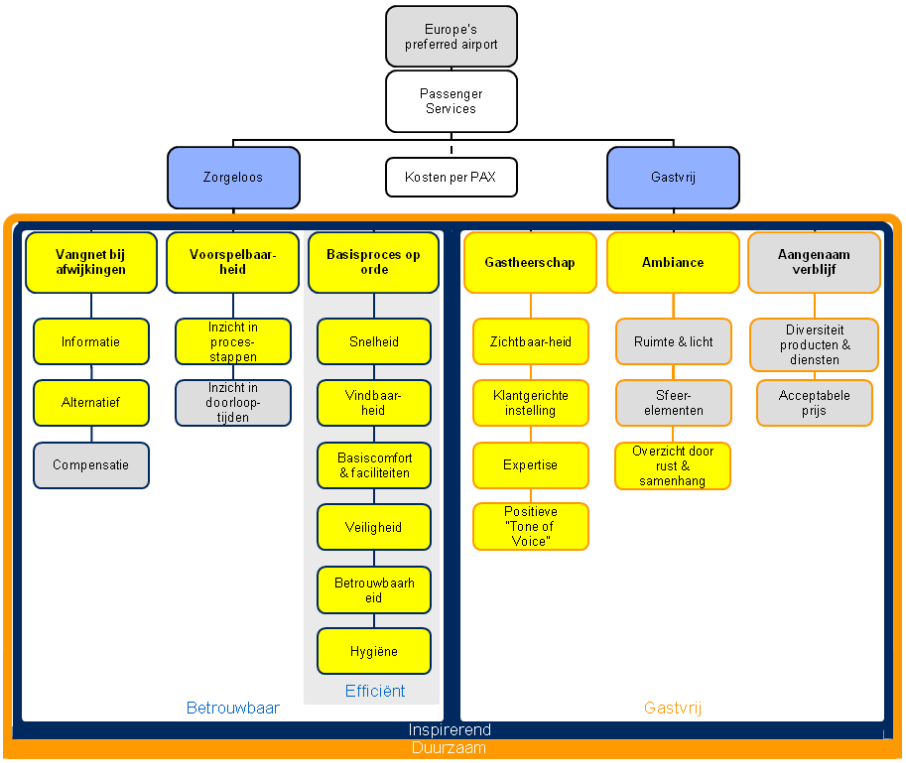

FIGURE 19-11: CTQ TREE

Explanation of CTQ tree

Starting point for the CTQ tree were the five core values as mentioned by the Schiphol Management: *Reliable, Efficient, Innovative, Hospitable and Sustainable.* All these core values are secured in the CTQ tree.

Three of these values are directly related to the passenger processes: *Reliable, Efficient and Hospitible.* These are given a prominent position on the CTQ tree and adhered to by stating six major factors that should lead top delivering qualities to the client, these are:

- coping with abnormalities
- predictability
- steady basic processes
- hospitality
- atmosphere
- pleasant stay

For each of these six factors several underlying sub factors are considered that are considered critical. Figure xx shows the full CtQ tree.

Also two preconditions are considered in the CtQ tree that are not critical to the client´s quality perception but are important to the PS (and also T&T) departments due to corporate core values. These are: "*Inspiring*" (referring to the work conditions for employ-

ees and related to the core value Innovative) and *"Sustainable"* (looking for solutions that minimize environmental effects).

As can be seen from the CtQ tree there is also a notion of "Costs per passenger". Although this tree is aimed at improving quality, this notion shows that in every quality decision costs have to be proportionally considered.

B.4 Traffic & Transportation

Europe´s most accessible multimodal hub

The T&T goals are a combination of the strategy and goals as formulated by the parent departments (AAS and PS) and the department´s responsibilities and customer groups. T&T wants to offer their clients a *reliable, seamless, predictable* and *fast connection with multiple travel alternatives* to Schiphol *(Schiphol Group NV - T&T, 2009)*. The ultimate goal is, in line with the AAS goals, formulated as:

To become Europe's most accessible multimodal hub

In T&T´s Accessibility Vision paper (Schiphol Group NV - T&T, 2009), this ultimate goal is accompanied with three sub goals that drive T&T in their activities and project development as mentioned. These are:

1. The multimodal transfer node
2. More capacity, better utilized
3. Increasing sustainability

In Table 19-3 a further specification of these three sub goals is given.

Table 19-3: T&T goals in Vision paper

The multimodal transfer node
• Increasing utilization of multimodal node by serving more targetgroups
• Troublesome travel: Comfortable, Realiable and Predictible
• Substantial flows: High capacity, high quality
• Hubfunction and seamless travel: Increasing catchment area and competitiveness by improving connection network
• Earning on transfering (OV) visitor
• Recognize different targetgroups
More capacity, better utilized
• Increase high-quality public transportation roadnetwork connections
• Increase high speed railroad connections and exploit in network
• Offer more travel alternatives
• Seamless transfers by better alignment and more offerings
• Optimal commercial offerings for customer (more earnings on visitors)
• Chain approach: i.e. parking as integral part of transportation
• Improve on travel information to customer
Increasing sustainability
• Strive for more sustainable modal split
• Reduce CO_2 footprint of passengers, schiphol workers and cargo

Business plan

T&T is currently developing a business plan based on the AAS strategy and T&T focus points that sets the vision for the coming five years (2011-2016). The stake of this plan is becoming the most accessible multimodal hub of Europe. The business plan describes three focus areas in reaching this ultimate goal: increase quality (Q), decrease capital investments (€) and increase employee satisfaction (☺) (Figure 19-12).

Although it is possible to develop a performance measurement system that is also focused at measuring employee satisfaction and the result of investments, as stated in the Assumptions & Limitations paragraph, the design of the PMS focuses at measuring quality to the client and is supportive to this goal of the business plan.

Very relevant to the design process is therefore the developed CTQ tree as discussed in the last paragraph.

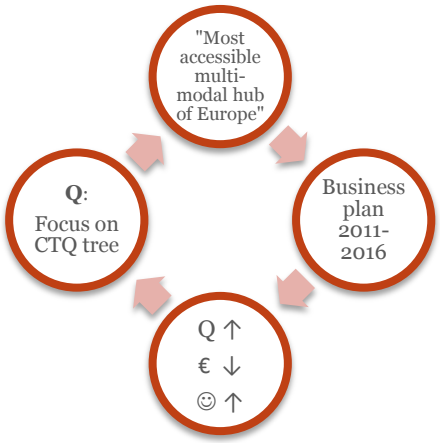

Figure 19-12: Business plan strategy

Sustainability

A key point in current developments is the increasing focus on sustainability.

A result of this climate plan is the developed Vision Sustainable Mobility that focuses on the (mobility) issues of relevance to the T&T department *(Schiphol Group NV, 2008)*. It states the vision of Schiphol on how sustainable mobility development is possible and what the developed program is to meet the set targets.

The targets set are impressive. The goal is to be CO_2 neutral in 2012 and have a reduction of 30% (compared to 1990) by the year 2020 *(Schiphol Group NV, 2007)*. This ambition has influence on the strategy of T&T. For instance there is an increasing focus on influencing the modality choice of passengers (public transportation instead of cars) and multiple incentives for Schiphol workers to travel by environmental friendly car.

It is expected that the focus on sustainability will only increase over the coming years. Therefore the developed KPI will have to be related to sustainability and present how the department is performing on its sustainability issues. Although the passenger´s perception of accessibility is the main focus, sustainability is a key constraint that will influence (future) performance figures.

C. Traffic Operations

The access of private cars is regulated by Traffic Operations. Traffic Operation's main responsibility is to warrant for an ongoing flow of arriving and departing passengers by motor vehicles on the Schiphol departure and arrival courts. Many passengers are dropped off and picked up directly from the departure & arrival terminals. On these terminals it is not allowed to park (parking only in the parking zones), only to load and unload passengers.

To ensure that the vehicles are not parked, Traffic Operations operates with 12 Special Investigation Officers (SIOs) (Bijzondere Opsporings Ambtenaren). The SIOs are authorized by the Royal Marechaussee to fine vehicles that are not in compliance with the parking regulation. Although parking is not allowed, only vehicles that are left unmanned for more than 15 minutes are fined. Fined vehicles can either be private vehicles, taxis or shuttles.

On all areas behind gates (such as the parking areas, the service-lane on the departure court and the A-lane on the arrival court) the SIOs are not allowed to fine. They regulate these areas by placing a wheel clamp on vehicles in violation.

The main goal of Traffic Operations is not to fine vehicles but to ensure that all arriving and departing passengers can quickly reach and depart the airfield. This means there should be no obstructions in the traffic flow. Besides this main goal, Traffic Operations also assist the Marechaussee in immediate traffic situations on the Schiphol area. Furthermore all non-passenger parking areas (employees) are inspected by Traffic Operations on correct parking in the designated areas. Possible methods to regulate these parking areas are warning, clamming or removing their parking authorisation.

A special situation are employees that have a Carpool or ECO2 authorization. They are allowed to park closer to the bus terminal on the employee parking areas P30 and P40 but have to arrive or depart the parking area with at least two passengers (Carpool) or drive a vehicle with low emissions (< 120 gr/km CO2, ECO2). If in non-compliance, their authorization to use these parking areas can be withdrawn.

Areas controlled by Traffic Operations are:

- P30 and P40 (employee parking)
- Schiphol oost (Separate Terminal)
- Drop-off roads arrivals and departures

D. Full Volume Analysis

Justification Schiphol Workers

Based on Mobiliteitsonderzoek 2008. The mobiliteitsonderzoek has given the percentual mix of modalities per region. The amount of people working in that area is based on the Regioplan 2008 data (including temporary employees), areas unknown in the regioplan are filled in with data from the mobiliteitsonderzoek. Where the increase from ´07 to ´08 on an area is unknown (Schiphol Rijk and AF Business Parc), the average increase in workers is taken.

To calculate the average number of in/out travellers per day, the average amount of working days per worker is calculated from the Osiris data on working day respondes in the mobiliteitsonderzoek. This is also aggregated per area. The Mobiliteitsonderzoek has data that shows the average workingdays per week based on modality (not area!), this suggest that those that have to come more often use other modalities. This is also taken into consideration. There is a correction for vacation days and the fact there is always two way travel (x2). On average an employee works 46 workweeks per year.

It is assumed every worker takes vacation on a different moment but there are of course periods that many people go on vacation. An equal spread of workers is assumed for all days of the week, in reality it is very well possible that the amount of workers in the weekends is significantly lower

Justification Passengers

2008 is used as a baseline, equal to to Schiphol Workers. The data is coming from Schiphol´s continuous research project. The year totals are divided by 365 to come to daily averages. Top days are created by selecting the 14 most busy days of 2008 (july: 11,13,14,18,19,20,21 and aug: 1,2,4,8,9,10,11). The total volume on these days was approx. 700.000 passengers

The total dataset is to extensive to be fully included in this thesis. Therefore graphs have been created that depict the essential findings on the data on both passengers and Schiphol Workers

D.1 Departing Passengers

Figure 19-13: Graphs on departing passenger volumes

D.2 Schiphol Workers

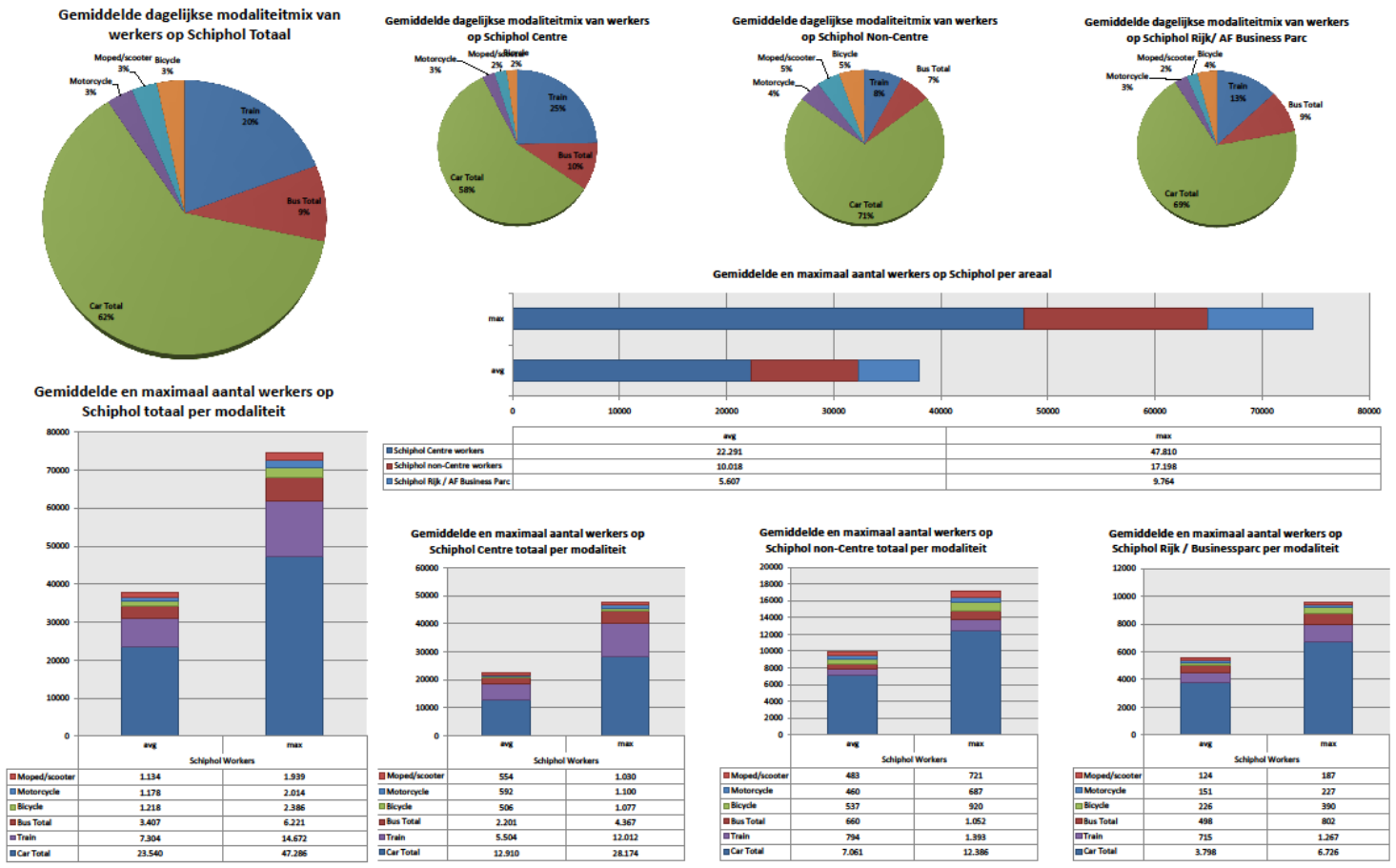

Figure 19-14: Graphs on Schiphol worker volumes

E. Resulting scores experiment on Schiphol workers

Table 19-4: Scores Schiphol Workers based on Experiment

		PAS1	PAS2	PAS3	PAS4	PAS5	PAS6	PAS7	PAS8	AVG	STD DEV (σ)	MED.	MOD.	RELIMP	COM FAC AVG	RELIMP
w11	TRANSPORATION COSTS	4	5	4	2	4	5	4	3	3,9	0,99	4	4	0,33		
w12	PRICE TRANSPARANCY	2	2	4	5	3	3	2	5	3,3	1,28	3	2	0,28	3,9	0,19
w13	PARKING COST	5	3	5	5	5	4	5	5	4,6	0,74	5	5	0,39		
w21	TRANSFER/WAITING TIME	2	3	3	4	3	3	2	4	3,0	0,76	3	3	0,12		
w22	TRAVELDISTANCE	4	4	3	2	2	3	2	2	2,8	0,89	2,5	2	0,11		
w23	AMOUNT OF TRANSFERS	3	2	4	5	4	3	2	3	3,3	1,04	3	3	0,13		
w24	DISTANCE ARRIVAL AND TERMINAL/OFFICE	2	4	4	5	4	5	4	4	4,0	0,93	4	4	0,16	3,6	0,17
w25	TOTAL TRAVELTIME	4	5	3	5	4	3	4	5	4,1	0,83	4	4	0,17		
w26	FEELING OF EFFICENCY (DISTANCE/TIME)	4	4	5	4	4	5	3	2	3,9	0,99	4	4	0,16		
w27	WAITING TIME ON SPL ON EGRESS	5	4	4	2	4	5	4	3	3,9	0,99	4	4	0,16		
w31	CHANCE ON CANCELLATION	4	5	4	3	4	5	5	4	4,3	0,71	4	4	0,16		
w32	TRAVEL ALTERNATIVES	4	5	5	4	4	5	5	5	4,6	0,52	5	5	0,17		
w33	DELAY DUE TO UNCLEAR SIGNPOSTING	5	4	5	5	3	5	5	5	4,6	0,74	5	5	0,17	4,6	0,22
w34	DELAY ON SPL GROUNDS	4	3	5	5	4	5	5	4	4,4	0,74	4,5	5	0,16		
w35	CHANCE ON DELAY	5	5	5	4	5	5	5	5	4,9	0,35	5	5	0,18		
w36	DELAY (IN TIME)	5	5	4	4	5	5	5	4	4,6	0,52	5	5	0,17		
w41	WAITING COMFORT ON SPL	4	3	4	2	2	4	4	3	3,3	0,89	3,5	4	0,08		
w42	LUGGUAGESPACE DURING TRANSPORT	4	2	4	3	4	4	3	4	3,5	0,76	4	4	0,09		
w43	SAFETY MODALITY	2	4	2	3	5	5	4	3	3,5	1,20	3,5	2	0,09		
w44	DRIVINGQUALITY OF CHAUFFEUR	3	2	4	3	4	3	2	4	3,1	0,83	3	3	0,08		
w45	WORK/ENTERTAINMENT DURING TRANSPORT	4	5	5	4	5	3	3	4	4,1	0,83	4	4	0,11		
w46	SEATCOMFORT	3	2	4	5	4	5	3	3	3,6	1,06	3,5	3	0,09	3,3	0,16
w47	CLEANLINESS INTERIOR	2	1	5	4	4	3	4	2	3,1	1,36	3,5	4	0,08		
w48	ATTITUDE STAFF MODALITY	2	2	5	4	5	3	3	2	3,3	1,28	3	2	0,08		
w491	FINDABILITY TERMINAL	2	4	3	5	3	4	4	3	3,5	0,93	3,5	4	0,09		
w492	ATTITUDE SPL TRAFFIC OPERATIONS PERSONEEL	3	2	4	3	5	5	2	3	3,4	1,19	3	3	0,09		
w493	CURBSIDE SAFETY ON SPL GROUNDS	2	2	3	2	1	1	2	3	2,0	0,76	2	2	0,05		
w494	FINDABILITY MODALITY	3	2	2	3	4	3	3	2	2,8	0,71	3	3	0,07		
w51	INCREASED WAITING DUE TO UNDERCAPACITY	3	4	2	4	4	5	4	3	3,6	0,92	4	4	0,30	4,1	0,20
w52	TRAVELFREQUENCY	4	5	4	5	4	5	5	4	4,5	0,53	4,5	4	0,37		
w53	OPERATIONAL TIMES MODALITY	4	4	5	4	4	3	4	5	4,1	0,64	4	4	0,34		
w61	TRAVELINFORMATION IN MODALITY AND STOP	1	2	1	1	2	2	1	1	1,4	0,52	1	1	0,32		
w62	REAL TIME INFORMATION ON DEVATIONS	2	2	1	2	2	1	2	2	1,8	0,46	2	2	0,41	1,4	0,07
w63	PRICE INFORMATION IN MODALITY AND STOP	1	2	1	1	1	1	1	1	1,1	0,35	1	1	0,26		

F. Full Results Data Need Analysis

F.1 Passengers

Table 19-5: Data needs for accessibility criteria on Passengers

									PASSENGERS (2008)					
			TRAVEL VOLUME (in & out/yr)						25.641.250 facts & figures cont. onderz.					
			MAIN KPI (lagging)						3,97 asq report					
			MODAL SPLIT						38%	27%	12%	15%	2%	6%
			MODALITY						TRAIN	CAR DROP/PICK	CAR PARKED	TAXI	BUS	OTHER
MAIN FACTOR	INFLU-ENCE	ON/OFF	SUB FACTOR	CTQ RELATION	INFLU-ENCE									
PRICE	2	OFF	Price per trip	gastvrij	4	d	compar. index	compar. index	compar. index	compar. index	compar. index			
				aang. verb.		u	euro/total trip	euro/total trip	euro/total trip	euro/total trip	euro/total trip			
				accep. Prijs		s	transporter	avg price/km	avg price/km	transporter	transporter			
		ON/OFF	Price transparancy	gastvrij	3	d	stating/comp prices	NA	stating/comp prices	stating/comp prices	stating/comp prices			
				aang. verb.		u	# yes/no		# yes/no	# yes/no	# yes/no			
				accep. Prijs		s	transporter/T&T		transporter/T&T	transporter/T&T	transporter/T&T			
		ON	Parking costs	gastvrij	5	d	NA	access price (fut)	price short/long	NA	NA			
				aang. verb.		u		euro/min	euro/hour					
				accep. Prijs		s		SPL parking	SPL parking					
TRAVEL-TIME	4	OFF	Actual time to randweg	zorgel oos	5	d	time to reach SPL	time to reach SPL	time to reach SPL	time to reach SPL	time to reach SPL			
				basisproces		u	min	min	min	min	min			
				snelheid		s	NS planner	ANWB planner	ANWB + SPL	ANWB + taxikwal	transporter planner			
			Waitingtime on transfers/stops/file	zorgel oos	2	d	time trans + stops	time file	time file	time file	time trans + stops			
				basisproces		u	min	min	min	min	min			
				snelheid		s	NS planner	ANWB file data	ANWB file data	ANWB file data	transporter planner			
			Travel efficiency	geen	3	d	comparison index	comparison index	comparison index	comparison index	comparison index			
				geen		u	min/km	min/km	min/km	min/km	min/km			
				geen		s	geo data + actual time	geo data + actual time	geo data + actual time	geo data + actual time	geo data + actual time			
			Amount of transfers	zorgel oos	3	d	number	NA	NA	NA	number			
				basisproces		u	#				#			
				snelheid		s	NS planner				transporter planner			
			Transfer distance w. suitcases	zorgel oos	2	d	number	NA	NA	NA	number			
				basisproces		u	meter				meter			
				comfort & facilit		s	NS planner				transporter planner			
			Number of stops	zorgel oos	1	d	number	NA	NA	NA	number			
				basisproces		u	meter				meter			
				snelheid		s	NS planner				transporter planner			
			Ratio unproductive waiting time	geen	2	d	avail. entert/prod	NA	NA	avail. entert/prod	avail. entert/prod			
				geen		u	%	xx %	xx %	%	%			
				geen		s	NS			taxikwal	transporters			
		ON	Actual time to courts	zorgel oos	4	d	NA	time rand to court	time rand to court	time rand to court	time rand to court			
				basisproces		u		min	min	min	min			
				snelheid		s		tbd	tbd	tbd	tbd			
			Walking distance on site	zorgel oos	4	d	NA	distance termin.	distance termin.	distance termin.	distance termin.			
				basisproces		u		m	m	m	m			
				comfort & facilit		s		tbd	tbd	tbd	tbd			
			Waiting time	zorgel oos	2	d	Avg time to cnnct	NA	NA	Avg time to cnnct	Avg time to cnnct			
			D traffic only	basisproces		u	min			min	min			
				snelheid		s	NSdatasource			taxikwal	Probit/SR			
			Ratio unproductive waiting time	geen	2	d	avail. entert/prod	NA	NA	avail. entert/prod	avail. entert/prod			
				geen		u	%			%	%			
				geen		s	allart			ferry	allart			
RELIABILITY	5	OFF	Chance on delay	zorgel oos	5	d	Timeliness	Filefree roads	Filefree roads	Filefree roads	Timeliness			
				basisproces		u	% UG	% UG	% UG	% UG	% UG			
				betrouwbaarhei		s	kwal. monitor	kwal. monitor	kwal. monitor	kwal. monitor	Probit			
			Average delay time	zorgel oos	4	d	Avg delay	Avg delay	Avg delay	Avg delay	Avg delay			
				basisproces		u	min	min	min	min	min			
				snelheid		s	NSdatasource	ANWB	ANWB	ANWB+taxikwal	Probit/SR			
			Chance on cancellation	zorgel oos	3	d	failure to transp	failure to transp	failure to transp	failure to transp	failure to transp			
				basisproces		u	%	%	%	%	%			
				betrouwbaarhei		s	NSrapport	sneeuwval	sneeuwval	sneeuwval	GVB en Connexion			
		ON/OFF	Possible alternatives	zorgel oos	3	d	Avail. routes	Avail. routes	Avail. routes	Avail. routes	Avail. routes			
				vangnet		u	%	%	%	%	%			
				alternatief		s	NSdatasource	ANWB	ANWB	ANWB+taxikwal	GVB en Connexion			
			Real time information on alternatives	zorgel oos	4	d	Scherm + pres inf	Scherm + pres inf	Scherm + pres inf	Scherm + pres inf	Scherm + pres inf			
				vangnet		u	Yes/No %	Yes/No %	Yes/No %	Yes/No %	Yes/No %			
				informatie		s	Allart/NS	RWS	RWS	Ferry	Allart/SR			
		ON	Delay onsite reaching	zorgel oos	5	d	Delay time tunnel	Delay t. RW+CRT	Delay t. RW+CRT	Delay t. RW+CRT	Delay t. RW+CRT			
				basisproces		u	% & min	% & min	% & min	% & min	% & min			
				snelheid		s	NS measurem.	TO & tbd	TO & tbd	TO & tbd	TO & tbd			
			Delay onsite parking	zorgel oos	5	d	NA	NA	Delay time park	NA	NA			
				basisproces		u			% & min					
				snelheid		s			SPL parking					
			Chance on onsite misdirection	zorgel oos	3	d	NA	Extra circle	Extra circle	NA	NA			
				basisproces		u		%	%					
				vindbaarheid		s		verk. telling/tbd	verk. telling/tbd					
QUALITY	3	OFF	Baggage storage	zorgel oos	4	d	compar. index	compar. index	compar. index	compar. index	compar. index			
				basisproces		u	piec/pssgr	piec/pssgr	piec/pssgr	piec/pssgr	piec/pssgr			
				comfort & facilit		s	NS/percep.	100	100	taxikwal	GVB en Connexion			
			Safety travel	zorgel oos	3	d	tot. accid. route	tot. accid. route	tot. accid. route	tot. accid. route	tot. accid. route			
			(var)	basisproces		u	# accidents/death	# accidents/death	# accidents/death	# accidents/death	# accidents/death			
				veiligheid		s	NS	RWS	RWS	RWS & research	GVB en Connexion			
			Motional comfort	zorgel oos	2	d	index vs car	100	100	index vs car	index vs car			
				basisproces		u	total accel.			total accel.	total accel.			
				comfort & facilit		s	NS			taxikwal	Allart			
			Physical comfort	zorgel oos	2	d	comfort percep.	comfort percep.	comfort percep.	comfort percep.	comfort percep.			
				basisproces		u	%UG	%UG	%UG	%UG	%UG			
				comfort & facilit		s	tbd	lit	lit	taxikwal	Sternet onderzoek			
			Cleanliness	zorgel oos	3	d	clean percep.	NA	NA	clean percep.	clean percep.			
				basisproces		u	%UG			%UG	%UG			
				hygiene		s	tbd			taxikwal	Sternet onderzoek			
			Driver friendliness	gastvrij	2	d	friendly percep.	NA	NA	friendly percep.	friendly percep.			
				gastheerschap		u	%UG			%UG	%UG			
				klantger. instelli		s	tbd			taxikwal	Sternet onderzoek			
		ON/OFF	Information on mode times/costs	gastheerschap	4	d	travelinfo access	NA	NA	travelinfo access	travelinfo access			
				voorspelbaarhei		u	%UG			%UG	%UG			
				inz. doorlooptij		s	tbd			taxikwal	Sternet onderzoek			
		ON	Safety SPL access road	zorgel oos	1	d	total accidents	total accidents	total accidents	total accidents	total accidents			
			(var)	basisproces		u	# accidents/death	# accidents/death	# accidents/death	# accidents/death	# accidents/death			
				veiligheid		s	NS accidents	Duursma	Duursma	Duursma	Duursma			
			Directions to terminal	zorgel oos	4	d	NA	findbility depart.	findbility depart.	findbility SPL	findbility SPL			
			O passengers	basisproces		u	% UG	% UG	% UG	% UG	% UG			
				vindbaarheid		s		kwal. monitor	kwal. monitor	kwal. monitor	kwal. monitor			
			Directions to mode	zorgel oos	4		findbility NS O/D	findabil. natransp.	findabil. natransp.	findbility TAXI O/D	findabil. natransp.			
			D passengers	basisproces			% UG	% UG	% UG	% UG	% UG			
				vindbaarheid			kwal. monitor	kwal. monitor	kwal. monitor	kwal. monitor	kwal. monitor			
			Service perc. SPL staff	gastvrij	4	d	NA	impres. & fines TO	impres. & fines TO	conflicts TS&P	NA			
				gastheerschap		u		% UG / # fines	% UG / # fines	# conflicts				
				klantger. instelli		s		TO	TO	TS&P				
			Onsite waiting comfort	zorgel oos	3	d	Percep qual	NA	NA	Percep qual	Percep qual			
				basisproces		u	% UG			% UG	% UG			
				comfort & facilit		s	tbd			taxikwal/tbd	tbd			
AVAILABILITY	4	OFF	Service Frequency	zorgel oos	5	d	# train conn. O/D	NA	NA	Avail. taxis	# bus conn/hr			
				voorspelbaarhei		u	% UG							
				???		s	kwal. monitor			TRS	GVB en Connexion			
			Occupancy	zorgel oos	3	d	percentenge full	NA	NA	NA	percentenge full			
				voorspelbaarhei		u	%/ride				%/ride			
				???		s	NS				GVB en Connexion			
			Hours of operation	zorgel oos	4	d	match hrs-flow	NA	NA	match hrs-flow	match hrs-flow			
				voorspelbaarhei		u	% match			% match	% match			
				???		s	tbd			tbd	tbd			
TOTAL PERCEIVED GROUND ACCESSIBILITY SCORE PER MODE							SOM(FACTORS * INFLUENCE(SOM (SUBFACTORS* SUBINFLUENCE)))							

F.2 SCHIPHOL WORKER

TABLE 19-6: DATA NEEDS FOR ACCESSIBILITY CRITERIA ON SCHIPHOL WORKERS

								SPL WORKERS (2008)			
				TRAVEL VOLUME (in & out/yr)				27.667.000 regioplan			
				MAIN KPI (lagging)				3,84 Mobilit. Onderzoek			
				MODAL SPLIT				62%	20%	9%	9%
				MODALITY				CAR PARKED	TRAIN	BUS	OTHER
MAIN FACTOR	INFLU-ENCE	ON/OFF	SUB FACTOR	CTQ RELATION	INFLU-ENCE						
PRICE	5	OFF	Price per trip	gastvrij	5	d		**compar. index**	**compar. index**	**compar. index**	
				aang. verb.		u		euro/total trip	euro/total trip	euro/total trip	
				accep. Prijs		s		avg price/km	transporter	transporter	
		ON/OFF	**Price transparancy**	gastvrij	1	d		**stating/comp prices**	**stating/comp prices**	**stating/comp prices**	
				aang. verb.		u		# yes/no	# yes/no	# yes/no	
				accep. Prijs		s		transporter/T&T	transporter/T&T	transporter/T&T	
		ON	Parking costs	gastvrij	5	d		**price per day**	**NA**	**NA**	
				aang. verb.		u		euro/hour			
				accep. Prijs		s		mob. Onderzoek			
TRAVEL-TIME	4	OFF	Actual time	zorgel oos	5	d		**time to reach SPL**	**time to reach SPL**	**time to reach SPL**	
				basisproces		u		min	min	min	
				snelheid		s		ANWB + SPL	NS planner	transporter planner	
			Time on transfers/stops/traffic	zorgel oos	2	d		**time file**	**time trans + stops**	**time trans + stops**	
				basisproces		u		min	min	min	
				snelheid		s		ANWB file data	NS planner	transporter planner	
			Travel efficiency	geen	5	d		**comparison index**	**comparison index**	**comparison index**	
				geen		u		min/km	min/km	min/km	
				geen		s		geo data + actual time	geo data + actual time	geo data + actual time	
			Amount of transfers	zorgel oos	4	d		**NA**	**number**	**number**	
				basisproces		u			#	#	
				snelheid		s			NS planner	transporter planner	
			Transfer distance	zorgel oos	5	d		**NA**	**number**	**number**	
				basisproces		u			meter	meter	
				comfort & facilit		s			NS planner	transporter planner	
			Number of stops	zorgel oos	2	d		**NA**	**number**	**number**	
				basisproces		u			meter	meter	
				snelheid		s			NS planner	transporter planner	
			Ratio unproductive waiting time	geen	5	d		**NA**	**avail. entert/prod**	**avail. entert/prod**	
				geen		u		xx %	%	%	
				geen		s			NS	transporters	
		ON	Actual time to office	zorgel oos	2	d		**time arr to off**	**NA**	**time rand to off**	
				basisproces		u		min		min	
				snelheid		s		tbd		tbd	
			Walking distance on site	zorgel oos	3	d		**distance termin.**	**NA**	**distance termin.**	
				basisproces		u		m		m	
				comfort & facilit		s		tbd		tbd	
			Waiting time	zorgel oos	2	d		**NA**	**Avg time to cnnct**	**Avg time to cnnct**	
				basisproces		u			min	min	
				snelheid		s			NSdatasource	Probit/SR	
			Ratio unproductive waiting time	geen	2	d		**NA**	**avail. entert/prod**	**avail. entert/prod**	
				geen		u			%	%	
				geen		s			allart	allart	
RELIABILITY	3	OFF	Chance on delay	zorgel oos	4	d		**Filefree roads**	**Timeliness**	**Timeliness**	
				basisproces		u		% UG	% UG	% UG	
				betrouwbaarhe		s		kwal. monitor	kwal. monitor	Probit	
			Average delay time	zorgel oos	2	d		**Avg delay**	**Avg delay**	**Avg delay**	
				basisproces		u		min	min	min	
				snelheid		s		ANWB	NSdatasource	Probit/SR	
			Chance on cancellation	zorgel oos	2	d		**failure to transp**	**failure to transp**	**failure to transp**	
				basisproces		u		%	%	%	
				betrouwbaarhe		s		sneeuwval	NSrapport	GVB en Connexion	
		ON/OFF	Possible alternatives	zorgel oos	2	d		**Avail. routes**	**Avail. routes**	**Avail. routes**	
				vangnet		u		%	%	%	
				alternatief		s		ANWB	NSdatasource	GVB en Connexion	
			Real time information on alternatives	zorgel oos	1	d		**Scherm + pres inf**	**Scherm + pres inf**	**Scherm + pres inf**	
				vangnet		u		Yes/No %	Yes/No %	Yes/No %	
				informatie		s		RWS	Allart/NS	Allart/SR	
		ON	Delay onsite reaching	zorgel oos	2	d		**Delay t. RW+CRT**	**Delay time tunnel**	**Delay t. RW+CRT**	
				basisproces		u		% & min	% & min	% & min	
				snelheid		s		TO & tbd	NS measurem.	TO & tbd	
			Delay onsite parking	zorgel oos	3	d		**Delay time park**	**NA**	**NA**	
				basisproces		u		% & min			
				snelheid		s		SPL parking			
			Chance on onsite misdirection	zorgel oos	1	d		**Extra circle**	**NA**	**NA**	
				basisproces		u		%			
				vindbaarheid		s		verk. telling/tbd			
QUALITY	2	OFF	Baggage storage	zorgel oos	4	d		**compar. index**	**compar. index**	**compar. index**	
			(flying personell)	basisproces		u		piec/pssgr	piec/pssgr	piec/pssgr	
				comfort & facilit		s		100	NS/percep.	GVB en Connexion	
			Safety travel	zorgel oos	5	d		**tot. accid. route**	**tot. accid. route**	**tot. accid. route**	
			(var)	basisproces		u		# accidents/death	# accidents/death	# accidents/death	
				veiligheid		s		RWS	**NS**	GVB en Connexion	
			Motional comfort	zorgel oos	2	d		**100**	**index vs car**	**index vs car**	
				basisproces		u			total accel.	total accel.	
				comfort & facilit		s			**NS**	Allart	
			Physical comfort	zorgel oos	2	d		**comfort percep.**	**comfort percep.**	**comfort percep.**	
				basisproces		u		%UG	%UG	%UG	
				comfort & facilit		s		lit	tbd	Sternet onderzoek	
			Cleanliness	zorgel oos	3	d		**NA**	**clean percep.**	**clean percep.**	
				basisproces		u			%UG	%UG	
				hygiene		s			tbd	Sternet onderzoek	
			Driver friendliness	gastvrij	2	d		**NA**	**friendly percep.**	**friendly percep.**	
				gastheerschap		u			%UG	%UG	
				klantger. instelli		s			tbd	Sternet onderzoek	
		ON/OFF	Information on mode times/costs	gastheerschap	1	d		**NA**	**travelinfo access**	**travelinfo access**	
				voorspelbaarhe		u			%UG	%UG	
				inz. doorlooptij		s			tbd	Sternet onderzoek	
		ON	Safety SPL access road	zorgel oos	3	d		**total accidents**	**total accidents**	**total accidents**	
			(var)	basisproces		u		# accidents/death	# accidents/death	# accidents/death	
				veiligheid		s		Duursma	NS accidents	Duursma	
			Directions to terminal	zorgel oos	1	d		**findbility depart.**	**NA**	**findbility SPL**	
			O passengers	basisproces		u		% UG	% UG	% UG	
				vindbaarheid		s		kwal. monitor		kwal. monitor	
			Directions to mode	zorgel oos	1	d		**findabil. natransp.**	**findbility NS O/D**	**findabil. natransp.**	
			D passengers	basisproces		u		% UG	% UG	% UG	
				vindbaarheid		s		kwal. monitor	kwal. monitor	kwal. monitor	
			Service from SPL staff	gastvrij	3	d		**impres. & fines TO**	**NA**	**NA**	
				gastheerschap		u		% UG / # fines			
				klantger. instelli		s		TO			
			Onsite waiting comfort	zorgel oos	4	d		**NA**	**Percep qual**	**Percep qual**	
				basisproces		u			% UG	% UG	
				comfort & facilit		s			tbd	tbd	
AVAILABILITY	4	OFF	Service Frequency	zorgel oos	5	d		**NA**	**# train conn. O/D**	**# bus conn/hr**	
				voorspelbaarhe		u			% UG		
				???		s			kwal. monitor	GVB en Connexion	
			Occupancy	zorgel oos	4	d		**NA**	**percentenge full**	**percentenge full**	
				voorspelbaarhe		u			%/ride	%/ride	
				???		s			NS	GVB en Connexion	
			Hours of operation	zorgel oos	5	d		**NA**	**match hrs-flow**	**match hrs-flow**	
				voorspelbaarhe		u			% match	% match	
				???		s			tbd	tbd	
	TOTAL PERCEIVED GROUND ACCESSIBILITY SCORE PER MODE							SOM(FACTORS * INFLUENCE(SOM (SUBFACTORS* SUBINFLUENCE)))			

G. SURVEY ON DATA AVAILABILITY

In this annex the full result of the Survey on the current use and availability of data is presented (in Dutch). All participants (employees of T&T) were asked to name all currently used data sources and provide additional information on: Informative value, source, creator, owner, format, frequency, use and value. The result are listed below. The name and function of the responder is mentioned.

Product Manager Public Transportation (Allart Lensvelt)

TABLE 19-7: DATA AVAILABILITY PUBLIC TRANSPORTATION

Naam:	Allart Lensvelt
Functie:	Productmanager OV

	NAAM (?)	(INFORMATIEVE) INHOUD (?)	BRON (?)	OPSTELLER (?)	EIGENAAR (?)	FORMAAT (?)	FREQ. (?)	GEBRUIK (?)	WAARDE (?)
BRON (1):	Mobiliteitsonderzoek	geeft infromatie over het woon-werkverkeer van de SPL medewerkers. Dit geeft voor mij input als Produktmanager OV tbv nut en noodzaak van het OV bussysteem m.n. het Schiuphol Sternet	schriftelijke enquete onder medewerkers	Adviesbureau SOAB te Breda	Schiphol	papier	1 keer per 2 jaar	regelmatig (ca. 1 keer per maand)	10
BRON (2):	Kwaliteitsmonitor	geeft infromatie over de klantperceptie (reizigers/ passagiers) mbt uitvoering van een aantal OV gerelateerde diensten zoals punctualiteit treinen, functionaliteit betaalautomaten etc, etc.	schriftelijke face to face enquete van reizigers/ passagiers/ schiphol bezoekers	afd. R/DBA/Market Research & Intelligence	Schiphol	papier/ electronische database	6 x per jaar	regelmatig (ca. 1 keer per maand)	10
BRON (3):	Kwaliteitsperceptie Schiphol Sternet	Dit onderzoek geeft informatie op de vraag hoe de klant/ gebruiker de kwaliteit van de aangeboden dienstverlening ervaart. In combinatie van kwantitatieve onderzoek door Probit heb je	face to face gesprekken met passagiers	afd. R/DBA/Market Research & Intelligence	Schiphol/ Stadsregio A'dam	papier/ database Electronisch ?	2 x per jaar	regelmatig (ca. 1 keer per maand)	10
BRON (4):	Rapportage OV Monitoring Schiphol Sternet	Dit onderzoek geeft kwantitatieve informatie over de kwaliteit van uitvboering van het Schiphol Sternet omtrent zaken als Punctualiteit, interval, reinheid bussen, bezettingsgraad, gedrag	metingen uitgevoerd door medewerkers van het bureau Probit	Adviesbureau Probit, te Apeldoorn	Stadsregio A'dam	papier/ Electr. Database (Excel sheet)?.	4 x per jaar	regelmatig (ca. 1 keer per maand)	10
BRON (5):	Eigen waarneming	Eigen waarneming: wekenlijks rijdt ik met de trein van en naar Schiphol , wekelijks maak ik meerdere ritten met het Sternet en begeef ik mij op de perrons, door Plaza en het Jan Dellaertplein om mij	eigen zintuigen	ikzelf	ikzelf	n.v.t	dagelijks/ wekenlijks	continu (werk constant met deze data/informatie)	10
BRON (6):	Klachtenafhandeling	Door het zelfstandig afhandelen van de klachten over het OV krijg je een goed inzicht van de zaken	schriftelijke klachten	ikzelf	ikzelf	n.v.t	maandelijks	regelmatig (ca. 1 keer per maand)	8
BRON (7):	Regulier overleg met producenten/ vervoerders	Periodiek vinden gesprekken plaats met de accountmanager van de vervoerders, dus: NS, Connexxion, GVB maar ook de Stadsregio Amsterdam en ProRail. Tijdens deze gesprekken	uitspraken van experts	n.v.t.	ikzelf	papier	4 x per jaar	regelmatig (ca. 1 keer per maand)	9

Sr. Advisor Accessibility Projects (Bibian van Dorst)

Table 19-8: Data availability Accessibility projects

	Naam:	Bibian van Dorst
	Functie:	Sr Adviseur

	NAAM (?)	(INFORMATIEVE) INHOUD (?)	BRON (?)	OPSTELLER (?)	EIGENAAR (?)	FORMAAT (?)	FREQ. (?)	GEBRUIK (?)	WAARDE (?)
BRON (1):	rapportages marktonderzoek	Diverse inhoud: van klantperceptie over luchthaven in geheel tot openbaar vervoer. Ook marketing onderzoeken.	enquetes/uitgevoerd onderzoek onder passagiers	Marktonderzoek	Hans Martens	PDF of powerpoint	ad hoc	soms (ca. 1 keer per kwartaal)	8
BRON (2):	Dashboard CAP / ADI	Capaciteits informatie en voorspellingen specifieke verkeersstromen. Is eigenlijk geen informatiebron want we voeden zelf	o.a. informatie uit analyse Sjoerd de Lange	ADI	Joyce Groot	Dashboard	eens per jaar	regelmatig (ca. 1 keer per maand)	8
BRON (3):	Internet	Diverse onderzoeken over verkeer en vervoer op en rond Schiphol	OV partijen	OV Partijen	OV partijen	Divers	ad hoc	zelden (ca. 1 keer per jaar)	6
BRON (4):	SOAB mobiliteitsonderzoek	mobiliteitsonderzoek Schiphol: informatie over reisgedrag Schipholwerker	Enquetes/uitgevoerd onderzoek onder schipholwerkers	SOAB	Schiphol	Papieren rapport	twee jaarlijks	regelmatig (ca. 1 keer per maand)	8
BRON (5):	Strategische rapporten Schiphol	Schiphol Strategie, Klimaatplan, Duurzame mobiliteit	papieren rapport/intranet	AD/ADI	Schiphol	Papieren rapport	ad hoc	vaak (ca. 1 keer per week)	

Manager Roads & Road conditions (Henk Duursma)

Table 19-9: Data availability Accessibility Roads & Road conditions

	Naam:	Henk D
	Functie:	Werkencoördinator

	NAAM (?)	(INFORMATIEVE) INHOUD (?)	BRON (?)	OPSTELLER (?)	EIGENAAR (?)	FORMAAT (?)	FREQ. (?)	GEBRUIK (?)	WAARDE (?)
BRON (1):	Verkeerstellingen vast	aantal voertuigen die een bepaald punt passeren.	technisch	TEC traffic systems	Ik	ascii	als ik het wil		8
BRON (2):	periodieke tellingen	1 x per kwartaal uitgevoerd op de hele luchthaven	technisch	Witteveen & Bos	ik	xls	4 x p.j		8
BRON (3):	Verkeersongevallen	1 x per maand	xls	Kmar	Kmar	xls	12 x p.j.	soms (ca. 1 keer per kwartaal)	8

Traffic Data Analist (Sjoerd de Lange)

TABLE 19-10: DATA AVAILABILITY DATA ANALIST

	Naam:	Sjoerd de Lange							
	Functie:	Traffic data analist							
	NAAM (?)	(INFORMATIEVE) INHOUD (?)	BRON (?)	OPSTELLER (?)	EIGENAAR (?)	FORMAAT (?)	FREQ. (?)	GEBRUIK (?)	WAARDE (?)
BRON (1):	Continue onderzoek luchtreizigers	Informatie mbt het reisgedrag van luchtreizigers naar Schiphol. Daarnaast komt er informatie over kenmerken van de reizigers zoals reismotief, nationaliteit, vertrekhal waar wordt ingecheckt enz	Bron: ESPRI bestanden.	diverse collega's	marktonderzoek	data-bestaan inzage in bestaat	4* per jaar	zeer vaak (meerder keren per week)	10
BRON (2):	Mobiliteisonderzoek werknemers	Informatie mbt het reisgedrag van werknmers in het woon-werkverkeer	Bron: ESPRI bestanden.	diverse collega's	T&T (vanwege de financiering)	data-bestaan inzage in bestaat	1* per 2 jaar	dagelijks (min. 1 keer per dag)	10
BRON (3):	Regioplan onderzoek	Informatie mbt het aantal arbeidsplaatsen op Schiphol en informatie waar de werknemers woonachtig zijn	Bron: op maat gemaakte uitdraaien op gebiedniveau door MO	Ik zelf & Marktonderzoek (Ronald Wolfers).	T&T (vanwege het mede financier zijn)	speciale uitdraai op gebied niuveau	1* per jaar	regelmatig (ca. 1 keer per maand)	9
BRON (4):	Verkeerstellingen op het luchthaven terrrein	Verkeersintensiteiten op diverse telpunten op het luchthaventerrein	Bron: verkeerstellingen van WIBO	WIBO en Henk D.	T&T (vanwege de financiering)	bestand in hard-copy	4* per jaar	vaak (ca. 1 keer per week)	10
BRON (5):	Verkeersteling van Rijkswaterstaat	Verkeertellingen op het Rijkswegennet	Bron: telsysteem van RWS	RWS	RWs	data-bestaan inzage in bestaat	3* per jaar	soms (ca. 1 keer per kwartaal)	6
BRON (6):	Toedelingsprogramma kostenlandzijdige infrastructuur	Rekenmodel dat gevuld moet worden met data uit diverse bronnen	Bronnen: luchthavenstatistieken, werkgelegenheidsonderzoeken, data	T&T	T&T	Excel-bestand	1 8 per jaar	zelden (ca. 1 keer per jaar)	10
BRON (7):	Voorrijwegevaluatie	Opgesteld rekenmodel dat het aanbod aan voetuigen voor de vertrekhallen berekend en bij een gegeven afhandelingstijd de filelengte vaststelt. Dit model wordt gebruikt voor het ACP en	Bron: model Voorrijwegevaluatie 09	T&T	T&T	Excel-bestand	3* per jaar	soms (ca. 1 keer per kwartaal)	9
BRON (8):	Woonlocatie Schipholwerkers	Rekenmodel dat de groei per woongebied van Schipholwekers vaststelt	Bron: het reken model Woonlocatie SchipholwerkersV	T&T	T&T	Excel-bestand	2 8 per jaar	soms (ca. 1 keer per kwartaal)	8
BRON (9):	Rekenmodellen voor de berkening van CO2 uitstoot	Diverse rekenmodellen welke de uitstoot aan CO2 berekenen op relatie niveau voor reizigers en werknemers. Dit model rekent met diverse variabelen en (nieuwe) vormen van reizen van en	Bron: diverse rekenmodellen	T&T	T&T	Excel-bestand	zeer regelmatig in gebruik	dagelijks (min. 1 keer per dag)	10
BRON (10):	Verkeersmodel GoudappelCoffent	Rekenmodel dat de verkeersbelasting voor wegen op het luchhaventerrein berekend in relatie tot het verkeer in de omgeving	Bron: model van Goudappel	Bureau Goudappel in Deventer	Gemeenten in de regio en deels ook Schiphol	Geen idee	1 8 per jaar	zelden (ca. 1 keer per jaar)	10

Manager Taxi Transportation (Ferry Jongkind)

Table 19-11: Data availability Taxis

	Naam:	Ferry Jongkind
	Functie:	productmanager vervoer

	NAAM (?)	(INFORMATIEVE) INHOUD (?)	BRON (?)	OPSTELLER (?)	EIGENAAR (?)	FORMAAT (?)	FREQ. (?)	GEBRUIK (?)	WAARDE (?)
BRON (1):	Taxi regulatie systeem (TRS)Rapportages	Het aantal gereden taxiritten vanaf de standplaats. Het aantal en soort (fouttransacties. niet in de maandelijkse rapportages) Het aantal bewegingen over de A-baan door andere groepen zoals	TRS	Een keer per maand (de eerste van de maand) worden de passages van alle meldposten van de	A/PS/OPS/TT	De maandelijkse rapporten in excel. De dagelijks info uit TRS kan niet geexporteerd	Eens per maand de 1e van de maand.De rapportages en de overige info binnen	zeer vaak (meerder keren per week)	9
BRON (2):	Mystery Guest onderzoek	De kwaliteit van het taxiproduct maar dan gemeten vanaf het instappen van de klant.	Onderzoek	Ecorys	A/OPS/PS/TT	Eindrapport Hardcopy. Gegevens invoersheet en de concentrappoartag	Laatste concessie 2 x per jaar	soms (ca. 1 keer per kwartaal)	8
BRON (3):	Dagrapportages van de coordinatoren TSAP	Geleverde kwaliteit van het taxiproduct en gedrag chauffeurs voor de klant instapt en tijdens het instapproces.	waarnemingen coordinator TSAP	TSAP	Stichting Taxi Controle (STC)	PDF online	Dagelijks	dagelijks (min. 1 keer per dag)	8
BRON (4):	Klachten	Gedrag chauffeur en overallkwaliteit geleverde taxiproduct.	Klager	Klager		Hardcopy en/of mail	continu	regelmatig (ca. 1 keer per maand)	8

H. Matching Need & Availability

Table 19-12: Match between need and availability of data(sources)

	Passenger					Schiphol Worker		
CRITERION	TRAIN	CAR DROP/PICK	CAR PARKED	TAXI	BUS	CAR PARKED	TRAIN	BUS
Price per trip	compar. index euro/total trip transporter	compar. index euro/total trip avg price/km	compar. index euro/total trip avg price/km	compar. index euro/total trip transporter	compar. index euro/total trip transporter	compar. index euro/total trip avg price/km	compar. index euro/total trip transporter	compar. index euro/total trip transporter
Price transparancy	stating/comp prices # yes/no transporter/T&T	NA	stating/comp prices # yes/no transporter/T&T	stating/comp prices # yes/no transporter/T&T	stating/comp prices # yes/no transporter/T&T	stating/comp prices # yes/no transporter/T&T	stating/comp prices # yes/no transporter/T&T	stating/comp prices # yes/no transporter/T&T
Parking costs	NA	access price (fut) euro/min SPL parking	price short/long euro/hour SPL parking	NA	NA	price per day euro/hour mob. Onderzoek	NA	NA
Actual time to randweg	time to reach SPL min NS planner	time to reach SPL min ANWB planner	time to reach SPL min ANWB + SPL	time to reach SPL min ANWB + taxikwal	time to reach SPL min transporter planner	time to reach SPL min ANWB + SPL	time to reach SPL min NS planner	time to reach SPL min transporter planner
Waitingtime on transfers/stops/file	time trans + stops min NS planner	time file min ANWB file data	time file min ANWB file data	time file min ANWB file data	time trans + stops min transporter planner	time file min ANWB file data	time trans + stops min NS planner	time trans + stops min transporter planner
Travel efficiency	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual time	comparison index min/km geo data + actual tim
Amount of transfers	number # NS planner	NA	NA	NA	number # transporter planner	NA	number # NS planner	number # transporter planner
Transfer distance w. suitcases	number meter NS planner	NA	NA	NA	number meter transporter planner	NA	number meter NS planner	number meter transporter planner
Number of stops	number meter NS planner	NA	NA	NA	number meter transporter planner	NA	number meter NS planner	number meter transporter planner
Ratio unproductive waiting time	avail. entert/prod % NS	NA xx %	NA xx %	avail. entert/prod % taxikwal	avail. entert/prod % transporters	NA xx %	avail. entert/prod % NS	avail. entert/prod % transporters
Actual time to courts	NA	time rand to court min tbd	time rand to court min tbd	time rand to court min tbd	time rand to court min tbd	time arr to off min tbd	NA	time rand to off min tbd
Walking distance on site	NA	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	distance termin. m tbd	NA	distance termin. m tbd
Waiting time	Avg time to cnnct min NSdatasource	NA	NA	Avg time to cnnct min taxikwal	Avg time to cnnct min Probit/SR	NA	Avg time to cnnct min NSdatasource	Avg time to cnnct min Probit/SR
Ratio unproductive waiting time	avail. entert/prod % allart	NA	NA	avail. entert/prod % ferry	avail. entert/prod % allart	NA	avail. entert/prod % allart	avail. entert/prod % allart
Chance on delay	Timeliness % UG kwal. monitor	Filefree roads % UG kwal. monitor	Filefree roads % UG kwal. monitor	Filefree roads % UG kwal. monitor	Timeliness % UG Probit	Filefree roads % UG kwal. monitor	Timeliness % UG kwal. monitor	Timeliness % UG Probit
Average delay time	Avg delay min NSdatasource	Avg delay min ANWB	Avg delay min ANWB	Avg delay min ANWB+taxikwal	Avg delay min Probit/SR	Avg delay min ANWB	Avg delay min NSdatasource	Avg delay min Probit/SR
Chance on cancellation	failure to transp % NSrapport	failure to transp % sneeuwval	failure to transp % sneeuwval	failure to transp % sneeuwval	failure to transp % GVB en Connexion	failure to transp % sneeuwval	failure to transp % NSrapport	failure to transp % GVB en Connexion
Possible alternatives	Avail. routes % NSdatasource	Avail. routes % ANWB	Avail. routes % ANWB	Avail. routes % ANWB+taxikwal	Avail. routes % GVB en Connexion	Avail. routes % ANWB	Avail. routes % NSdatasource	Avail. routes % GVB en Connexion
Real time information on	Scherm + pres inf Yes/No % Allart/NS	Scherm + pres inf Yes/No % RWS	Scherm + pres inf Yes/No % RWS	Scherm + pres inf Yes/No % Ferry	Scherm + pres inf Yes/No % Allart/SR	Scherm + pres inf Yes/No % RWS	Scherm + pres inf Yes/No % Allart/NS	Scherm + pres inf Yes/No % Allart/SR
Delay onsite reaching	Delay time tunnel % & min NS measurem.	Delay t. RW+CRT % & min TO & tbd	Delay t. RW+CRT % & min TO & tbd	Delay t. RW+CRT % & min TO & tbd	Delay t. RW+CRT % & min TO & tbd	Delay t. RW+CRT % & min TO & tbd	Delay time tunnel % & min NS measurem.	Delay t. RW+CRT % & min TO & tbd
Delay onsite parking	NA	NA	Delay time park % & min SPL parking	NA	NA	Delay time park % & min SPL parking	NA	NA
Chance on onsite misdirection	NA	Extra circle % verk. telling/tbd	Extra circle % verk. telling/tbd	NA	NA	Extra circle % verk. telling/tbd	NA	NA
Baggage storage	compar. index piec/pssgr NS/percep.	compar. index piec/pssgr 100	compar. index piec/pssgr 100	compar. index piec/pssgr taxikwal	compar. index piec/pssgr GVB en Connexion	compar. index piec/pssgr 100	compar. index piec/pssgr NS/percep.	compar. index piec/pssgr GVB en Connexion
Safety travel	tot. accid. route # accidents/death NS	tot. accid. route # accidents/death RWS	tot. accid. route # accidents/death RWS	tot. accid. route # accidents/death RWS & research	tot. accid. route # accidents/death GVB en Connexion	tot. accid. route # accidents/death RWS	tot. accid. route # accidents/death NS	tot. accid. route # accidents/death GVB en Connexion
Motional comfort	index vs car total accel. NS	100	100	index vs car total accel. taxikwal	index vs car total accel. Allart	100	index vs car total accel. NS	index vs car total accel. Allart
Cleanliness	clean percep. %UG tbd	NA	NA	clean percep. %UG taxikwal	clean percep. %UG Sternet onderzoek	NA	clean percep. %UG tbd	clean percep. %UG Sternet onderzoek
Driver friendliness	friendly percep. %UG tbd	NA	NA	friendly percep. %UG taxikwal	friendly percep. %UG Sternet onderzoek	NA	friendly percep. %UG tbd	friendly percep. %UG Sternet onderzoek
Information on mode times/costs	travelinfo access %UG tbd	NA	NA	travelinfo access %UG taxikwal	travelinfo access %UG Sternet onderzoek	NA	travelinfo access %UG tbd	travelinfo access %UG Sternet onderzoek
Safety SPL access road	total accidents # accidents/death NS accidents	total accidents # accidents/death Duursma	total accidents # accidents/death Duursma	total accidents # accidents/death Duursma	total accidents # accidents/death Duursma	total accidents # accidents/death Duursma	total accidents # accidents/death NS accidents	total accidents # accidents/death Duursma
Directions to terminal	NA % UG	findbility depart. % UG kwal. monitor	findbility depart. % UG kwal. monitor	findbility SPL % UG kwal. monitor	findbility SPL % UG kwal. monitor	findbility depart. % UG kwal. monitor	NA % UG	findbility SPL % UG kwal. monitor
Directions to mode	findbility NS O/D % UG kwal. monitor	findabil. natransp. % UG kwal. monitor	findabil. natransp. % UG kwal. monitor	findbility TAXI O/D % UG kwal. monitor	findabil. natransp. % UG kwal. monitor	findabil. natransp. % UG kwal. monitor	findbility NS O/D % UG kwal. monitor	findabil. natransp. % UG kwal. monitor
Service perc. SPL staff	NA	impres. & fines TO % UG / # fines TO	impres. & fines TO % UG / # fines TO	conflicts TS&P # conflicts TS&P	NA	impres. & fines TO % UG / # fines TO	NA	NA
Onsite waiting comfort	Percep qual % UG tbd	NA	NA	Percep qual % UG taxikwal/tbd	Percep qual % UG tbd	NA	Percep qual % UG tbd	Percep qual % UG tbd
Service Frequency	# train conn. O/D % UG kwal. monitor	NA	NA	Avail. taxis TRS	# bus conn/hr GVB en Connexion	NA	# train conn. O/D % UG kwal. monitor	# bus conn/hr GVB en Connexion
Occupancy	percentenge full %/ride NS	NA	NA	NA	percentenge full %/ride GVB en Connexion	NA	percentenge full %/ride NS	percentenge full %/ride GVB en Connexion
Hours of operation	match hrs-flow % match tbd	NA	NA	match hrs-flow % match tbd	match hrs-flow % match tbd	NA	match hrs-flow % match tbd	match hrs-flow % match tbd
	DATA NOT AVAILABLE			LAGGING DATA AVAILABLE			LEADING DATA AVAILABLE	

I. Screenshots existing BI systems Schiphol

Qlikview

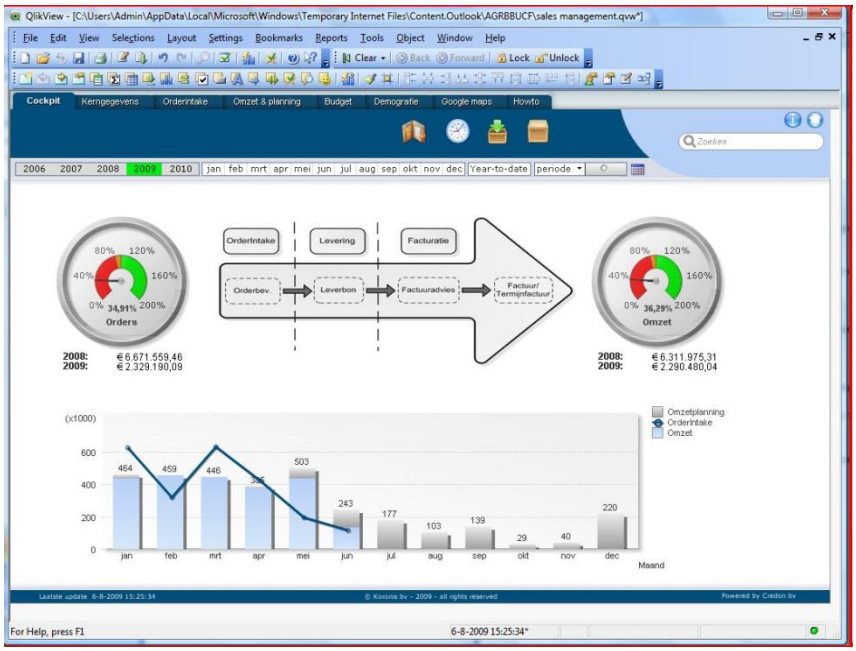

Figure 19-15: Screenshot dashboard Cliqview

Oracle OBIEE

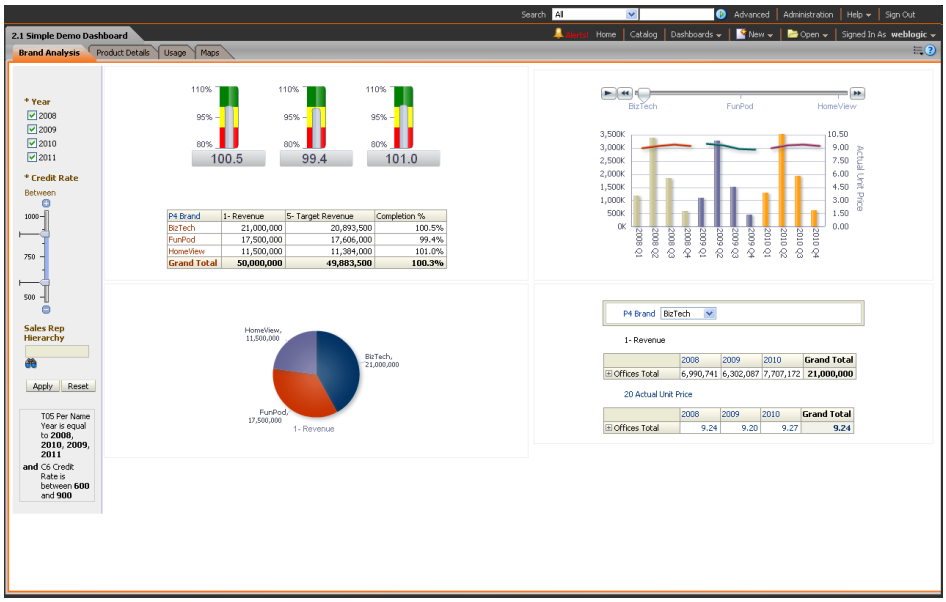

Figure 19-16: Screenshot Dashboard Oracle OBIEE