Off-Airport Baggage Check-in

A Logistics Network & Business Model for the situation at Amsterdam Airport Schiphol

Master Thesis

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A Logistics Network & Business Model for the situation at Amsterdam Airport Schiphol

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Preface

The final part of my master Management of Technology has been my master thesis research. The report that lies before you is the result of this research that I have performed in the last six months at QuinTech Engineering Innovations.

The main idea behind this research has been to reduce the hassles of traveling by plane by developing an off-airport baggage check-in. This subject corresponded well with both the specialization in Integrated Operations and Supply Chain Management I have followed in the past year and my interest in baggage and baggage handling systems. Hopefully this research can help QuinTech in consultancy projects and maybe in the future result in an actual implementation of an off-airport baggage check-in service.

Many different people have helped me during my research and have contributed to this report. I would like to thank all of them for their support, but I especially want to thank a few people. First of all I want to thank my first supervisor, Ron van Duin for his support, for the time he invested in this research and for the many advices with regard to the process. Secondly, I want to thank Victor Scholten for being my second supervisor and for ensuring that I did not lose track of the scientific quality of the research. Thirdly, I would like to thank professor Tavasszy for being the chairman of my graduation committee. During the meetings we have had, he had many creative ideas that have really helped in developing the proposed concept.

Besides the graduation committee, I would like to thank all the people that have provided information for my research. The interviews with Victor Vaessen, Edwin Okèl, Olaf van Reeden, and Michel Schipper have been very helpful for my research. Besides them, my thanks go to Andrew Sharp, who helped me finding the right people and the right information without even knowing me.

Furthermore, I would like to thank all my colleagues at QuinTech Engineering Innovations for sharing their thoughts with me, helping me with finding interesting articles and brainstorming on possible concepts. I would especially like to thank Reinout vander Meûlen for being my daily supervisor and helping me identifying the weak spots and developing possible solutions for these weak spots. I have really enjoyed working at QuinTech!

Last but not least I want to thank my family and friends for supporting me and helping me where possible. Special thanks go to Daphne for being so patient with me and for checking the many pages I have written.

I hope you enjoy reading this report.

Rick van Zundert

August 2010, Delft
Summary
Many large airports and airlines are facing congestion problems in airport terminals. Several different studies have identified the check-in process as one of the bottleneck processes that lead to the congestion problems. While many of the suggested solutions in literature focus on changes inside the airport terminal, this research applies a wider, supply chain oriented approach. The main goal is to develop a service for passengers based on the most suitable location for handover of baggage from passenger to airline.

Because of large differences between airlines and airports around the world, it has been chosen to focus on the case of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines. Forty percent of all departing passengers from Amsterdam Airport Schiphol fly with KLM. For the development of the service, a four-phase approach, based on the Innovation Model of in ‘t Veld (2002) will be used. These four phases are:

- **Environment Scanning** – Assessing what is already known on the subject and performing a stakeholder analysis
- **Developing Concepts** – Developing possible alternatives
- **Evaluating Concepts** – Assessing which of the alternatives is most suitable
- **Improving & Detailing** – Improving the concept, designing logistics network and developing business model

Based on a literature study, it can be concluded that off-airport baggage check-in is not a new concept. It has been introduced in many different forms around the world. Some of the concepts have failed, while other still exist. Based on the analysis of the existing concepts, critical issues that need to be dealt with can be identified. Obviously, security issues are the most important ones to account for. Furthermore it is necessary to take customer concerns into account and ensure that the process is transparent. Finally, financial issues regarding the investments are important.

The three most important stakeholders in off-airport baggage check-in are airport, airline, and passengers. For the airport, it is important that the service concept will operate according to specifications without hindering other operations at the airport. For the airline, it is important that the service is an actual service for the passengers, and that liability and security issues are covered. Finally, for the passengers it is important that the service is transparent, not too costly, and that the service reduces the hassles of traveling. These stakeholder requirements need to be taken into account in designing possible service concepts.

Based on concepts that have been developed in earlier initiatives and based on the stakeholder requirements, five different off-airport baggage check-in concepts have been developed in a creative brainstorm session at QuinTech Engineering Innovations:

1. **Baggage Collection Service** – Baggage is collected at an address specified by the passenger on the evening prior to departure
2. **Local Drop-Off Service** – Baggage can be checked in at a local drop-off point, such as TNT service points, on the day prior to departure.

3. **Train Station Service** – Baggage can be checked in at seven major train stations in the Netherlands up to three or four hours prior to departure.

4. **Schiphol Parking Lot Service** – Baggage can be checked in at the Schiphol long-stay parking lots up to an hour and a half prior to departure.

5. **Schiphol Station Service** – Baggage can be checked in at Schiphol train station up to an hour and a half prior to departure.

For each of these concepts, logistical activity models have been developed using the Structured Analysis and Design Technique. These activity models have formed the bases for the financial assessments of the concepts. To derive cost structures for each of the concepts, Activity Based Costing has been applied. Besides the financial assessments, SWOT analyses have been performed based on the stakeholder analysis. The financial assessments, the SWOT analyses, and a survey performed by KLM Royal Dutch Airlines are used to evaluate the suitability of each of the concepts. From this evaluation, the Baggage Collection Service has been identified as the most suitable for the situation at Amsterdam Airport Schiphol.

Though the Baggage Collection Service has been identified as the most suitable concept, the SWOT analysis has revealed some weaknesses and threats that need to be resolved. For security issues, seals with unique numbers will be used during transportation. Furthermore, two shifts, in the evening and in the morning, will be used to ensure passengers do not have to hand in their bags more than 20 hours prior to departure. Finally, because financial issues are important, the question of whether to outsource the service is an interesting question for the airline.

As concluded from the literature study, investment issues are very important in off-airport baggage check-in. The make-or-buy decision is therefore very important. In order to execute the Baggage Collection Service, a logistics network is required. For the design of this network, the arrangement stage of Logistics Network Design of Mourits and Evers (1995) has been applied. A network consisting of four service areas, north, east, south and west, has been designed. In the northern, eastern, and southern region, distribution centers will be used. The locations have been determined using the center-of-gravity approach. In the western region, collected baggage will be transported directly to the airport.

To analyze the costs of operating the Baggage Collection Service, several scenarios have been developed:

- A pessimistic scenario in which 5 percent of all passengers uses the service
- A baseline scenario, in which 15 percent uses the service
- An optimistic scenario in which 25 percent uses the service

Again, Activity Based Costing has been used to determine the costs of operating the service. The average costs per bag are ranging between € 16,- and € 27,-. Especially in the western region, costs are relatively low because of the densely populated Randstad area.
Based on the scenario analyses, it appears to be possible for an airline to execute the Baggage Collection Service itself through the designed logistics network. Nevertheless, the optimal business model for the service will depend on prices charged by other parties and the availability of money for investments.

The results are promising and can be used for developing an off-airport baggage check-in service. The designed service is especially suitable for airports that serve densely populated areas, as many of the major European airports do. For QuinTech Engineering Innovations, the initiators of the research, the results can be used for consultancy projects for airports and airlines concerning the congestion problems inside the terminals.
Samenvatting (In Dutch)

Veel grote luchthavens and luchtvaartmaatschappijen hebben problemen met opstoppingen in de terminals van de luchthaven. Verschillende onderzoeken hebben het check-in proces aangeduid als het zogenaamde bottleneck proces dat tot deze problemen leidt. Terwijl de oplossingen die in bestaande literatuur worden voorgesteld veelal gericht zijn op veranderingen in de terminal, wordt in dit onderzoek een bredere, supply chain gerichte aanpak toegepast. Het doel van het onderzoek is een service ontwikkelen voor passagiers, gebaseerd op het meest geschikte punt om bagage van passagier te overhandigen aan de luchtvaartmaatschappij.

Vanwege de grote verschillende tussen luchthavens en luchtvaartmaatschappijen in de wereld is dit onderzoek gericht op de casus van Amsterdam Airport Schiphol en KLM Royal Dutch Airlines. Veertig procent van alle passagiers die van Amsterdam Airport Schiphol vertrekken vliegen met KLM. Voor het ontwikkelen van de service is een gefaseerde aanpak gebruikt, gebaseerd op het Innovatie Model van in ’t Veld (2002). De aanpak bestaat uit de volgende vier fases:

- *Omgeving in kaart brengen* – Uitzoeken wat er al bekend is over het onderwerp en een stakeholder analysee uitvoeren
- *Concept ontwikkeling* – Mogelijke alternatieven ontwikkelen
- *Concept evaluatie* – Bepalen welk van de alternatieven het meest geschikt is
- *Verbeteren en details uitwerken* – Gekozen concept verbeteren, logistiek netwerk ontwerpen en business model ontwikkelen.

Op basis van een literatuur onderzoek kan er geconcludeerd worden dat het inchecken van bagage buiten de luchthaven geen nieuw concept is. Het is al geïntroduceerd in veel verschillende vormen op verschillende plaatsen. Een aantal van de concepten is voortijdig gestopt, maar een aantal concepten wordt nog steeds gebruikt. Op basis van deze concepten kunnen kritieke factoren waar rekeningen mee gehouden moet worden worden geïdentificeerd. Vanzelfspreken is veiligheid een van deze factoren. Daarnaast is het belangrijk dat de twijfels van passagiers worden weggenomen en het proces transparant wordt gemaakt. Tot slot zijn de financiële aspecten van belang.

De drie belangrijkste stakeholders in het inchecken van bagage buiten de luchthaven zijn de luchthaven zelf, de luchtvaartmaatschappij en de passagiers. Voor de luchthaven is het van belang dat de service goed uitgevoerd wordt, zonder dat deze andere activiteiten op de luchthaven hindert. Voor de luchtvaartmaatschappij is het belangrijk dat de service een daadwerkelijke service is voor passagiers. Daarnaast is het zaak dat veiligheid en aansprakelijkheid goed worden geregeld. Voor de passagiers is het belangrijk dat de service transparant is, tegen niet al te hoge kosten en dat de service het reizen aangenamer maakt. Deze eisen van de drie stakeholders moeten meegenomen worden bij het ontwerpen van mogelijke service concepten.

Op basis van deze eisen, en op basis van concepten die gevonden zijn in de literatuur, zijn vijf verschillende concepten voor het inchecken van bagage buiten de luchthaven ontwikkeld in een brainstorm sessie met experts van QuinTech Engineering Innovations:
1. **Baggage Collection Service** – Bagage wordt op de avond voor vertrek opgehaald op het adres dat aangegeven is door de passagier

2. **Local Drop-Off Service** – Bagage kan ingecheckt worden bij locale afgiftepunten zoals TNT service punten. Dit kan op de dag voor vertrek

3. **Train Station Service** – Bagage kan ingecheckt worden op zeven grote treinstations in Nederland tot drie of vier uur voor vertrek

4. **Schiphol Parking Lot Service** – Bagage kan ingecheckt worden op de lang-parkeren parkeerplaatsen bij de luchthaven. Dit kan tot anderhalf uur voor vertrek

5. **Schiphol Station Service** – Bagage kan ingecheckt worden op het treinstation op de luchthaven tot anderhalf uur voor vertrek

Voor elk van de bovenstaande concepten is een logistiek activiteiten model ontwikkeld met behulp van de Structured Analysis and Design Technique. Deze modellen zijn vervolgens gebruikt voor de financiële analyses. Voor elk concept is met behulp van Activity Based Costing een kostenstructuur afgeleid. Naast de financiële analyses zijn er SWOT analyses uitgevoerd voor elk concept, op basis van de eisen van de stakeholders. De financiële analyses, de SWOT analyses and een enquête uitgevoerd door KLM onder passagiers zijn gebruikt om te bepalen welk van de concepten het meest geschikt is voor de situatie op Amsterdam Airport Schiphol. Uit deze evaluatie is naar voren gekomen dat de Baggage Collection Service het meest geschikte concept is.

Desalniettemin zijn er uit de SWOT analyze nog wel enkele zwakke punten van de Baggage Collection Service naar voren gekomen. Om mogelijke problemen met veiligheid op te lossen kunnen zegels met unieke nummers gebruikt worden tijdens transport. Om te voorkomen dat passagiers soms al ruim 20 uur voor vertrek hun bagage in moeten leveren, zullen er twee ophaalrondes geïntroduceerd worden. Tot slot, omdat het financiële aspect erg belangrijk is, is de vraag of een luchtvaartmaatschappij de service zelf uit moet voeren of uit zou moeten besteden een erg interessante vraag.

Om de Baggage Collection Service zelf uit te voeren is een logistiek netwerk een vereiste. Voor het ontwerp van zo een netwerk is de zogenaamde “arrangement stage” van het logistiek netwerk ontwerp van Mourits en Evers gebruikt (Mourits and Evers, 1995). Het ontwikkelde netwerk is opgedeeld in vier service gebieden (noord, oost, zuid en west). In de gebieden noord, oost en zuid zullen distributiecentra gebruikt worden van waaruit opgehaalde bagage met een vrachtwagen naar de luchthaven gebracht wordt. De optimale locaties voor de distributiecentra is bepaald door middel van de “center-of-gravity” methode. In de westelijke regio zal de opgehaalde bagage rechtstreeks naar de luchthaven worden gebracht.

Om het kostenaspect van de service te analyseren zijn verschillende scenarios ontwikkeld:

- Een pessimistisch scenario waarin slechts 5 procent van alle passagiers de service gebruikt
- Een basis scenario waarbij 15 procent van de passagiers de service gebruikt
- Een optimistisch scenario waarin 25 procent van de passagiers de service gebruikt
Opnieuw is Activity Based Costing gebruikt om de kosten van de service te bepalen. De gemiddelde kosten per koffer varieren voor de verschillende scenarios tussen € 16,- en € 27,-. Met name in de westelijke regio zijn de kosten relatief laag, omdat passagiers daar vrij dicht bij elkaar wonen.

Op basis van de scenario analyses lijkt het zeer goed mogelijk voor een luchtvaartmaatschappij om de Baggage Collection Service zelf uit te voeren. Desalniettemin hangt de vorm van het optimale business model af van de prijs die andere partijen rekenen voor het uitvoeren van een dergelijke service en van de beschikbaarheid van geld voor de benodigde investeringen.

De resultaten zijn veelbelovend en kunnen gebruikt worden voor het daadwerkelijk implementeren van een service om bagage buiten de luchthaven in te checken. Met name voor luchthavens die geografisch geconcentreerde groepen passagiers bedienen is de service erg geschikt. Voor QuinTech Engineering Innovations, door wie dit onderzoek gestart is, kan de opgedane kennis gebruikt worden in consultancy projecten voor luchthavens en luchtvaartmaatschappijen die een oplossing zoeken voor de problemen in de terminals.
List of Abbreviations

3PL  Third Party Logistics Provide
AAS  Amsterdam Airport Schiphol
ABC  Activity Based Costing
ACI  Airports Council International
ATA  Air Transport Association
BCS  Baggage Collection Service
BHS  Baggage Handling System
CBS  Central Bureau for Statistics
COG  Center of Gravity
COROP  Coördinatie Commissie Regionaal OnderzoeksProgramma
CUPPS  Common Use Passenger Processing System
CUSS  Common Use Self-Service
CUTE  Common Use Terminal Equipment
DB  Deutsche Bahn - German Railways
DCS  Departure Control System
GPS  Global Positioning System
HSL  Hogesnelheidslijn - High Speed Line
IARO  International Air Rail Organization
IATA  International Air Transport Association
ICOM  Input, Control, Output, Mechanism
IT  Information Technology
JAL  Japan Air Lines
KLM  Koninklijke Luchtvaart Maatschappij - Royal Dutch Airlines
LDOS  Local Drop-Off Service
LND  Logistics Network Design
NCTB  Nationaal Coördinator Terrorisme Bestrijding
NDC  National Distribution Center
NS  Nederlandse Spoorwegen - Dutch Railways
RDC  Regional Distribution Center
RPP  Redesign Passenger Process
SADT  Structured Analysis and Design Technique
SITA  Société Internationale de Télécommunications Aériennes
SPLS  Schiphol Parking Lot Service
SSS  Schiphol Station Service
SWOT  Strengths, Weaknesses, Opportunities, Threats
TSA  Transportation Security Administration
TSS  Train Station Service
US  United States
## Contents

Preface .......................................................................................................................... iii

Summary .......................................................................................................................... v

Samenvatting (In Dutch) ................................................................................................ ix

List of Abbreviations .................................................................................................... xiii

Introduction ................................................................................................................... 21

  Background .................................................................................................................. 21

Research Objectives and Questions ............................................................................. 23

Research Approach ....................................................................................................... 23

  Scope of Research ...................................................................................................... 24

  Innovation Model in Theory ....................................................................................... 25

  Innovation Model Applied ......................................................................................... 26

Data Collection ............................................................................................................. 30

Research Model ............................................................................................................ 31

Scientific Contribution ................................................................................................. 33

Societal Relevance ........................................................................................................ 33

Report Structure .......................................................................................................... 34

  Reading Guide ........................................................................................................... 34

Chapter 1 – Current Situation ....................................................................................... 35

  Check-in ....................................................................................................................... 35

Current Process ............................................................................................................. 35

Examples of Off-airport Check-in Solutions ................................................................. 36

  Amsterdam .................................................................................................................. 36

  Frankfurt ...................................................................................................................... 37

  Houston ....................................................................................................................... 37

  Japan ............................................................................................................................ 37

  London Heathrow ....................................................................................................... 38

  Los Angeles ................................................................................................................ 38

  Madrid ........................................................................................................................ 38

  Walt Disney ................................................................................................................ 38

  Moonlight Check-in .................................................................................................... 38

Stakeholders in Off-Airport Baggage Check-in ............................................................... 39
Chapter 4

Chapter 3

Chapter 2

Chapter 1

Critical Issues in Off-airport Baggage Check-in ................................................................. 40
Initiation Issues ......................................................................................................................... 40
Operational Issues ..................................................................................................................... 40
Design Issues ............................................................................................................................ 40
Security and Regulatory Issues ............................................................................................... 41
Financial Issues ....................................................................................................................... 41
Customer Issues ..................................................................................................................... 42
Trends in Airport Processes ..................................................................................................... 42
Self-Service ............................................................................................................................... 42
Common Use ............................................................................................................................. 42
Baggage Restrictions ............................................................................................................... 43

Chapter 2 – Design Requirements and Objectives ..................................................................... 45
Stakeholder Analysis .................................................................................................................. 45
  Airport ..................................................................................................................................... 46
  Airline ..................................................................................................................................... 46
  Passengers ............................................................................................................................... 47
  Facility Host ............................................................................................................................. 47
  Dutch Railways (NS) .............................................................................................................. 48
  Third-Party Logistics Provider ............................................................................................ 48
General Requirements .............................................................................................................. 48

Chapter 3 – Concept Development ............................................................................................ 51
Concepts .................................................................................................................................... 51
  Passenger Distribution .......................................................................................................... 52
  Baggage Collection Service .................................................................................................. 53
  Local Drop-Off Service ......................................................................................................... 53
  Train Station Service ............................................................................................................ 54
  Schiphol Parking Lot Service ............................................................................................... 55
  Schiphol Station Service ....................................................................................................... 55

Chapter 4 – Concept Evaluation ................................................................................................ 59
Analysis Method ....................................................................................................................... 59
Concept Analysis ...................................................................................................................... 61
Baggage Collection Service ..................................................................................................... 61
<table>
<thead>
<tr>
<th>Chapter 9 – Process Improvements</th>
<th>.................................................................</th>
<th>77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Description</td>
<td>........................................................................................................................................</td>
<td>79</td>
</tr>
<tr>
<td>Chapter 6 – Logistics Network Design</td>
<td>..........................................................................................................................</td>
<td>81</td>
</tr>
<tr>
<td>Arrangement Stage</td>
<td>........................................................................................................................................</td>
<td>81</td>
</tr>
<tr>
<td>Service Area Decision</td>
<td>........................................................................................................................................</td>
<td>82</td>
</tr>
<tr>
<td>Location Decision</td>
<td>........................................................................................................................................</td>
<td>86</td>
</tr>
<tr>
<td>Operations Stage</td>
<td>........................................................................................................................................</td>
<td>88</td>
</tr>
<tr>
<td>Chapter 7 – Scenario Development</td>
<td>.......................................................................................................................................</td>
<td>89</td>
</tr>
<tr>
<td>Chapter 8 – Cost Structures</td>
<td>........................................................................................................................................</td>
<td>93</td>
</tr>
<tr>
<td>Activity Based Costing</td>
<td>........................................................................................................................................</td>
<td>93</td>
</tr>
<tr>
<td>Geographical Distribution</td>
<td>........................................................................................................................................</td>
<td>95</td>
</tr>
<tr>
<td>Geographical Dispersion</td>
<td>........................................................................................................................................</td>
<td>96</td>
</tr>
<tr>
<td>Scenario Analysis</td>
<td>........................................................................................................................................</td>
<td>100</td>
</tr>
<tr>
<td>Scenario 1: Disappointing Numbers</td>
<td>.....................................................................................................................................</td>
<td>100</td>
</tr>
<tr>
<td>Scenario 2: Foreseen Results</td>
<td>........................................................................................................................................</td>
<td>100</td>
</tr>
<tr>
<td>Scenario 3: Unexpected Successes</td>
<td>....................................................................................................................................</td>
<td>101</td>
</tr>
<tr>
<td>Chapter 9 – Conclusions and Discussions</td>
<td>..................................................................................................................................</td>
<td>103</td>
</tr>
<tr>
<td>Conclusions</td>
<td>........................................................................................................................................</td>
<td>103</td>
</tr>
<tr>
<td>Reflection</td>
<td>........................................................................................................................................</td>
<td>105</td>
</tr>
<tr>
<td>Reflection on Methodology</td>
<td>........................................................................................................................................</td>
<td>105</td>
</tr>
<tr>
<td>Reflection on Assumptions</td>
<td>........................................................................................................................................</td>
<td>107</td>
</tr>
<tr>
<td>Reflection on Research</td>
<td>........................................................................................................................................</td>
<td>109</td>
</tr>
<tr>
<td>Recommendations</td>
<td>........................................................................................................................................</td>
<td>110</td>
</tr>
<tr>
<td>Recommendations for Airlines</td>
<td>........................................................................................................................................</td>
<td>110</td>
</tr>
<tr>
<td>Recommendations for the Academic Society</td>
<td>...............................................................................................................................................</td>
<td>111</td>
</tr>
<tr>
<td>Recommendations for QuinTech Engineering Innovations</td>
<td>..................................................................................................................................</td>
<td>111</td>
</tr>
<tr>
<td>References</td>
<td>........................................................................................................................................</td>
<td>113</td>
</tr>
</tbody>
</table>
List of Figures ................................................................................................................................. 117
List of Tables ................................................................................................................................. 121
Appendix A – Interview with AAS Representative ................................................................. 123
  Appendix A.1 – Protocol for Interview with AAS Representative ........................................ 123
  Appendix A.2 – Transcript of Interview with AAS Representative (In Dutch) ................. 124
Appendix B – Interview with KLM Representatives ..................................................................... 127
  Appendix B.1 – Protocol for Interview with KLM Representatives ..................................... 127
  Appendix B.2 – Transcript of Interview with KLM Representatives (In Dutch) ............... 128
Appendix C – Interview with TNT Representative ................................................................. 131
  Appendix C.1 – Protocol for Interview with TNT Representative (In Dutch) .................... 131
  Appendix C.2 – Transcript with TNT Representatie (In Dutch) ........................................ 132
Appendix D – Marketing Strategy Amsterdam Airport Schiphol ............................................. 135
Appendix E – Geographical Distribution of Passengers ....................................................... 137
  Appendix E.1 – COROP Regions in the Netherlands ......................................................... 137
  Appendix E.2 – Passenger Distribution over COROP Regions ........................................ 138
Appendix F – Baggage Collection Service Concept ............................................................... 139
  Appendix F.1 – Baggage Collection Service Logistical Model – Service Provider .......... 139
  Appendix F.2 – Baggage Collection Service Logistical Model – Passenger .................... 145
  Appendix F.3 – Cost Structure per Activity ........................................................................ 148
Appendix G – Local Drop-Off Service Concept ................................................................. 149
  Appendix G.1 – Local Drop-Off Service Logistical Model – Service Provider ................ 149
  Appendix G.2 – Local Drop-Off Service Logistical Model – Passenger .......................... 154
Appendix H – Train Station Service Concept ........................................................................ 159
  Appendix H.1 – Train Station Service Logistical Model – Service Provider .................... 159
  Appendix H.2 – Train Station Service Logistical Model – Passenger ............................... 164
  Appendix H.3 – Cost Structure per Activity ....................................................................... 168
Appendix I – Schiphol Parking Lot Service ............................................................................. 169
  Appendix I.1 – Schiphol Parking Lot Service Logistical Model – Service Provider .......... 169
  Appendix I.2 – Schiphol Parking Lot Service Logistical Model – Passenger ................. 174
  Appendix I.3 – Cost Structure per Activity ....................................................................... 178
Appendix J – Schiphol Station Service ...................................................................................... 179
  Appendix J.1 – Schiphol Station Service Logistical Model – Service Provider ............... 179
Appendix J.2 – Schiphol Station Service Logistical Model – Passenger .......................................................... 183
Appendix J.3 – Cost Structure of Schiphol Station Service Concept ............................................................. 187
Appendix K – Pickup Capacity Assessment .................................................................................................. 189
Appendix L – Passenger Survey .................................................................................................................. 191
  Appendix L.1 – Passenger Survey Protocol ............................................................................................... 191
  Appendix L.2 – Passenger Survey Results ................................................................................................. 193
Appendix M – SADT Model of Final Baggage Collection Service ............................................................... 197
Appendix N – Baggage Weight and Volume Distribution ............................................................................. 199
Appendix O – Cost Structures for Scenario Analyses .................................................................................. 201
Appendix P – Sensitivity Analyses per Region ............................................................................................ 203
Introduction
This master thesis research aims at designing a solution to a problem that is faced by many airlines and airports around the world. According to the definition of Verschuren and Doorewaard (1995) this thesis research will have the form of a design-oriented project. More specifically, this research is focused on designing an off-airport baggage check-in process. Because little has been published on the subject of off-airport baggage check-in, this research will have an explorative character. In order to structure the research, the design will be applied to a case study for the situation at Amsterdam Airport Schiphol. To successfully execute a design-oriented research, it is necessary to identify the problem at hand. In this introduction, the problems at many major airports such as Amsterdam Airport Schiphol that have led to the initiation of this research will be described. Besides that, the main goals of the research will be discussed as well as the approach that will be used to achieve those goals. The final part of this introduction will be devoted to the outline of the report.

Background
The number of passengers departing from major airports as Amsterdam Airport Schiphol (AAS) has been increasing over the past decades. At AAS, the number of departing passengers has grown with over fifty percent in the past twelve years (Centraal Bureau voor de Statistiek, 2010b). This growth in passengers has led to significant capacity problems for AAS and many other airports. Especially congestion in the terminal is an important problem. As many other airlines do, KLM Royal Dutch Airlines advises its passengers to check-in two hours before departure (KLM, 2010). Because of the fact that the number of departing passengers is not equally distributed over the day and over the year as shown in Figure 1 and Figure 2, this results in peak loads in the number of check-in passengers. As those that have been at AAS during the holiday season probably have witnessed, these peak loads can results in long queues at the check-in desks in the terminal.

Terminal congestion has been the subject of many different studies in literature. Different methodologies have been used in the different studies in order to derive possible solutions for the congestion problems in airport terminals. A bottleneck analysis performed by Daniel (2000) identified congestion pricing, charging higher fees to airlines for operating during peak times, as a possible solution to reduce peak loads and thereby decrease the congestion problems in the airport terminal.
A simulation analysis of international departure passengers performed by Takakuwa and Oyama (2003) concluded that by adding support staff to the regular staff and by making use of separate check-in counters for different types of passengers (business class, economy class, groups), the waiting time of passengers in the airport terminal can be reduced with over forty percent. Another simulation analysis, performed by Joustra and Van Dijk (2001) and validated using the queuing theory, concluded that several different solutions could reduce the check-in time for passengers. One possible solution was introducing common use check-in counters instead of dedicated airline counters. This will result in a more even distribution of check-in passengers over all counters and might reduce the number of counters required at the departure terminals.

To solve the problems in the terminals of Amsterdam Airport Schiphol, AAS and KLM Royal Dutch Airlines have launched the Redesign Passenger Process (RPP) program. This program has been focused on increasing efficiency at the airport, easing the travel process for the passengers and reducing waiting times. In order to define the processes that need to be redesigned, a bottleneck analysis and stakeholder analysis have been performed (Bouland, 2007). Examples of solutions that have been implemented at AAS are self-service check-in systems that allow online or mobile check-in. Nevertheless, passengers still need to check-in their baggage at the airport terminal. To increase the efficiency in this check-in process, AAS installed several self-service drop-off points in Terminal 2, which passengers can use to check-in their hold baggage. Nevertheless, this still requires passengers to perform part of the check-in process inside the airport terminal.

One solution that could take the entire check-in process, identified as an important bottleneck by Takakuwa and Oyama (2003) and by Gatersleben and van der Weij (1999), out of the terminal is the introduction of off-airport baggage check-in. An example of an off-airport baggage check-in solution is the baggage check-in at Cruise Terminals in Miami and Vancouver, where cruise passengers can check in their bags when they leave the cruise ship and recollect them at their destination airport (IARO, 2007). Off-airport baggage check-in solutions allow passenger to perform the entire check-in process, including checking in baggage and receiving boarding passes, at a point outside the airport terminal. Using such a system, baggage can be transported to the airport separately from the passengers. This system can have operational advantages for both airlines and airports. Furthermore, approximately 60 percent of the respondents of the SITA Passenger Self-Service Survey indicates they would use off-airport baggage check-in systems when available and over 42 percent of them indicated to be willing to pay for such services (SITA, 2008; SITA, 2009). Therefore, off-airport baggage check-in can be a promising solution to the capacity and congestion problems at airport terminals.

Moreover, introducing off-airport baggage check-in for AAS can solve another problem the airport is currently facing. Ever since the 1950’s the average life expectancy for both men and women in the Netherlands has been increasing significantly and since the 1980’s, the percentage of the population that is older than 40 years has been increasing (Centraal Bureau voor de Statistiek, 2010d). Older people typically have more trouble carrying their luggage from the parking lot towards the terminal than younger people. Off-airport baggage check-in solutions can allow older passengers to move to the airport without the trouble of carrying the luggage themselves and therefore the airport can become more attractive to these passengers.
Research Objectives and Questions
Several off-airport baggage check-in solutions have been successfully implemented for different airports around the world. Not every solution is suitable for all situations at major airports. The situation at Amsterdam Airport Schiphol might require a different solution that the situation at London Heathrow or the situation at Orlando International Airport. Therefore, the goal of this research is to develop a logistics network and a business model for an off-airport baggage check-in solution suitable for the situation at Amsterdam Airport Schiphol.

In order to achieve the objective as described above, the following main research question has been formulated:

“What is a suitable logistics network and a suitable business model for an off-airport baggage check-in solution for Amsterdam Airport Schiphol?”

To structure the answering of the main research question as identified above, a set of sub-research questions has been developed:

1. Which types of off-airport baggage check-in solutions have been used earlier?
2. What factors have been critical in the success and failures of these solutions?
3. Which trends in airport check-in processes can be identified?
4. What are the main stakeholders and their requirements for introducing off-airport baggage check-in?
5. What possible off-airport baggage check-in solutions can be developed?
6. Which of the identified solutions is the most suitable?
7. What is a suitable logistics network for the service?
8. What is a suitable business model for the service?

The sub-research questions needs to be answered subsequently. The answers to sub-question seven and eight combined can answer the main research question as stated above.

Research Approach
The sub-research questions identified above will serve as guidelines for the research approach. The research will be aimed at innovating the baggage check-in process for airports. To structure an innovation process, many different methodologies can be used (Utterback and Abernathy, 1974; Papinniemi, 1999). In this research, the Innovation Model methodology of In ’t Veld will be applied (in ’t Veld, 2002). This model has been successfully used in several other projects that aimed to innovate logistics processes (Veeke, 2003; Koopman, 2008), and can help structuring the steps required for process innovation. This methodology will serve as a guideline for developing an off-airport baggage check-in process for Amsterdam Airport Schiphol. As mentioned earlier, this research will have the form of an explorative case study. According to the definition of Yin, exploratory case studies do not use propositions to focus the research (Yin, 2003). However, a purpose needs to be defined. The purpose of this exploratory case study is to develop an off-airport baggage check-in solution for the case of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines, assuming that such a solution could reduce
the congestion problems in the airport terminal. To ensure the quality of this single-case study, three tests will be used. First of all, construct validity will be incorporated by using multiple data sources where possible. Furthermore, experts from QuinTech Engineering Innovations will review the draft versions of the research report. Secondly, the domain to which the findings of this research can be applied will be established. This corresponds with the definition of external validity by Yin. Finally, to ensure the reliability of the case study, a case study protocol will be developed in which each of the steps of the research will be described. Furthermore, data sources will be carefully documented and assumptions that are used will be clarified (Yin, 2003). In the following sections, the protocol for the case study research will be discussed, using the innovation model of in ’t Veld as a framework. However, first the focus of the research will be defined.

Scope of Research
In Figure 3 a simplified representation is shown of the steps departing passengers have to go through. The processes indicated with dashed lines are optional steps that are not offered at every airport, such as online check-in and self-service baggage drop-off. The blue rectangles in Figure 3 indicate the steps on which this research will focus. Offering off-airport baggage check-in solutions at an airport will influence the steps preceding the security check at the airport. Most likely the proposed solution will have an effect on the passenger check-in step as well; nevertheless the research is focused on the baggage check-in procedures. Therefore the passenger check-in steps are not included in the blue rectangle.

Though many of the major airports worldwide face similar problems as Amsterdam Airport Schiphol, the focus of this research will be on the situation in the Netherlands. More precisely, Amsterdam Airport Schiphol will be used as a reference case for the analysis. In consultation with QuinTech Engineering Innovations, it has been decided to focus on KLM Royal Dutch Airlines and the partners in the SkyTeam Alliance as the most important airlines. It is preferable to choose one specific reference case, because different airports have different environments in terms of stakeholders and their objectives, available infrastructure and numbers and types of passengers and there is not one solution that fits all different situations.

As presented in Figure 4, the Innovation Model consists of five phases. In this research the final phase, the execution phase, will be out of scope. The actual execution might be a follow-up activity after this research, so advice will be given on how to execute the presented solution with respect to logistics and finance.
Furthermore this research will not focus on the return flow of baggage. Though it is an interesting topic and would complete any off-airport baggage check-in service, it is out of scope for several reasons. First of all, Dutch customs regulations require passengers to pass through customs with their hold baggage, because suspects can only be caught red-handed according to Dutch law (Douane Nederland, 2009). Nevertheless, baggage that arrives at the airport on a different flight than the passenger is also transported to the home address of the passengers. Introducing such a service on a large scale however, would require significant infrastructural changes at the airport. Furthermore, it would require intensive cooperation with customs and changes in the regulations would be necessary. Therefore, the return flow is not included in the scope of this research. Nevertheless, the return flow of baggage is certainly an interesting research opportunity.

**Innovation Model in Theory**

“When the functions a firm provides are no longer satisfying the wishes of its customers, changes in these functions are necessary. Such changes often come in the form of innovations” (in ’t Veld, 2002). In order to structure the innovation process in a firm, In ’t Veld developed a so-called innovation model. He structures the process by identifying five process phases. The entire process can be seen as a series of iterative loops through these five phases. The structure of the innovation model is shown in Figure 4.

The first phase of the model entails scanning the environment. In this step it is necessary to identify trends in the environment, the needs of the customers and develop goals for the innovation process. The second phase is focused on developing policies to reach the goals identified in the previous step.

![Diagram](image-url)
Sometimes the development of these policies results in new questions with respect to the environment and a further analysis of the environment is required. Phase 3 in the innovation process is focused on comparing goals and criteria articulated in phase 1 with the policies developed in the second step. This confrontation should lead to choosing a policy. The fourth phase in the process is further developing the chosen policy and restructuring the processes in the company according to that policy. The final phase is the execution of the new policy, resulting in a steady-state situation for the company.

To ensure the process functions as expected, it is necessary to monitor and control the entire process, by setting norms and developing a planning. This is difficult because of the iterative character of the model. Nevertheless, a master plan is required to ensure progress in the model. After the steps have been completed and the developed policy is in execution, it is necessary to evaluate the results. If necessary, a new innovation cycle can be initiated.

Innovation Model Applied

Since this research is focused on innovating baggage check-in processes for an airport, the innovation model of Professor In ‘t Veld can be partially applied. The first four phases described above will be applied for the development of an off-airport baggage check-in solution. The final phase, the execution, will be out of the scope of this research, as will be the evaluation of the executed policy. In Figure 5, the framework for the innovation model applied to this research is presented.

Phase 1

Phase one of the innovation model is focused on scanning the environment and setting goals. In this research, the first phase can be divided into two parts. The first part is focused on identifying and analyzing previous initiatives with respect to off-airport baggage check-in and corresponds with questions one to three, the second part is focused on identifying requirements and wishes of the main stakeholders involved in off-airport baggage check-in and aims to answer question four.

The data for answering the first three sub-research questions can be gathered mainly through a secondary literature study. Several news-articles are published on examples of off-airport baggage check-in concepts that have been applied worldwide (Falconer, 2008; Medical News Today, 2010). Furthermore, well-known organizations in the aviation industry have published several reports with respect to off-airport baggage check-in and trends in the industry. Especially reports of the International
Air Rail Organization (IARO) (IARO, 2001; IARO, 2007) on worldwide links between airports and railways can provide very useful information on early initiatives in the industry. Annual reports published by the Société Internationale de Télécommunications Aéronautiques (SITA) can provide insight into important trends in airport and airline industry.

To identify important success factors in the early initiatives in literature, publications of Sharp (2004) and Merten (2009) will be used. These publications identify critical issues in introducing off-airport baggage check-in concepts based on analysis of different initiatives and interviews with representatives of involved stakeholders. These publications will also be used for identifying the most important stakeholders in the process.

In the second part of phase one, for each of these stakeholders the most important interests in introducing an off-airport baggage check-in solution will be identified. Because the case study is focused on the situation at Amsterdam Airport Schiphol, information on stakeholder requirements will be gathered through interviews with representatives from the main stakeholders. The main stakeholders will be identified by studying secondary literature. Suitable subjects for the interviews will be selected based on their experience with passenger and baggage check-in processes. Because of the explorative character of the research, the interviews will be rather open and unstructured (Verschuren and Doorewaard, 1995). Nevertheless, for each interview a protocol will be developed. Furthermore, passenger wishes will be identified based on a study into passenger preferences and expectations performed at Hong-Kong Airport (Gilbert and Wong, 2002). To avoid making incorrect generalizations about passengers preferences, the results of the case study will be compared with results of the annual passenger survey performed by SITA (Gilbert and Wong, 2002; SITA, 2009).

Answering the first three sub-research questions will provide insight in possible concepts for off-airport baggage check-in solutions. Furthermore, factors that can influence the success of a concept will be identified together with important trends in the industry. The data gathered will be used for designing the different concepts that will be analyzed in this research. Furthermore, the requirements and wishes of the different stakeholders in the process will form the basis for the design requirements and will be used for evaluation of the different concepts.

**Phase 2**

Phase two is focused on developing a set of possible off-airport baggage check-in concepts. The design requirements and stakeholder preferences that have been identified in phase one will serve as guidelines for the development. Input for the development of the concepts will be derived from the secondary literature that is used for the first phase. Furthermore, a creative brainstorm session will be held with experts from QuinTech Engineering Innovations to gather ideas on possible concepts for the situation in the Netherlands.
To structure the development of the alternatives, the Structured Analysis and Design Technique (SADT) will be used. According to Marca and McGowan (1988) “SADT is one of the best-known and most widely used system engineering methods.” SADT is a graphic notation and an approach to system descriptions that has been applied in many different fields such as aerospace engineering, military weapons control (under the name IDEF0) and logistics management (Marca and McGowan, 1988). For each of the alternatives the logistical activities will be described using an activity model. Each of the models will present a system description of that concept.

The development of the different concepts will answer the fourth sub-research question. Using SADT ensures that all concepts are developed in a similar way, with similar purposes and from the same viewpoints (Marca and McGowan, 1988). This is necessary in order to facilitate a reliable evaluation of the different concepts.

Phase 3
The third phase of the innovation model is focused on evaluating the possible concepts that have been defined in the previous phase. Two different types of analyses will be applied for the evaluation of the concepts. First of all, for each of the concepts a financial analysis will be performed. The aim of the financial analysis is to derive a cost structure for operating each of the concepts. This means that initial investments will not be taken into account; neither will the benefits of the services in terms of revenue and savings. To derive the cost structures, the Activity Based Costing (ABC) technique will be used (Themido, Arantes et al., 2000; van Damme, 2001). According to the American Institute of Management Accountants Activity Based Costing is “a methodology that measures the cost and performance of activities, resources and cost objects, assigns resources to activities and activities to cost objects, based on their use and recognizes the causal relationship of cost drivers to activities” (Institute of Management Accountants, 1992). For each concept the cost drivers will be derived and for each activity within the concepts the required resources are identified. This will result in a cost structure for each of the concepts. Based on the cost structure it can be assessed whether the costs of operating the service are not excessively high.

These cost structures will be used in the second analysis that will be performed for each of the concepts. The second type of analysis that will be performed is a so-called Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. A SWOT analysis can help identifying both internal and external factors that are either supportive or unfavorable for achieving the objectives of a concept. The strengths and weaknesses are the internal factors that influence the possible success of a concept, while the opportunities and threats are the external factors (Hill and Westbrook, 1997; Valentin, 2001). SWOT analysis has been widely used in developing business strategies and evaluating concepts and cases (Hill and Westbrook, 1997; Valentin, 2001). Nevertheless, the methodology is not without criticism in
literature. The main issue with SWOT analysis is that it generates a list of vague terms that do not help mitigating threats and correcting for weaknesses (Hill and Westbrook, 1997).

Based on the two types of analyses and a market research performed by KLM Royal Dutch Airlines (KLM Royal Dutch Airlines, 2007), the most suitable concept for the situation in the Netherlands can be determined.

**Phase 4**

In the final phase, the chosen concept will be subject to further development. First of all, the weaknesses and threats identified in the SWOT analyses will be analyzed and solutions to deal with the weaknesses and threats will be proposed. The solutions will be based on ideas generated from the aforementioned interviews with representatives from the different stakeholders.

The enhanced service can be performed using different business models. For instance, it can be performed by the airline or it can be outsourced to a third-party logistics provider. Factors such as costs, reliability and quality control influence this decision (Walker and Weber, 1984; Vining and Globerman, 1999). The final part of the research will be focused on this decision. For analyzing the outsourcing option, the concept will be discussed with the Manager Sales Sameday of TNT Express in a face-to-face interview. TNT Express has been chosen because of the extensive logistical network in the Netherlands. The interview will have an open and unstructured character, though a protocol will be used to address important issues.

In order to decide whether or not to outsource the service concept, a logistics distribution network will be designed for the service. The development of the logistical distribution network will be based on the framework proposed in the article of Mourits and Evers (1995). They propose a framework for designing logistic distribution networks that consists of four stages:

- **Arrangement Stage** – Geographical arrangement or layout of the distribution network
- **Deployment Stage** – Optimal distribution of inventory and final assembly activities
- **Flow stage** – Required inventory levels, safety stocks, batch sizes and order frequencies
- **Operations Stage** – Vehicle routing, ordering procedures and delivery scheduling

For this research, the deployment stage and flow stage are not applicable, since inventory and assembly issues are not part of the distribution process. The operations stage will be left out of scope during this research, it is considered to be a possible follow-up. So the focus will be on the arrangement stage. The primary objective will be defining the number and location of distribution centers required for the service and which customer zones they should be assigned to serve (Mourits and Evers, 1995). For defining the number of distribution centers required, analogous systems in the Netherlands, such as the distribution network of Albert Heijn, will be analyzed. For the location decision, the center-of-gravity approach will be used. Using this approach, the optimal location for a distribution center can be found, based on minimization of transportation distance per unit of transport (Reid and Sanders, 2007). It considers both locations and volumes of the markets, or in this case customer areas, that need to be served. For deciding on the actual location of the distribution centers, factors such as proximity to the road-network and availability of land are taken into account as well.
In order to evaluate the (financial) performance of the logistic distribution network, scenario analyses will be performed. Three different scenarios will be developed using the seven-step process proposed by Ratcliffe (2000). These steps consist of:

1. Identifying the decision that needs to be taken
2. Specifying key factors that influence the success or failure of the decision
3. Identifying driving forces that influence these key factors
4. Ranking the driving forces and key factors on the degree of importance and uncertainty
5. Establishing alternative projections
6. Developing alternative scenarios
7. Interpreting scenarios

The three scenarios that will be developed will be predictive scenarios of the “What-if” type; these scenarios are used to investigate what will happen on the condition of some specified future events (Börjeson, Höjer et al., 2006). These scenario analyses will form the basis of the financial evaluation of the concept, by combining scenario analysis with Activity Based Costing of operating the concept in the designed distribution network, as proposed by Podsada (2007b). This combination can provide insight in total costs for different scenarios compared to the costs of outsourcing the service to a third-party logistics provider.

By finalizing all the phases described above, the answers to the eight sub-research questions as defined earlier can be found. The answers to question seven and eight combined answer the main research question, while the first six questions need answering in order to find answers to the final two questions.

**Data Collection**

In a case study research, often many different data collection methods need to be applied in order to obtain reliable information on the research units (Verschuren and Doorewaard, 1995). Many of the methods that will be applied have been discussed above. This section presents a clear overview of the required data for the different research phases and the collection methods used to acquire these data. Furthermore, an overview of the most important literature on which this research builds is presented.

As presented in Table 1, literature studies are important data collection methods in this research. Both secondary and primary literature sources in different research areas are used for gathering important data. Besides that, internal reports from stakeholders and publications from independent organizations will be used.
Table 1 - Data Collection Methods

<table>
<thead>
<tr>
<th>Research Step</th>
<th>Required Data</th>
<th>Data Collection Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping Environment</td>
<td>Data on early initiatives, Critical issues, Important trends, Important stakeholders</td>
<td>Secondary Literature Study</td>
</tr>
<tr>
<td>Identifying Requirements</td>
<td>Requirements and wishes of important stakeholders</td>
<td>Interviews, Reports from industry</td>
</tr>
<tr>
<td>Concept Development</td>
<td>Possible concepts</td>
<td>Brainstorm Session, Secondary Literature Study</td>
</tr>
<tr>
<td>Concept Evaluation</td>
<td>Activity Based Costing technique, SWOT Analysis</td>
<td>Literature on Activity Based Costing, Literature on SWOT Analysis</td>
</tr>
<tr>
<td>Concept Optimization</td>
<td>Data on network design, Input for ABC</td>
<td>Primary Literature Study, Interviews</td>
</tr>
</tbody>
</table>

Table 2 presents an overview of the most important articles and publications used as data sources in this research.

Table 2 - Literature Overview

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Important Authors</th>
<th>Subjects</th>
</tr>
</thead>
</table>

Research Model

To clarify the approach to this research, a research model has been developed. In this model, the most important data sources are linked to the steps that will be taken in this research. In Figure 6 the research model is presented. Above the model, the different phases as discussed above are indicated. The first phase consists of a literature study and a stakeholder analysis. These will result in a set of design requirements. These design requirements will be used as input in the second phase, in which the different concepts will be developed based on literature studies, interviews and a brainstorm session. These concepts will be analyzed based on the requirements, passenger preferences and cost structures and in the third phase, a choice for the most suitable concept will be made. This concept will be further developed with respect to the logistics network. Several scenarios will be developed for analyzing this network on costs. Finally, a recommendation will be given with respect to how to organize the logistics of an off-airport baggage check-in service for the situation at AAS and whether or not to outsource the service to a third-party logistics provider.
Recommendation on Service Cost Structure per Scenario

Scenario Analysis

Activity Based Costing

Logistic Distribution Network Concept Choice

Design Requirements

Structured Analysis and Design Technique Concept

Cost Structures

Theory on Activity Based Costing

Phase 4

Phase 3

Phase 2

Phase 1

Figure 6 - Research Model
**Scientific Contribution**

Most of the research on passenger and baggage flows for airports has been focused on the flows inside the airport terminals (Joustra and Dijk, 2001; Takakuwa and Oyama, 2003; Bouland, 2007). Suggested solutions to the congestion problems have been limited to changes inside the airport terminal. In this research however, the flow of baggage from the passenger’s home address to the airport is viewed from a wider, supply chain perspective. The point of baggage handover from passenger to airline will be the focus of the research. The first part of this research aims to identify the most suitable location of the baggage handover point for the case study of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines. For this purpose, a combination of Structured Analysis and Design Technique, Activity Based Costing, and SWOT analyses is used. The Structured Analysis and Design Technique supports the usage of Activity Based Costing. The combination of Activity Based Costing and SWOT analyses allows one to incorporate not only financial aspects, but also the non-financial strengths, weaknesses, opportunities and threats of the concepts from all different stakeholder perspectives.

In the second part of the research, the service concept for off-airport baggage check-in with the most suitable baggage handover point will be subject to further development. The arrangement stage of logistics network design (LND) as proposed by Mourits and Evers (1995) will be applied in this research. Besides that, a combination of Activity Based Costing and Scenario Analysis will be used for the financial evaluation of the logistics network. This can provide a detailed insight in cost variations in the individual activities as an effect of uncertainties in future events, as argued by Podsada (2007b).

Besides developing an off-airport baggage check-in solution for the situation at Amsterdam Airport Schiphol, this research aims to contribute to existing literature by extending the scope of airport process literature to flows outside of the terminal. Though off-airport baggage check-in is not a new concept, very little on the subject can be found in literature, mostly because researches have been conducted internally by airports and airlines. During this research, a roadmap for developing off-airport baggage check-in solutions will be designed that can be applied to other case studies with similar objectives. Furthermore, the applicability of conclusions drawn from this case study with respect to other cases will be discussed. If possible, general conclusions on off-airport baggage check-in solutions will be presented.

**Societal Relevance**

Introducing an off-airport baggage check-in service can have significant impact on future traveling by airplane. If the service is implemented successfully, the experience of flying will change for passengers and the journey should become more pleasant. Since many people travel by airplane, the societal relevance of this study is significant.
Report Structure
The sub-research questions as identified above and the phases of the innovation model will serve as guidelines for both the research and the report. The main body of the report can be divided into three main parts. The first part will be focused on scanning the environment. Chapter 1 will focus on identifying off-airport baggage check-in strategies that are currently being used, the critical issues involved in these strategies, and mapping the stakeholders involved in designing and implementing such a strategy. This corresponds with phase one of the innovation model.

The second part of the research will be focused on developing possible off-airport baggage check-in concepts. Chapter 2 will focus on identifying the requirements and wishes of the stakeholders discussed in Chapter 1. Chapter 3 will be devoted to the identification and description of possible off-airport baggage check-in solutions using SADT. In Chapter 4, the developed alternatives will be evaluated with respect to the financial and logistical feasibility as well as the stakeholder interests. As a result of the evaluation, the most suitable solution for AAS will be selected. These chapters will cover phases two and three of the innovation model.

In the final part of the report, the focus will be on elaborating on the most suitable solution as identified in the concept evaluation of Chapter 4. Chapter 5 will be used to identify possible improvements of the defined concept based on the SWOT analysis of Chapter 4. In Chapter 6, the design of a logistics network for the chosen solution will be the central issue. The following chapter will focus on developing several scenarios for evaluating the logistical network. In Chapter 8, the scenario analyses will be performed. These four chapters will cover the fourth phase of the research as identified in Figure 6.

The final chapters will present the conclusions of the research and will answer the main research question. Furthermore, a reflection on the research will be presented. Besides that, recommendations will be given with respect to the concept and with respect to further research.

Reading Guide
Although this report reflect the entire process of the research, certain parts of the report might be more interesting to different types of readers.

For readers who are specifically interested in the case study of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines, the most important chapters of the research are Chapters 2 to 8 and the Conclusions and the Recommendations chapters. For those readers that are focusing on this case from a management perspective, especially Chapter 5, Chapter 6 and Chapter 8 are important.

For readers who are more interested in off-airport baggage check-in in general, the focus in reading can be placed on Chapter 1, the Conclusions and the Recommendations chapters, and the Reflection. In these chapters, the general aspects of the history of off-airport baggage check-in and the general applicability of the case study results will be discussed. These final two chapters, together with this Introduction, are also the most important chapters for readers that focus on the academic contribution of this research. These chapters discuss the methodology that is applied to the case study and possible generalizations of the conclusions drawn from the case study.
Chapter 1 – Current Situation
The check-in of passengers and their baggage outside the airport terminal has been the subject of many different programs that have been developed for airports all around the world. Different forms of off-airport check-in have been used in the different programs. In this chapter, several of these initiatives will be identified and briefly analyzed. Based on these analyses, the critical issues in developing an off-airport check-in solution will be identified, as well as the main stakeholders in the process. Besides that, trends that are visible in the airport processes will be identified. As identified in the Introduction, the data on early initiatives will mainly be derived from a study into secondary literature. Especially reports published by the International Air Rail Organization (IARO), an organization that is specialized in integrated air-rail intermodality and is well known in the aviation industry, on check-in processes outside airport terminals around the world will be used in this chapter. In this chapter, the first three sub-research questions will be answered. The most important initiatives and critical issues will be used as inputs for designing possible off-airport baggage check-in concepts in phase two of the research.

Check-in
Before going into the different off-airport check-in solutions that have been developed throughout the world, it is necessary to clearly define the check-in process. Several definitions of check-in exist in literature. The International Air Rail Organization describes check-in as “the process by which passengers present themselves, their documentation and their baggage with the positive intention of boarding a specific flight, and are accepted for this by the airline or its agent” (IARO, 2007). Other definitions are “The announcing of the arrival of the passenger” (Wikipedia, 2009) or “The procedure by which an airline formally registers the arrival of a passenger for a flight” (Business Dictionary, 2009). In this report, two different types of check-in definitions will be used based on the definition used by the IARO. The term passenger check-in will be used for describing the process by which passengers present themselves and their documentation with the positive intention of boarding a specific flight, and are accepted for this by the airline or its agent. Baggage check-in will be used for describing the process by which passengers present their hold baggage, and this is accepted by the airline or its agent for transfer to the aircraft. Traditionally, passenger check-in and baggage check-in are combined in one process; however it is very well possible to separate both processes.

Current Process
As identified in Figure 3, passengers arriving at an airport for departure have to go through a series of steps before they board the plane. Passengers can check themselves and their baggage in at the check-in desks in the airport terminal. At AAS, passengers have to check-in in one of the three departure halls of the airport. At one of the check-in counters tickets and passports are checked, boarding passes are printed and baggage is labeled and sent into the baggage handling system (BHS) of the airport. Passengers can use online check-in, or make use of the self-service check-in kiosks located in the departure halls. Passengers that use these forms of check-in can drop off their hold-baggage at (self-service) baggage drop-off points.
After the check-in process, passengers have to go through the security check at the airport. After this checkpoint, passengers have the opportunity to do some tax-free shopping or have drinks at a lounge close to the departure gates as shown in Figure 7; only passengers departing from gate H or M will depart from gates with limited facilities (Schiphol Group, 2010b). The final step before boarding the plane at the gate is the boarding pass and passport check.

![Figure 7 - Departure Halls and Gates of Amsterdam Airport Schiphol (Schiphol Group, 2010c)](image)

In this process, passengers have to spend a lot of time waiting, mainly because the baggage needs to be transferred from the terminal to the departing airplane. Therefore, passengers might have to spend up to three hours between checking in and boarding the airplane (KLM, 2010). To reduce the so-called dwell time at airports and prevent congestion in the terminal, some airports have introduced off-airport baggage check-in programs in the past. The following section will analyze several of these programs.

**Examples of Off-airport Check-in Solutions**

In airport history, many examples of off-airport passenger and baggage check-in programs can be identified. Different strategies have been used in different cases, some successful, some not. Many of the operations have been stopped due to increased safety regulations after the terrorist attacks of September 11th 2001 in the US. Nevertheless, some of the programs are still being used. In this section, a selection of different off-airport check-in strategies that have been in place will be described.

**Amsterdam**

In the mid 1990’s the Dutch railway operator, Nederlandse Spoorwegen (NS), provided an on-board check-in service for KLM passengers with hand baggage only. This service was available on intercity trains from Enschede to AAS, between Enschede and Apeldoorn. During that same period, off-airport check-in was available at The Hague Central station. Both services were abandoned because of cost considerations.
In 2000 KLM was looking at self-service passenger check-in at 47 major train stations; however these plans were never executed because of the economic downturn in the industry after the terrorist attacks of September 11th 2001.

In early 2006, plans were being made by the High-Speed Alliance, the alliance formed to operate the HSL-Zuid of which KLM was part of, to integrate the rail segment in the multi-modal service. Self-service passenger check-in was to be offered at the HSL train stations. However, at the moment of writing of this report, this service is not yet offered, and it is doubtful whether it will be in the nearby future (IARO, 2001; IARO, 2007).

**Frankfurt**

In Germany, as part of a strategy to increase efficiency by providing short haul service by rail instead of through the air, the Airail project has been started by several cooperating parties such as Fraport (Frankfurt Airport), the airport authority, Deutsche Bahn (DB), and Lufthansa. For passengers traveling from Stuttgart, Siegburg/Bonn, or Köln through Frankfurt to international destinations, Airail services were provided. Passengers can check-in at airline desks at Stuttgart and Köln train stations. They receive their boarding passes and can hand in their hold baggage. On the return journey, similar services were offered. Initially, the bags were transported in a dedicated part of the train to and from the airport. However, this service has been abandoned. Now passengers need to take their own bags from the train to the Airail terminal at Fraport (IARO, 2007; Lufthansa, 2009a).

**Houston**

At Houston George Bush International Airport, Continental Airlines operates a car-park check-in system. At the parking lot next to the main road to the airport, several self-service check-in kiosks and a few manned check-in positions are placed. Passengers can receive their boarding passes and drop their bags. The baggage is taken to the airport by airline staff (IARO, 2007).

**Japan**

In Japan, Japan Air Lines (JAL) operates three different off-airport baggage services.

The Departure Delivery is a service in which the baggage is picked up by a caddy at any home address in Japan and transferred to one of the 5 departure airports that JAL serves in Japan (Narita Airport, Tokyo International Airport, Kansai International Airport, Nagoya Airport, and Sapporo Airport). The fee for the services is between 1650 and 1950 Yen (between € 14, and € 16,-)*.

The Arrival Delivery service is similar to the Departure Delivery systems, but then in opposite direction. Passengers can have their bags delivered from the same five airports to their home address in Japan. Fees for this service are in the same range as for the Departure Delivery.

The Both-way Delivery service is a combination of both services described above. This service enables passengers to travel to and from the airport without having to take the heavy baggage. Fees are in the

* Euro values are based on the currency at the time of writing this report. This value might be subject to changes over the course of time.
range of 3500 to 3900 Yen (between € 29,- and € 32,-), depending on the departure and arrival airport (IARO, 2007; Japan Airlines, 2009; Euro Investor, 2010).

**London Heathrow**
Several years ago, at Paddington station in London, passengers of London Heathrow could use the full check-in facility and use the Heathrow Express as means of transport towards the airport. The checked in baggage was transported underneath the designated platforms towards the load make-up area on the platform and loaded onto the train in containers. In 2004, the full check-in service was stopped because of economic considerations (IARO, 2007). Currently, passenger check-in is still possible at Paddington station, using self-service check-in machines. These passengers can drop off their bags at the airline’s designated bag-drop (Heathrow Express, 2009).

**Los Angeles**
In Los Angeles, it is possible for passengers to check-in themselves and their bags at several different locations, such as the Convention Centre, two major Bus Terminals, and the cruise ship terminal (for cruise passengers only). Passengers can drop off their bags and receive boarding passes on board of the cruise ship or in the terminal on the day of departure. If the cruise ends in the morning and they fly in the evening, their bags are already transferred to the airport. Similar services are offered at other cruise terminals such as Vancouver.

**Madrid**
In the late 1990’s, the metro station Nuevos Ministerios was extensively rebuilt. It is in the Madrid city centre and offers a fast and direct travel service to Barajas Airport, the 4th largest European airport (Schiphol Group, 2008). From 2002 on, a full check-in service was offered. Passengers with hold baggage had to check in at least 2 hours before flight departure. The bags are sent down to the platform level and loaded in containers and onto secure areas in the trains by airport employees (IARO, 2007).

**Walt Disney**
Disney’s Magical Express offers check-in and transport services both from and to the airport, for guests staying in one of the Disney hotels. On the inbound side, bags are transported directly from the airport to the hotel, while guests can use the airport shuttle buses. The departure times of the shuttle buses are not scheduled; the buses move when there are guests to be moved (Falconer, 2008). On the outbound side, bags are checked through from the Disney hotels to the destination airports of the passengers.

Disney pays the airport authority a fee for each passenger handled and also pays for each bag moved. The main airline involved (Continental Airlines) does not pay for the service. Disney does not charge the guests a fee for using the Magical Express services. In 2007, nearly 2.1 million passengers used the services, easing the congestion in airport check-in lines and at baggage-claim carousels (IARO, 2007; Falconer, 2008).

**Moonlight Check-in**
Moonlight check-in is a system in which the check-in of baggage and passengers are often separated. With moonlight check-in, passengers can check-in their bags the night before their flight. The passenger check-in can take place at the airport on the day of the flight, or passengers can use online check-in.
Moonlight check-in points can be placed in-town or at the airport. In Germany, Lufthansa offered the service for many flights, using 12 German train stations as check-in locations (Transportation Research Board, 2000). Recently, Lufthansa has changed the service into late night check-in; a full check-in service at the airport on the night before departure (Lufthansa, 2009b).

**Stakeholders in Off-Airport Baggage Check-in**

Introducing an off-airport baggage check-in solution involves, as every large project, different stakeholders, each having different interests and goals. In this section, the most important stakeholders in off-airport baggage check-in processes will be identified based on the initiatives discussed above and a study performed by Sharp on off-airport processing of baggage and passengers (Sharp, 2004).

**Airport** – One of the most obvious stakeholders is the airport under consideration. Part of the process that is traditionally performed at the airport, namely the baggage check-in, will be performed at a remote location. This will affect airport processes.

**Airline** – Another important stakeholder is the airline or the airlines involved in the off-airport baggage check-in program. Baggage check-in at the terminal desks is an activity that is normally performed by airline staff. Furthermore, the baggage handling and loading is also the responsibility of the airline, though often it is outsourced. Therefore, off-airport baggage check-in will have an effect on airline operations.

**Passengers** – Clearly, passengers departing from the specific airport are stakeholders in the process. They will be the eventual users of the off-airport baggage check-in facility and are therefore very important stakeholders in the process.

**Facility Host** – A somewhat less obvious stakeholder is the host of the off-airport baggage check-in facility. If for example the check-in facility is located in a train station, the operations at the train station will be affected by the presence of the baggage check-in facility.

**Railway Operator (NS)** – If passengers can travel to the airport without the hassle of carrying their hold-baggage, they might be more willing to use public transportation to access the airport (Transportation Research Board, 2002). Thus introducing off-airport baggage check-in services can have an effect on the number of passengers using the train and on NS operations.

**3PL** – In some off-airport baggage check-in solutions identified above, external companies were involved to perform part of the process. Such a company is called a third-party logistics provider (3PL). For example in the Disney Magical Express service, a 3PL is used to perform the transportation of checked-in baggage to Orlando International Airport (Falconer, 2008).

Though many more stakeholders can be identified, these are the most important ones. Especially airport, airline and passengers can be decisive in the process. Passengers are important because they will be the end users and end users are decisive for the success of the service concept. Airport and airlines are important stakeholders because the service will be executed for and possibly by the airport or airline. These stakeholders can decide whether or not the service will be implemented.
Critical Issues in Off-airport Baggage Check-in
Besides the initiatives described earlier, many more examples of off-airport (baggage) check-in solutions can be found in the literature. Though some of them are still in use, such as the Disney Magical Express, many other solutions have been abandoned. In this section, some of the critical issues and problems with off-airport baggage check-in are discussed.

Initiation Issues
Many attempts to introduce off-airport baggage check-in have failed in the initiation phase. Mostly, these failures occurred because of disagreement among the many different stakeholders involved, as described above. Especially problems with reaching agreements on the funding of the projects have been a significant factor in inhibiting the launch of the off-airport check-in solutions (IARO, 2007).

Operational Issues
For an off-airport check-in facility to be successful, it is critical that operations run smoothly. Therefore, tested baggage handling equipment needs to be used. It is essential that the percentage of mishandled bags at the off-airport facility does not exceed the percentage of mishandled bags at the airport check-in, otherwise customers will be reluctant to use the facility. To assure quality of service for passengers, detailed service level agreements need to be development between the parties involved in providing the off-airport check-in solution (IARO, 2001; IARO, 2007).

Besides the equipment, it is of vital importance that IT systems function as intended. The airline’s Departure Control System (DCS) need to be sophisticated enough to handle off-airport check-in.

Furthermore timing is an important operational issue. Using the off-airport check-in should preferably decrease, but definitely not increase the amount of time passengers have to spend at the airport before departure, because dwell-time at the airport is ranked second in the steps of the journey passengers would like to change according to the SITA passenger self-service survey of 2009 and was ranked first in that of 2008 (SITA, 2008; SITA, 2009).

Design Issues
Another issue that has led to the failure of some off-airport check-in solutions is the design of the facility. At Newark International Airport Station, Continental Airlines opened a check-in facility. The check-in desks were slightly off the passengers’ natural route from the station towards the airport terminals. This slight detour proved to be enough of a deterrent to be not worth-while. The desks have been closed. The same problem initially occurred at Paddington Station for the Heathrow Express. In this case, the check-in desks were significantly off the natural route between the entrance of the station and the Heathrow Express platforms.

Another important design aspect is the design of customer interfaces. For reasons of customer confidence in the remote check-in facility, the facility needs to be designed as much like an airport terminal as possible. In case self-service check-in systems are employed, it is essential to design the IT interface in a clear and simple manner.
Security and Regulatory Issues
Security issues have become increasingly important in air transportation, mainly after the terrorist attacks of 2001. Both the checking of passengers and their bags are important security issues in remote check-in facilities, because there is a concern that threat posing actions could take place after the check-in. In the past, the main threat was hijacking and the focus was mainly on checking passengers and hand baggage for weapons. Later on, bombing became the most important threat, shifting the focus towards checking hold baggage. Recently, suicide bomb attacks have become more of a threat, and the focus has returned to the passenger and hand baggage.

Nevertheless, checking hold baggage is still very important from a security and safety perspective. Hold baggage that is checked-in needs to be secured and monitored, in order to prevent unauthorized access to the baggage. Normally these bags are thoroughly screened in the airport’s baggage handling system (BHS), together with the bags that are checked-in at the airport.

Security issues need to be considered because of the different agencies involved in the off-airport check-in process. Setting common standards and adapting to ever changing security regulations are challenging aspects.

Closely related to security issues are regulatory issues with respect to baggage. In the US, the Transportation Security Administration (TSA) determines safety regulations for baggage check-in and transport. In different countries, different regulations apply. In the Netherlands for example, passengers entering the country have to accompany their hold baggage through customs at the airport, because suspects can only be caught red-handed according to the Dutch customs law (Douane Nederland, 2009).

Financial Issues
Though the service can be beneficial, there are also significant costs to such an introduction, and it is difficult to balance the costs and the benefits for each of the stakeholders involved. Most difficulties arise because of the inability to fully capture the benefits, the inability to clearly demonstrate exactly which stakeholder incurs which costs and receives what extra revenue up front, and because the benefits are generated evenly over the life of the project while most costs are incurred before the project has even started (IARO, 2001; IARO, 2007).

The most important additional costs for off-airport baggage check-in are those related to the transport of checked baggage, equipment and accommodation costs. The staffing costs are less important, because staff is required at airports as well, and there may be savings in on-airport requirements for staffing.

In the examples described earlier, different funding strategies have been used. In Frankfurt, costs were split equally between the three partners; Lufthansa, Fraport, and DB. In London Paddington, airlines rented the desks in the building paid by the railway. The (airport-owned) railway provided train space, equipment, and staff at both ends. The airlines also funded the transport of the bags from the airport station to the terminals (IARO, 2007). In other examples, such as in Switzerland, customers had to pay an additional fee in order to cover the costs, while in Disney the host paid for the costs of checking-in the passengers and transporting the bags (Falconer, 2008).
Customer Issues
Last but not least, it is important to take customer expectations and concerns into account in developing off-airport baggage check-in solutions. Different customers will have different expectations. Business class travelers using high-end airlines will expect high service levels, while other passengers might expect low prices.

Concerns customers might have can be about mishandled bags (van Reeden, 2010). A common conception is that the additional transfer of baggage from the check-in point to the airport results in higher rates of mishandled bags. However, experience at London Heathrow and in Hong Kong shows that the rates were even lower than with baggage checked in at the airport (IARO, 2007). It is necessary to reassure passengers that the off-airport facility will not result in higher rates of mishandled bags.

Because of the limited scope of the research, not all issues are equally important for the design of the off-airport baggage check-in concept. In Table 3 the issues that are considered to be most important for this research are presented.

Table 3 - Critical Issues in Off-Airport Baggage Check-In

<table>
<thead>
<tr>
<th>Type of Issues</th>
<th>Problems</th>
<th>Involved Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment Issues</strong></td>
<td>High investments</td>
<td>All initiating stakeholders</td>
</tr>
<tr>
<td><strong>Design Issues</strong></td>
<td>Unreliable appearance</td>
<td>Passengers and airline</td>
</tr>
<tr>
<td></td>
<td>Not on natural route</td>
<td></td>
</tr>
<tr>
<td><strong>Regulatory Issues</strong></td>
<td>Interference after check-in</td>
<td>Passengers, airline and executing party</td>
</tr>
<tr>
<td><strong>Transparency Issues</strong></td>
<td>Customer concerns on the process</td>
<td>Passengers and airline</td>
</tr>
</tbody>
</table>

Trends in Airport Processes
Technological developments and cost considerations are the main drivers of changes in airport processes, such as passenger and baggage check-in and handling. In this section, the main trends in these processes that are currently visible are identified.

Self-Service
Self-service is the most clearly visible trend in airport processes. Different forms of self-service check-in exist already, such as internet check-in, check-in kiosks, and mobile phone check-in. The key driver of self-service check-in is cost. According to the IARO, a traditional passenger check-in costs about $3.62, while check-in at a self-service kiosks costs approximately $0.52 and internet check-in approximately $0.16. Self-service check-in often entails the issuance of boarding pass and baggage tag. Some airports also have self-service baggage drop-off points, for example AAS. According to the SITA Passenger Self-Service Survey the usage of self-service check-in has been increasing and will continue to increase (SITA, 2009).

Common Use
As mentioned, cost considerations are important for airlines. These considerations have led to the increase of common-use platforms. Common-use platforms are IT platforms that can be used by more than one airline. Common use systems can save space and thereby costs. Especially in self-service, common-use platforms are important. The International Air Transport Association (IATA) has develop
the Common Use Self-Service (CUSS) standard, a platform that offers convenience to passengers while allowing airlines to maintain their branding and identity (IATA, 2010). The latest development in common use platforms is the development of the Common Use Passenger Processing System (CUPPS), developed by IATA, ACI and ATA. This is an overhaul of the Common Use Terminal Equipment (CUTE) to result in a standardized platform for common-use implementation at airports. Currently this is still focused on agent-facing systems, but in the future this will also entail self-service platforms such as CUSS kiosks (ACI IATA & ATA, 2009). Nevertheless, many high-end airlines are still focused on contact with the passengers and therefore are unwilling to introduce common-use platforms (Vaessen and Okèl, 2010). Therefore, this research will focus on off-airport baggage check-in services for KLM Royal Dutch Airlines and its SkyTeam partners.

**Baggage Restrictions**

Another cost driven trend that is clearly visible is the change in baggage handling practices by airlines. Many airlines, mainly the low-end airlines, are trying to reduce the amount of hold baggage by restricting the allowance of hold baggage or by charging a fee for any hold baggage passengers wish to check in (IARO, 2007).

As described above, off-airport baggage check-in solutions have been implemented in several places around the world. Some of these solutions have been abandoned for a variety of reasons, others are still in use. There are some critical issues with respect to investments, design, regulations and transparency that need to be addressed when an off-airport baggage check-in solution is developed. Furthermore, some clear trends in airport processes can influence decisions on off-airport baggage check-in solutions. Besides these issues and trends, the interests of the different stakeholders involved in off-airport baggage check-in will have a significant effect on the decisions concerning possible solutions. The following chapter will focus on analyzing the different stakeholders mentioned earlier and identifying their interests and objectives with respect to off-airport baggage check-in solutions.
Chapter 2 – Design Requirements and Objectives
As mentioned in Chapter 1, many different stakeholders are involved in the introduction of an off-airport baggage check-in solution. Each of these stakeholders has its own wishes, goals and requirements that need to be taken into account when designing possible solutions. In this chapter, the goals and requirements of each of the most important stakeholders will be analyzed. Furthermore, some general requirements such as security requirements will be identified.

For identifying the goals and requirements of the most important stakeholders, information that cannot be found in literature was required. In order to obtain this information, face-to-face interviews have been held with representatives from both the airline (KLM) and the airport (AAS). Both interviews have been set-up in a rather open and unstructured approach, which corresponds with the explorative character of the case study. (Verschuren and Doorewaard, 1995). Nevertheless, for both interviews protocols have been developed that included the items that needed to be discussed in the interviews. The items in the protocols have been based on findings from the literature study as described in the previous chapter. The protocols can be found in Appendix A.1 and Appendix B.1. To ensure that the protocols were complete and all items on the protocols were relevant, these have been discussed with experts from QuinTech Engineering Innovations. Based on the protocols, both airport and airline have been contacted and interviewees have been selected. As mentioned, two face-to-face interviews have been held at the offices of KLM and AAS at Amsterdam Airport Schiphol. Both interviews took approximately one and a half hours. To ensure the reliability of the interviews, two interviewers have been used in each interview, in order to prevent researcher’s bias. Finally, the summaries of the interviews have been sent to the interviewees for approval and any feedback has been taken into consideration.

For identifying the general requirements, several different sources have been used. For security regulations, the different laws that apply have been consulted, such as the Dutch law “Burgerluchtvaart” (Civil Aviation) and the European law on Civil Aviation Security (European Parliament and Council of the European Union, 2008; Minister van Verkeer en Waterstaat, 2010). Furthermore, a telephonic interview has been held with Mr. Derks, Nationaal Coördinator Terrorismebestrijding (NCTB) in the Netherlands. In the Netherlands, the minister of Justice is the so-called Appropriate Authority, “the authority responsible for the coordination and monitoring of implementation of the common basic security standards” (European Parliament and Council of the European Union, 2008). On behalf of the minister of Justice, the NCTB is responsible for executing this function.

From this chapter on, the focus will be on the situation in the Netherlands and more specifically the situation for Amsterdam Airport Schiphol for reasons identified earlier.

Stakeholder Analysis
Each of the stakeholders identified in Chapter 1, will have its own requirements and wishes with respect to the design of an off-airport baggage check-in solution. This section will focus on analyzing the requirements and wishes of these stakeholders. Furthermore, potential benefits for the different stakeholders will be identified.
Airport
Introducing off-airport baggage check-in will have an effect on airport processes and flows through the airport terminals. To ensure the solution will not conflict with other operations at the airport, a set of requirements for the off-airport baggage check-in solution from the perspective of Amsterdam Airport Schiphol can be identified. In order to derive this set of requirements, an interview has been held with Olaf van Reeden, Manager Traffic & Transportation of Amsterdam Airport Schiphol. Mr. van Reeden has been selected for the interview because he is responsible for the catchment area and the accessibility of the airport. As Manager Traffic & Transportation, Mr. van Reeden tries to ensure that passengers can travel to the airport without too many hassles. Introducing an off-airport baggage check-in concept will certainly affect the accessibility and catchment area of the airport. Therefore, the Manager Traffic & Transportation can provide a good insight into the requirements and wishes of the airport with respect to off-airport baggage check-in. During the interview, the subjects presented in the protocol in Appendix A have been discussed. The first two items in the protocol were the main focus of the interview. The other items were mainly developed for gathering additional insight in possible concepts and passengers wishes. Based on the interview, the following requirements from AAS have been identified:

- The solution cannot be in conflict with other operations
- The logistics network must function according to specifications
- The partners in the solution must align the goals
- The solution must comply with existing security regulations

Besides the requirements identified above, there are also possible benefits for the airport in introducing off-airport baggage check-in.

- AAS can offer an additional service to its passengers, which complies with the new marketing strategy (see Appendix D)
- Introducing off-airport baggage check-in can increase the terminal and baggage handling capacity of the airport by reducing the peak-loads due to early baggage collection
- The solution can have a positive effect on the airport’s corporate image because it is innovative and can possible promote usage of public transportation to the airport

Airline
Currently, airlines are responsible for the check-in process including the baggage handling. To ensure the off-airport baggage check-in solution will not result in more problems with baggage, the airline involved will have requirements with respect to the proposed solutions. To identify the requirements of the airline, an interview has been held with Victor Vaessen, manager Product Development and Edwin Okèl, of Passenger Services at KLM Royal Dutch Airlines. Both Mr. Vaessen and Mr. Okèl are experienced in improving passenger experiences by introducing services for passengers. Off-airport baggage check-in is certainly a service that could improve the experience of the passengers. Furthermore, Mr. Okèl has already been involved in earlier, internal research into similar services. Therefore Mr. Vaessen and Mr. Okèl have been selected for the interviews. Again, the first two items in the protocol are the main focus of the interview. From the interview, the following requirements have been identified:
• The solution has to comply with all security regulations and must ensure secure storage of the baggage after check-in
• The partners in the solution must make clear agreements on liability issues
• Additional service for the passengers; enabling a hassle-free journey with added value for passengers

Besides the requirements, airlines can also have interests and goals in participating in an off-airport baggage check-in solution:

• Operational advantage because peak loads can be reduced by early baggage collection
• Stimulation public transport usage and thereby creating a positive corporate image and increasing the catchment area

Passengers
Passengers are possibly the most important stakeholders in the introduction of off-airport baggage check-in. Therefore it is important to take the passengers wishes and requirements into account in the design of possible solutions. Passenger wishes have been discussed with Mr. Vaessen and Mr. Okèl, of Passenger Services at KLM Royal Dutch airlines. Furthermore, the annual Air Transport World Passenger Self-Service Surveys of SITA (2008; 2009) have been used to identify passenger wishes. This survey has been held among over 2000 respondents at six major airports around the world. Besides that, a study performed by Gilbert and Wong (2002) at Hong-Kong International Airport into passenger expectations has been used for identifying passenger wishes.

• The baggage check-in process needs to be clear and transparent
• Passengers must be able to retrieve their checked baggage in case of emergency
• It must be clear which company to contact in case of problems (only one company)
• It is preferable if passengers would not have to make an additional journey for the baggage check-in
• It is preferable if passengers do not have to hand in the baggage too long before departure
• The service should not be too costly for passengers

When the off-airport baggage check-in service meets the passengers’ wishes, the service can add value for the customer for several reasons:

• More convenience during the journey to the airport
• Less stress during the journey
• Easy usage of public transport to the airport
• Less waiting time at the airport before departure

Facility Host
For the facility host, it is important that the baggage check-in service does not interfere with any possible regular operations in the facility. The interests of possible hosts will probably be mainly financial ones; facilitating the baggage check-in service location will result in additional revenue for the host of the facility.
**Dutch Railways (NS)**
Introducing off-airport baggage check-in services for passengers traveling through Amsterdam Airport Schiphol can help improving the access of the airport through public transportation. The railway station at AAS is a typical hub station, trains travel through the station from different directions (Transportation Research Board, 2002). Currently, many passengers do not use the train as means of transportation to the airport because of the transits with baggage are experienced as hassles (Vaessen and Okèl, 2010). Currently, approximately 39 percent of all departing passengers uses the train as means of transport (Amsterdam Airport Schiphol, 2010c). For the Dutch Railways, participating in the off-airport baggage check-in service can help increasing the number of passengers traveling by train to AAS, thereby generating more revenue.

**Third-Party Logistics Provider**
In case a 3PL is used on the designed off-airport baggage check-in solution, this party will require clear agreements on liability issues. The possible benefits for the 3PL are additional business activities and thereby increased profits.

The requirements and wishes of the stakeholders as identified above will serve as inputs during the design of possible off-airport baggage check-in solutions. Furthermore, these requirements and wishes will be used to evaluate the suitability of each of the proposed solutions.

**General Requirements**
Next to the stakeholder specific requirements identified above, several general requirements are important in the design of an off-airport baggage check-in solution. Many of these requirements are based on safety and security regulations.

Based on the European Regulation 300/2008 and Annex 17 to the Chicago convention of 1944 on safety and security for civil aviation, the following requirements with respect to hold baggage can be identified (International Civil Aviation Organization, 2006; European Parliament and Council of the European Union, 2008):

- Baggage needs to be protected from interference by unauthorized persons once it has undergone the security checks or it has been accepted into the care of the airline, whichever is earlier.
- Baggage can only be loaded onto an aircraft if it is identified as accompanied, meaning the passengers needs to be on board of the same aircraft, or when it is identified as unaccompanied and has undergone additional security checks.

Furthermore, based on the interview with Mr. Derks, NCTB, it can be concluded that the concept needs to be approved by the airline, the airport and the appropriate authority before it can be implemented (Derks, 2010).
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Requirements</th>
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<tbody>
<tr>
<td>Airport</td>
<td>Not conflict with other operations</td>
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<tr>
<td></td>
<td>Comply with security regulations</td>
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<tr>
<td></td>
<td>Function according to specifications</td>
</tr>
<tr>
<td>Airline</td>
<td>Comply with security regulations</td>
</tr>
<tr>
<td></td>
<td>Clear agreements on liability</td>
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<tr>
<td></td>
<td>Service for passengers</td>
</tr>
<tr>
<td>Passengers</td>
<td>Clear and transparent process</td>
</tr>
<tr>
<td></td>
<td>Not too costly</td>
</tr>
<tr>
<td></td>
<td>No additional hassles</td>
</tr>
</tbody>
</table>

Based on the interviews held with representatives of the stakeholders and many different documents, the most important requirements of the different stakeholders have been identified. As mentioned in the previous chapter, the three most important stakeholders are airport, airline and passengers. These stakeholders will have most power in the development and execution of any off-airport baggage check-in concept. Table 4 presents an overview of the most important requirements of these stakeholders. In the following chapters, these requirements will be used in both developing and evaluating different off-airport baggage check-in concepts.
Chapter 3 – Concept Development

As discussed in Chapter 1, off-airport baggage check-in solutions can exist in many different forms. In this chapter, a set of possible solutions will be discussed. To arrive at the set of concepts that will be subject to further development, a creative brainstorm session is held with experts from QuinTech Engineering Innovations. In this brainstorm session possible locations for off-airport baggage check-in have been discussed, as have possible modes of transport and advantages and disadvantages of possible concepts. Besides that, possible concepts have been discussed with Mr. Vaessen and Mr. Okèl from KLM Royal Dutch Airlines in the interviews as mentioned in Chapter 2 (Vaessen and Okèl, 2010; van Reeden, 2010). Furthermore, the secondary literature studied for Chapter 1 has been used for the generation of possible concepts based on early initiatives.

In developing the concepts, assumptions with regard to passengers’ locations and modes of transport to the airport have been used. These assumptions have been based on information gathered by Amsterdam Airport Schiphol through annual surveys among passengers departing from the airport.

Concepts

Using the different sources described above, the following list of concepts has been developed.

- Baggage collection at specified address
- Baggage drop-off at local collection points
- Baggage check-in at major train stations throughout the country
- Baggage drop-off at AAS parking lots
- Baggage check-in at Schiphol train station

In this chapter, the five abovementioned concepts will be discussed. Besides a brief description of each of the concepts, top-level logistical models will be presented and briefly discussed. As mentioned in the Introduction, the logistical models will be developed using the Structured Analysis and Design Technique. This technique allows a breakdown of the logistical activities into different levels, each level being more detailed than the previous one. For each of the models, the purpose and the viewpoint need to be identified. The purpose indicates the function of the model while the viewpoint defines the perspective. Then, for each level the activities are defined in rectangular boxes. Arrows entering and exiting the boxes are used to indicate the inputs and outputs of the activities, as well as the required resources and the constraining controls (Marca and McGowan, 1988). For the models of this chapter, three levels of activities have been developed. The third level is detailed enough to identify the individual activities that will be used for the activity based costing process. In Figure 8, an example of a three-level SADT Model is presented. The top level is the so-called A-0 drawing. This drawing shows the overall model with the main inputs, outputs, resources and controls (ICOMs) and presents the purpose and viewpoint of the model. The second level is a breakdown of the model into the main activities, presented in the A0 drawing. In the example of Figure 8, the model can be split up into two main activities, represented by the two rectangular boxes in drawing A0. The third level shows breakdowns of the main activities identified in A0. The breakdown of the first main activity is shown in drawing A1, the second in A2 and so on. The arrows identified in drawing A-0 reappear in the lower level drawings and
represent the same ICOMs. For each of the concepts mentioned above, the three-level SADT models have been developed both from the service provider viewpoint as from the viewpoint of the passenger using the service.

For the development of the SADT models in this research, the software package BPWin © has been used. BPWin © is a process modeler especially equipped for IDEF0 (SADT), IDEF1 and IDEF3 modeling.

Passenger Distribution
Before going into the actual concepts, an explanation on passenger distribution is required. Amsterdam Airport Schiphol monitors the point of departure of its passengers by surveying departing passengers. To
categorize the departure locations, the airport uses COROP regions. COROP stands for the Dutch “Coördinatie Commissie Regionaal OnderzoeksProgramma” and is developed in 1971. The Netherlands is divided into forty COROP regions that are used by the Central Bureau for Statistics to present outcomes of researches. In Appendix E, the division of the COROP regions in the Netherlands is illustrated. Furthermore, Appendix E.2 shows the percentage of passengers departing from each COROP region (Amsterdam Airport Schiphol, 2010a; Centraal Bureau voor de Statistiek, 2010a). For the development of the different concepts, this division into COROP regions is used as well. It has been assumed that the passengers using the service are similarly distributed over the COROP regions as are all departing passengers.

**Baggage Collection Service**

Passengers departing from Amsterdam Airport Schiphol can check-in themselves online. In this process they can indicate they want to use the baggage collection service. The evening prior to departure the baggage will be collected at the address specified by the passenger. An airline representative accepts, weighs and labels the baggage. Passengers need to identify themselves. The baggage is loaded into a secure part of a van and is transport to AAS, where it is entered in the BHS. For this service, it is assumed that the entire check-in process will take place at the address specified by the passenger, including weighing and labeling the baggage.

**Logistical Model**

In order to identify all logistical activities in the baggage collection process, as well as the required resources and constraints, a logistical model of the process has been developed using the Structured Analysis and Design Technique (SADT). As mentioned, two models have been developed; one from the viewpoint of the service provider, one from the viewpoint of the passenger using the Baggage Collection Service (BCS). Both models can be found in Appendix F. Appendix F.1 shows that the process can be divided into four main steps; driving to the COROP area, collecting baggage at the addresses, driving back to Amsterdam Airport Schiphol and unloading the baggage at the airport. From Appendix F.2 it becomes clear that the passenger has to perform little logistical activities and does not require many resources, while the service provider has to perform many different activities of the baggage check-in process.

**Local Drop-Off Service**

Passengers departing from Amsterdam Airport Schiphol can check-in their baggage at a drop-off point in their home town. Since logistics service provider TNT has over 2000 service points located throughout the Netherlands and has an extensive logistical network in place, the TNT service points appear to be most suitable as drop-off points for the Local Drop-Off Service (LDOS).

Baggage can be checked in on the day prior to departure, during opening hours of the drop-off point. The baggage will be stored in locked storage rooms and during the night the baggage will be transported to Amsterdam Airport Schiphol. The distribution network of TNT Express will be used for the transportation of the baggage to the airport.
Assumptions:

- The service will be performed by third party logistics provider TNT
- All personnel required for the service is TNT personnel

Logistical Model

The logistical model for the drop-off of baggage at local TNT Service points can be found in Appendix G. Appendix G.1 presents the logistical activities the service provider, in this case TNT, needs to perform, while Appendix G.2 presents the activities the passenger needs to perform. Once again, the steps that passengers have to go through are relatively small. Nevertheless, passengers do have to take their baggage to the drop-off point.

Train Station Service

Passengers departing from Amsterdam Airport Schiphol can check-in their baggage at seven major train stations throughout the Netherlands: Amsterdam Centraal, Rotterdam Centraal, Den Haag Hollands Spoor, Utrecht Centraal, Eindhoven, Arnhem and Groningen.

These seven stations are chosen for several reasons:

1. The stations Amsterdam Centraal, Rotterdam Centraal, Utrecht Centraal and Den Haag Hollands Spoor are located in the COROP areas from which most passengers of Amsterdam Airport Schiphol (Amsterdam Airport Schiphol, 2010a).
2. The stations Eindhoven, Arnhem and Groningen are chosen because they are the largest stations located in the COROP areas from which most passengers of Amsterdam Airport Schiphol depart in the North, East and South of the Netherlands respectively (Amsterdam Airport Schiphol, 2010a; Treinreiziger.nl, 2010).

Passengers can check in their baggage up until three hours\(^1\) prior to departure. An airline representative accepts, weighs and labels the baggage. Passengers need to identify themselves and pay for the possible overweight of the baggage. Labeled baggage is stored until it is transported to the airport. The baggage is loaded into a secure part of a van. Baggage will be transported to AAS using vans, because the Dutch trains are not equipped for transporting baggage.

Assumptions:

- Only passengers departing from the COROP region of the train station will use the Train Station Service (TSS), because passenger departing from other COROP regions will depart from other train stations since every COROP region except for Zeeuwsch-Vlaanderen has a train station (Nederlandse Spoorwegen, 2010)
- Only passengers departing between 8.00 and 22.00 can use the service. This means opening hours of the check-in points between 5.00 and 19.00

\(^1\) Four hours for Groningen
Logistical Model
The logistical model for the check-in service at major train stations can be found in Appendix H.1 and H.2. The logistical activities from the viewpoint of the service provider are similar to the activities in the local drop-off service described in Appendix G. From the viewpoint of the passenger, the activities and required resources are also quite similar; the main difference is in the distance the average passenger needs to travel with the baggage.

Schiphol Parking Lot Service
Passengers departing from Amsterdam Airport Schiphol can check-in their baggage at the major long-stay parking lots of the airport. Passengers can do so up to two hours before departure. Check-in facilities similar to the ones inside the airport terminal are available at central locations on the parking lots. Passengers need to identify themselves and hand over the baggage. The baggage is labeled by airline personnel and is loaded into a truck. This truck transports the baggage to the entrance of the baggage handling system.

Assumption:
- Only passengers arriving at Amsterdam Airport Schiphol by own car will use the Schiphol Parking Lot Service (SPLS), because other passengers will not use the long-stay parking lots

Logistical Model
In Appendix I, the logistical model for this service is presented. Appendix I.1 presents the logistical activities from the perspective of the service provider, while Appendix I.2 provides the passenger perspective to the service. The logistical activities that passengers need to perform in order to use the service are similar to those in other drop-off services as described above, however the distance passengers need to cover with their baggage is larger than in the services described above.

Schiphol Station Service
The final concept that will be evaluated is the Schiphol Station Service (SSS); a service at the NS train station at Amsterdam Airport Schiphol. The train station at the airport is located below the terminal buildings at the same level as the baggage handling area. Passengers arriving by train at the airport can unload their baggage from the train and proceed towards the check-in area on the platform. Airline representatives check the identity of the passengers and accept and label the baggage. The baggage is then directly transported to the baggage handling area.

Assumptions:
- Only passengers arriving by train will use the service, because other passengers will not enter the train station
- The baggage check-in service can be linked to the new backbone of the Schiphol BHS that is currently being developed. Therefore, baggage can be transported without the need for human interference.

Logistical Model
The logistical activities required for the service at Schiphol train station are identified in the model in Appendix J. As mentioned, the transport of the checked baggage can take place without human
interference. In Figure 9, the location of the backbone is presented by the black line that connects all different areas. A baggage belt can connect the baggage check-in area at the train station with the backbone. In Appendix J.2, the logistical activities the passenger needs to perform are presented.

Figure 9 - Baggage Handling Area of AAS with backbone (Based on: Schiphol Group, 2010a)

All five concepts have been described on a top-level, using the SADT approach. In the following chapter, these concepts will be further analyzed using Activity Based Costing analyses and SWOT analyses. Based on these analyses, and the results of a market research performed by KLM Royal Dutch Airlines and a small passenger survey, the most suitable concept for the situation at Amsterdam Airport Schiphol will
be identified. This concept will be subject to further development with respect to logistics and cost structure.
Chapter 4 – Concept Evaluation

In this chapter, the concepts discussed in Chapter 3 will be assessed on their logistical and financial feasibility. Based on these assessments, the most suitable concept for the situation at Amsterdam Airport Schiphol will be identified. For the financial assessments, assumptions have been made regarding certain values of different variables. Where possible, the assumptions have been based on values used by KLM Royal Dutch Airlines and Amsterdam Airport Schiphol. In case these values were not available, assumptions have been based on information gathered by experts from QuinTech Engineering Innovations.

Analysis Method

For the different concepts, financial analyses will be performed using Activity Based Costing. Activity Based Costing is a technique that enables one to assign costs to specific activities based on the resource usage of the activities. In this chapter, Activity Based Costing will be used to evaluate the costs of actually operating each of the service concepts. Before going into the actual technique, firstly some terminology will be explained:

“Activities are tasks or sets of tasks that require the consumption or utilization of resources and result in the completion of a specific service, or in the physical transformation of a product from one state to another;
A cost object is the final good or service created as a result of the performance of an activity, or of a chain of activities;
Resources are the ingredients required for the production of a good or of a service. They are referred to, in their most basic form, as labour, material, and capital;
A cost driver is a variable that demonstrates a logical and quantifiable cause and effect relationship between the utilization of resources, the performance of activities, and the final cost object(s). ABC utilizes a multi-step cost assignment approach, in the first step, the resources consumed in the performance of activities are assigned to activities using resource cost drivers. In the following steps, resource costs accumulated within the activity centers are assigned to the final cost object(s) using activity cost drivers. For simplicity, we will use, instead of resource cost drivers and activity cost drivers, the terms resource driver and activity driver, respectively” (Themido, Arantes et al., 2000).

In each case, the cost object is the execution of the service concept. For every concept, a list of activities will be developed. This list of activities will be based on the second level (See Figure 8) of the logistical models developed using SADT as described in the previous chapter. Resource drivers will be used to link the utilization of resources to the specific activities. A list of resources and resources drivers are presented in Table 5. Furthermore, the costs for utilizing each of the resources are identified. The activity driver will be used to assign activity costs to the total costs of operating the service; the cost object. In Figure 10 a graphical representation of the Activity Based Costing approach is presented. The activity driver in the concepts will be the number of passengers using the service. This number will be varied and using a simplified mathematical model, the costs of operating each of the concepts will be estimated. For the mathematical model, several assumptions have been used:
• Initial investments in vans and trucks for transportation are not incorporated in the cost structure.
• The geographical distribution of passengers using the service is assumed to be similar to the geographical distribution of all departing passengers of Amsterdam Airport Schiphol (Amsterdam Airport Schiphol, 2010a) (See Appendix E)
• Forty percent of all departing passengers travels with KLM Royal Dutch Airlines or a SkyTeam partner (Schiphol Group, 2009)
• Sixty percent of all departing passengers is carrying hold luggage (vander Meûlen, 2010)
• The average check-in process at a drop-off location, including passengers identification and baggage check-in, takes two minutes (vander Meûlen, 2010)
• Unloading baggage at the airport will take an average of 30 seconds per piece of baggage
• Transport of baggage is performed in vans with an average storage compartment in which 20 pieces of baggage will fit (Mercedes Benz, 2009; Ross, 2009)
• Vans are expected to drive with an average speed of 80 km per hour on the highway

Besides these general assumptions, some concept specific assumptions have been used. These will be clarified in the respective concept analysis. Based on these assumptions, and the resources identified in Table 5, the costs of operating the service will be calculated using Equation 1 and Equation 2.

\[ \text{Equation 1 - Costs per Activity} \]
\[ \text{Costs of Activity} = \text{Labour Costs} + \text{Fuel Costs} + \text{Label Costs} \]

\[ \text{Equation 2 – Total Cost Calculations} \]
\[ \text{Costs per Bag} = \frac{\sum \text{Costs of Activities}}{\text{Total Number of Bags}} \]

<table>
<thead>
<tr>
<th>Resource</th>
<th>Resource Driver</th>
<th>Resource Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>Hours of work</td>
<td>€ 22,- (^2) per hour (KLM, 2007)</td>
</tr>
<tr>
<td>Fuel</td>
<td>Kilometers</td>
<td>€ 0.151 (^3) per kilometer</td>
</tr>
<tr>
<td>Labels</td>
<td>Pieces of Baggage</td>
<td>€ 0.15 per piece of baggage</td>
</tr>
</tbody>
</table>

Figure 10 - The Activity Based Costing Approach (Based on: van Damme, 2001)

\(^2\) The resource costs for labour include a fifteen percent overhead and five percent sick leave charge and are based on the monthly salary of an A-07 KLM Ground Employee in step 13
\(^3\) Based on fuel prices of July 7th 2010 and an average usage of 1 liter of diesel for 8 kilometers
As mentioned, SWOT analysis has been widely used in developing business strategies and evaluating concepts, but is not without criticism. (Hill and Westbrook, 1997; Valentin, 2001). In order to make the SWOT analysis of the concepts meaningful, the strengths, weaknesses, opportunities and threats will be based on the requirements identified in Chapter 2.

**Concept Analysis**

The following section will focus on individually analyzing all of the concepts according to the method described above. The results of these analyses will be used to evaluate which of the concepts is most suitable for the situation in the Netherlands, what weaknesses need to be corrected for, and what threats need to be averted.

**Baggage Collection Service**

To assess the feasibility and the suitability of the baggage collection service concept, a SWOT analysis and a financial analysis have been performed. The results of these analyses are compared with the requirements identified in Chapter 2.

**Financial Analysis**

Based on the logistical model developed in the previous chapter, a list of activities can be developed for the Baggage Collection Service. These activities can be linked to the resources that are utilized for the activities. An overview is presented in Table 6. Using a simplified mathematical model, the costs of executing each of the activities will be calculated. Furthermore, the total costs per piece of baggage for operating the Baggage Collection Service will be determined.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Required Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive to COROP region</td>
<td>Labour, Fuel</td>
</tr>
<tr>
<td>Baggage Collection</td>
<td>Labour, Fuel, Labels</td>
</tr>
<tr>
<td>Drive to AAS</td>
<td>Labour, Fuel</td>
</tr>
<tr>
<td>Deliver Baggage</td>
<td>Labour</td>
</tr>
</tbody>
</table>

Besides the general assumptions clarified above, some additional assumptions have been made for the determination of the cost structure:

- All collections will take place within a time window of two hours
- On average, a driver can collect six pieces of baggage within these two hours (See Appendix K)
- Each driver will be assigned to a specific COROP region and will not perform collections in other regions

These assumptions will be used in a mathematical model that will be developed in Matlab, a numerical computing environment. For percentages of the target group using the activity, the activity costs and total costs per piece of baggage will be determined. For the Baggage Collection Service, the target group consists of all departing passengers. The results for the total costs per piece of baggage are displayed in Figure 11. The costs per activity are displayed in Appendix F.3.
From Figure 11 it becomes clear that if the percentage of passengers using the service increases, the costs per piece of baggage significantly decrease. If the percentage of the target group using the service is above approximately ten percent, the costs per piece of baggage are close to € 20,-. The high initial costs can be explained by the underutilization of vans and drivers in the relatively small COROP regions. The line in Figure 11 is not a totally smooth line; little peaks are visible at approximately 12, 24 and 36 percent. Two causes can be identified for these peaks. First of all, it might be caused by a change in the number of vans required. At certain percentages, an additional van will be needed that is underutilized. This will cause an increase in the costs per bag. Furthermore, the discrete nature of the script used for the cost assessments inhibits a totally smooth function.

SWOT Analysis
To assess the suitability of each of the concepts a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis has been performed. To make the SWOT analysis meaningful, it has been performed from the different stakeholder perspectives as identified in Chapter 2.

Airport – From the perspective of Amsterdam Airport Schiphol, the main strength of the baggage collection service is that it is an actual service for passengers; passengers do not have to travel to check-in their baggage. The most important of the opportunity of the service concept is in the possibility to expand easily and reach all departing passengers. The possible size of the target group allows the airport to increase its passenger handling capacity without the need of building an additional terminal. Another possible opportunity is one that might contribute to the corporate image of the airport. If passengers
that use the collection service will use the train to travel to the airport, the service might contribute to the green image of the airport.

Airline – From the airline perspective, the main threat of the service is in the security and liability field. According to European legislation, the baggage has to be protected from unauthorized interference once it has been accepted into the care of the airline. This means that when the airline provides or outsources the collection service, the baggage needs to be secured once it has been collected. If the airline outsources the service, liability issues might pose a threat for the service as well. The main opportunity of the service is in the fact that the potential target group is significant (all departing passengers can use the service) and therefore the amount of baggage that can be processed during non-peak hours can help reducing the peak loads in baggage processing.

Passengers – From a passenger perspective, the main strength of the service is in the fact that passengers do not have to travel to check-in their baggage. Besides that, passengers do not have to spend as much time at the airport, because baggage is already processed during the night. Passengers can arrive up to an hour before departure. The main threat from a passenger perspective is that it might be unclear which company to contact in case of problems, especially when the service is outsourced to a 3PL.

Dutch Railways – From the perspective of the NS, an opportunity of the service might be an increase in the number of passengers traveling to the airport by train.

3PL – For the third party logistics provider, the main opportunity of the service is in the possible target group. Since all departing passengers will be able to use the service, the possible market size is significant. This might result in an increase in revenue for the 3PL. The main threat of the service is the difficulty concerning liability issues.

General Requirements – Based on the general requirements, the possible threat to the service is that of interference with the baggage during transport. A possible weakness is that if the service is outsourced to a 3PL, personnel might need expensive training as defined in the European regulation concerning the security of civil aviation (European Parliament and Council of the European Union, 2008).

The most important internal and external factors identified above are summarized in Table 7.

Table 7 - SWOT Analysis for Baggage Collection Service

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>High service level for passenger</td>
<td>Passenger has to check-in baggage a day prior to departure</td>
</tr>
<tr>
<td>Baggage arrives early at airport</td>
<td>High initial investments</td>
</tr>
<tr>
<td>Significant target group</td>
<td></td>
</tr>
<tr>
<td>Opportunities</td>
<td>Threats</td>
</tr>
<tr>
<td>Easy to expand the service</td>
<td>Possible interference with baggage after check-in</td>
</tr>
<tr>
<td>Possibly promote green image</td>
<td>Uncertainty regarding the process and liability issues</td>
</tr>
</tbody>
</table>

Local Drop-Off Service

For the drop-off service at local TNT service points, the financial analysis and SWOT analysis have been performed as well.
Financial Analysis
For the Local Drop-Off Service, activities and required resources can be identified in a similar way. Table 8 presents the activities as defined in the SADT model and the resources linked to these activities. For the financial analysis, some data was required from TNT. Therefore, a face-to-face interview has been held with Mr. Schipper, Manager Sales Sameday of TNT Express. The interview has been set up in a similar way as the interviews with KLM managers and the AAS manager. Again, to prevent the possible effects of researcher’s bias, the interview has been held together with ir. R. vander Meûlen of QuinTech Engineering Innovations and the transcript of the interview, which can be found in Appendix C.2, has been sent to Mr. Schipper for approval. The protocol for the interview, which can be found in Appendix C.1 has been set-up in such a way that it covers the possible concepts in which a third-party logistics provider as TNT could play a part.

Table 8 - Activities for Local Drop-Off Service

<table>
<thead>
<tr>
<th>Activities</th>
<th>Required Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check in Baggage</td>
<td>Labour, Labels</td>
</tr>
<tr>
<td>Transport Baggage</td>
<td>Labour, Fuel</td>
</tr>
<tr>
<td>Deliver Baggage</td>
<td>Labour</td>
</tr>
</tbody>
</table>

During the interview, Mr. Schipper indicated that even though the service would be financially feasible, the main problem with the concept would be security. Many of the TNT service points are being located in other shops in the Netherlands and are being operated by employees of those shops. Furthermore, the shops often have little or no secured storage space. Based on the advice of Mr. Schipper and in consultation with ir. R. vander Meûlen of QuinTech, it has been decided not to focus on the cost structure of the Local Drop-Off Service.

SWOT Analysis
Even though the financial analysis has not been executed, a SWOT analysis has been performed in which the supportive and the unfavorable factors of the Local Drop-Off Service are determined and discussed below.

Airport – From an airport perspective a strength of the service is that passengers only have to travel to a local drop-off point with their baggage, and can travel to the airport without many hassles of baggage. Besides that, the service uses a logistical network that is already in place. The service offers opportunities to increase capacity, because all departing passengers can use the service (except for last-minute business travelers). Furthermore, the service might stimulate passengers to travel to the airport by train, thereby improving the corporate image of the airport and possible increasing the catchment area. The main threat of the service is in the large transport distance and the many loading and unloading activities. These activities are sensitive to unauthorized human interference with baggage that has been checked in.

Airline – For the airline, the service’s main strengths are the early arrival of baggage and the hassle free journey for passengers that is offered. The main threats are similar to those for the airport; security issues need to be dealt with, which is difficult and costly as indicated by Mr. Schipper (Schipper, 2010). Furthermore liability might become problematic when multiple companies are involved in the
service. Improving the corporate image of the airline is one of the most important opportunities the service offers.

**Passengers** – For passengers, the main strength of the service is that it enables a hassle free journey to the airport on the day of departure. A downside of the service is the fact that passengers have to check-in their baggage a day prior to departure and that they have to make an additional journey, though probably a small one, to the TNT service point. A threat posed by the service is that it might be unclear for passengers whom to contact in case of problems.

**Dutch Railways** – From the perspective of the Dutch Railways, this service offers opportunities to increase the number of passengers traveling to AAS by train. Since the rest of the service is operated without the use of the railway network, this service does not threaten any regular operations of the Railways.

**3PL** – For TNT, this service can generate business and thereby revenue. Since it uses the existing logistical network, it will require little initial investments from the company. The main threat for TNT exists in liability and security issues, similar to those for the airline.

**General Requirements** – Since the logistical activities are quite similar to those of the collection service, the SWOTs with respect to the general requirements are nearly the same. The main threat is in unauthorized interference with checked baggage during the transportation or cross-docking of the baggage. Furthermore, the training of TNT employees might be costly and difficult in case of high employee turnover rates.

Table 9 presents an overview of the main issues identified above.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>High service level for passenger</td>
<td>Passenger has to check-in baggage a day prior to departure</td>
</tr>
<tr>
<td>Baggage arrives early at airport</td>
<td>Passengers have to make an additional journey</td>
</tr>
<tr>
<td>Significant target group</td>
<td>No secured storage space</td>
</tr>
<tr>
<td>Uses existing logistical network</td>
<td>No TNT personnel in the service points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to expand the service</td>
<td>Possible interference with baggage after check-in</td>
</tr>
<tr>
<td>Improve corporate image</td>
<td>Uncertainty regarding the process and liability issues</td>
</tr>
</tbody>
</table>

**Train Station Service**
For the check-in service at seven major train stations, Amsterdam Centraal, Rotterdam Centraal, Utrecht, Den Haag Hollands Spoor, Eindhoven, Arnhem and Groningen, similar analyses have been performed as for the other services.

**Financial Analysis**
For the ABC analysis, the list of activities as identified in the logistical model has been presented in Table 10 including the required resources for each activity. In the mathematical model the following assumptions have been used:
• Only passengers who will depart from one of the seven COROP regions in which the train stations are located will use the service
• Forty percent of all passengers uses the train to get to the airport (Amsterdam Airport Schiphol, 2010c), only part of these passengers will use the service
• The distribution over the day of passengers using the service is equal to the distribution of departing passengers over the day (Amsterdam Airport Schiphol, 2010b)

Based on the assumptions defined above, the target group for the Train Station Service can be defined as all passengers departing from the seven COROP regions in which the train stations are located and are traveling to the airport by train.

**Table 10 - Activities for Train Station Service**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Required Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check in Baggage</td>
<td>Labour, Labels</td>
</tr>
<tr>
<td>Transport Baggage</td>
<td>Labour, Fuel</td>
</tr>
<tr>
<td>Deliver Baggage</td>
<td>Labour</td>
</tr>
</tbody>
</table>

Besides the resource utilization of the defined activities, fixed costs of renting the check-in facilities have been incorporated as well. However, these costs are not attributed to any of the activities and are only included in the total costs per piece of baggage. The fixed costs of renting the facilities are approximately € 735,- per year per m² (Hueber, 2010). In Figure 12 these costs per piece of baggage for different numbers of passengers using the service are presented. In Appendix H.3 the costs of the individual activities are presented.
The fixed costs of renting the facilities are clearly visible in Figure 12. The costs per piece of baggage exceed € 100,- for small percentages of users. Only above thirty percent of the target group, the costs per bag are below € 20,-. The service is therefore considerably more expensive than the Baggage Collection Service, because of the high fixed costs for the rental of the drop-off locations.

**SWOT Analysis**

For the train station check-in service, the design requirements have been evaluated as well. The results of the SWOT analyses are presented below from the different stakeholder perspectives.

**Airport** – From the airport perspective, the service can meet all the design requirements. The main weakness of the service is that the service targets only the group of passengers departing from the six COROP regions. The most important opportunity from the airport perspective is that the service might promote using the train as a mode of transport to reach the airport, thereby improving the corporate image of the airport.

**Airline** – From an airline perspective the main opportunity is the same as for the airport; improving the corporate green image. The main threat is again in security and liability. Since the baggage needs to be transported from the train stations to the airport, the threat of unauthorized interference with the baggage exists. A weakness of the service is that it will not help reducing peak loads, since baggage of passengers using the service will not arrive earlier than baggage of passengers checking-in in the airport terminal.

---

Figure 12 - Costs of Operating Train Station Service
Passengers – From a passenger perspective, the main strength of the service is that passengers do not have to check-in their baggage a day prior to departure. Downside of this service is that passengers have to travel to the train station with their baggage.

Dutch Railways – For the Dutch Railways, the service offers opportunities with respect to the number of passengers using the train. A threat might be that the check-in process at the train station might result in congestion in the stations and thereby interfere with regular operations.

3PL – The main strength of the service from the perspective of the 3PL is that the service can result in an increase in revenue for the 3PL. The main threat of the service is the difficulty concerning liability issues.

General Requirements – Based on the general requirements, the possible threat to the service is that of interference with the baggage during transport. A possible weakness is that if the service is outsourced to a 3PL, personnel might need expensive training as defined in the European regulation concerning the security of civil aviation (European Parliament and Council of the European Union, 2008).

The most important strengths, weaknesses, opportunities and threats of the check-in service at major train stations are summarized in Table 11.

### Table 11 - SWOT Analysis for the Check-In Service at Major Train Stations

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-in on day of departure</td>
<td>Service cannot target all passengers</td>
</tr>
<tr>
<td></td>
<td>Baggage does not arrive early</td>
</tr>
<tr>
<td></td>
<td>Passenger needs to travel to the station with baggage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase number of passengers using the train</td>
<td>Possible interference with baggage after check-in</td>
</tr>
<tr>
<td>Improve corporate image</td>
<td>Uncertainty regarding the process and liability issues</td>
</tr>
<tr>
<td></td>
<td>Possible interference with regular operations at the train stations</td>
</tr>
</tbody>
</table>

Schiphol Parking Lot Service

For the option of checking in baggage at the long-stay parking lots of AAS, the financial and SWOT analyses have been performed.

### Financial Analysis

The different activities identified in the logistical model of the Schiphol Parking Lot Service are shown in Table 12. Different resources defined above are linked to the different activities. Using a similar mathematical model as for the previously described concepts, the costs of executing the different activities have been determined for different percentages of the target group using the service. For this service, it has been assumed that only people arriving at the airport by own car will use the service; the target group therefore consists of approximately 15 percent of all passengers (Amsterdam Airport Schiphol, 2010c).
### Table 12 - Activities for Schiphol Parking Lot Service

<table>
<thead>
<tr>
<th>Activities</th>
<th>Required Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check In Baggage</td>
<td>Labour, Labels</td>
</tr>
<tr>
<td>Transport Baggage</td>
<td>Labour, Fuel</td>
</tr>
<tr>
<td>Deliver Baggage</td>
<td>Labour</td>
</tr>
</tbody>
</table>

In Figure 13 the costs per piece of baggage of operating the Schiphol Parking Lot Service are displayed. The costs per bag are considerably lower than for the Baggage Collection Service and the Train Station Service. If more than five percent of the target group uses the service, the costs per piece of baggage are below € 5.-. Again, because of the discrete function, the line presented in Figure 13 is not totally smooth.

![Costs of Operating Schiphol Parking Lot Service](image)

**Figure 13 - Costs of Operating Schiphol Parking Lot Service**

### SWOT Analysis

The financial analysis and the design requirements identified in Chapter 2 will serve as inputs for the SWOT analysis of the parking lot check-in service.

**Airport** – From an airport perspective this service has as main weakness that it is only a partial service, since passengers still have to travel to the airport with their baggage. The main threat of the service is that it might deteriorate the corporate image of the airport, since it promotes traveling to the airport by car. Furthermore it might interfere with regular parking operations, resulting in congestion at the parking lots.
Airline – From the perspective of the airline the main strengths of the service is that due to the small distance to the BHS, transportation security and liability issues are less significant than with the other services. A weakness is that the passengers are not offered a fully hassle-free journey. And as for the corporate image, the same holds as for the airport, so that is a threat.

Passengers – Based on the passengers’ views, the service has as main strengths that it is relatively cheap and passengers do not have to check-in their baggage a day before departure. Another strength of the service is that it is clear which company to contact in case of problems. The main weakness is that the passengers need to travel to the airport parking lot with their baggage. This requires passengers to own or borrow a car if they want to use the service.

Dutch Railways – For the Dutch railways, this service is mostly a threat since it promotes using the car as means of accessing the airport. This might result in fewer passengers using the train to get to the airport.

3PL – Most likely this service will be operated without the use of a third party logistics provider, since the transportation over 4.1 kilometers by truck can be performed by airline or airport personnel. Nevertheless, in case a 3PL is used for the service the main opportunity of the service is that it is easily expandable if the number of passengers grows.

General Requirements – The strength of the service with respect to safety and liability requirements is that the possibility of interference is minimal due to the short transport distance. If desirable, the transport can be performed entirely without human interference, however this would result in higher costs.

Table 13 summarizes the most important internal and external factors that determine the achievability of the service.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-in on day of departure</td>
<td>Baggage does not arrive early</td>
</tr>
<tr>
<td>Little chance of unauthorized interference</td>
<td>Passenger needs to travel to the AAS Parking Lot with baggage</td>
</tr>
<tr>
<td>Relatively cheap service</td>
<td>Passenger needs a car</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to expand if the number of passengers grows</td>
<td>Possibly harm corporate image</td>
</tr>
<tr>
<td>Transport after check-in without human interference is possible</td>
<td></td>
</tr>
</tbody>
</table>

Schiphol Station Service

The final concept, checking in baggage at the NS train station underneath the terminal buildings of Amsterdam Airport Schiphol is also analyzed on financial aspects and a SWOT analysis has been performed based on the design requirements of Chapter 2. The results are discussed below.

Financial Analysis

The activities identified at level 2 of the logistical model for this service concept are listed in Table 14. Each of these activities requires one or more resources as identified. The costs of each of the activities have been determined using a simplified mathematical model. For these calculations it has been assumed that the target group consists of only passengers arriving at the airport by train will use the
Using the activity driver, the number of passengers using the service, the costs per piece of baggage have been determined. Again, the fixed costs of renting the facility have not been attributed to the activities and are only incorporated in the total costs. The results are shown in Figure 14.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Required Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check In Baggage</td>
<td>Labour, Labels</td>
</tr>
<tr>
<td>Process Baggage</td>
<td>Labour</td>
</tr>
</tbody>
</table>

The costs of operating the Schipol Station Service are comparable to the costs for the Schiphol Parking Lot Service. The costs are relatively low due to the small transport distances. However, this service will probably require high initial investments in order to connect the check-in service to the main BHS of the airport.

**SWOT Analysis**

*Airport* – From the airport perspective this service’s main strength is that it can be operated without disturbing other airport operations. Besides that, there is no need for human interference in transport, so security issues will not form a problem. An opportunity for the airport is the possible improvement of the corporate image, since the service is aimed at passengers using the train. An important weakness in the service is the fact that it is not a full service; passengers still have to travel to the Schiphol train station with their baggage.
Airline – Based on the airlines requirements, this service meets all requirements. Security and liability issues are easily solved because little transportation takes place; the entire service can be operated by the airline. Downside is that the service is, as mentioned, only a partial service for passengers. Nevertheless, the service can contribute to the corporate image of the airline.

Passengers – From the passengers’ viewpoint, the main weakness of this service is that they still have to travel to Schiphol train station with their baggage. For passengers that need to make a transition from one train to another, this can be quite a hassle. Furthermore, the service is rather expensive compared to the parking lot service. The main strength of the service is that the process is very transparent; passengers do not have to worry about baggage not arriving on time at the airport.

Dutch Railways – For the Dutch railways, this service offers opportunities with respect to the number of passengers traveling by train to the airport. If more departing passengers start using the train to reach the airport, this will result in additional revenues for the Dutch Railways. Nevertheless, the service should not interfere with regular operations of the Dutch Railways, for example due to congestion at the platforms.

3PL – For this service no external logistics provider will be required.

General Requirements – With respect to safety, the main strength of this service is that transport is performed over short distances and can be done without human interference. This means that complying with security regulations is not a problem. Furthermore, since a central collection point is used, the service can be operated by airline employees. This means no additional employees need to be hired and trained for the service.

Table 15 summarizes the main issues discussed above in the SWOT analysis.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check-in on day of departure</td>
<td>Baggage does not arrive early</td>
</tr>
<tr>
<td>Transport without human interference</td>
<td>Passenger needs to travel to the Schiphol train station with baggage</td>
</tr>
<tr>
<td></td>
<td>Relatively expensive, partial service</td>
</tr>
<tr>
<td></td>
<td>High initial investments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve corporate image</td>
<td>Possible interference with regular railway operations</td>
</tr>
</tbody>
</table>

Concept Evaluation

Based on the analyses performed for all five concepts, the concepts will be evaluated below. For each of the stakeholders, the most promising concept will be identified. Furthermore, a small survey will be used to identify passenger preferences towards any of the concepts. This survey is a web-based questionnaire held among 42 respondents. To ensure the face validity, whether the questionnaire is understood by the respondents in the way intended by the researcher, two interviews have been held. In these interviews, the questionnaire has been discussed with non-experts that were not involved in any other part of the research. Based on these interviews, the questionnaire has been adapted. The final version of the questionnaire can be found in Appendix L. However, because of the small sample of
respondents, it is difficult to assess the reliability of the survey (van der Velde, Jansen et al., 2004). Therefore, an internal study performed by KLM Royal Dutch Airlines among approximately 1200 respondents on remote baggage check-in will also be used in the evaluation of the different concepts. This evaluation will lead to the selection of the most suitable concept based on costs and design requirements.

![Costs per piece of baggage for the different concepts](image)

**Figure 15 - Costs of operating the different service concepts**

As described in this chapter, the costs of operating four of the five concepts have been assessed using Activity Based Costing. In Figure 15 the cost functions of the four concepts are presented in one graph. It becomes clear that the Schiphol Station Service and the Schiphol Parking Lot Service are significantly cheaper than the other two services. Especially for the Train Station Service, a high percentage of the target group needs to use the service to obtain a reasonable price per bag. This is certainly a disadvantage of the service.

From the airport perspective the most important criterion is that the service is functioning well without a negative impact on other airport operations. Furthermore the service should be in line with the AAS marketing strategy. Therefore, the Baggage Collection Service and the Local Drop-Off Service, as well as the Schiphol Station Service, are suitable services from the airport’s perspective. However, for the first two service concepts, security issues need to be resolved.
From the airline perspective security and liability issues are very important. Besides that, the service should enable passengers to travel hassle free to the airport. Both the Baggage Collection Service and the Local Drop-Off Service enable passengers to travel hassle free to the airport, however the Local Drop-Off Service introduces the hassle of an additional travel to the drop-off point. For both services, issues with security and liability need to be resolved. The Schiphol Station Service is a service that can be operated without the security and liability issues; however this service requires passengers to travel to Schiphol train station with their baggage.

Based on the passenger requirements of Chapter 2, a suitable service is a full service that is not too costly and in which it is clear which company is liable in case of problems. None of the service concepts of Chapter 3 meets all the requirements. The Baggage Collection Service is an extensive service that allows passengers to travel the entire journey to the airport without carrying baggage. However, this service is more costly and possibly more complex with respect to liability issues. The Schiphol Station Service is a relatively cheap service in which liability issues are easily dealt with, however this service is only a partial service for a smaller target group.

For a possible third-party logistics provider it is important that liability issues are dealt with and that the service can generate profits for the company. This means that the size of the target group is an important criterion. Especially the Baggage Collection Service and the Local Drop-Off Service are service concepts that target all departing passengers, except for business passengers that do not know when they will depart in advance.

For the Dutch Railways it is important that the service concept does not disrupt regular railway operations. Furthermore, it is desirable that the service enables passengers to travel to the airport by train without the hassles of carrying the baggage. This means that the Schiphol Parking Lot Service is the only service that is definitely not among the desirable concepts from the perspective of the NS.

**Passenger Preferences**

Many different studies into passenger preferences with respect to remote baggage check-in have been performed. For this research, a small web-based survey has been held amongst 42 respondents. In this survey, the respondents have been asked to identify whether they would like to use any of the off-airport baggage check-in concepts developed in this research and which of the concepts they would prefer. In Appendix L the full survey and the graphical representation of the answers can be found. Below, in Figure 16 and Figure 17 the most important findings are presented. From Figure 16 it appears that most of the respondents would not consider using the Local Drop-Off Service and the Train Station Service.
From Figure 17 it can be concluded that most of the respondents would prefer the Baggage Collection Service of the other four service concepts.

Though the group of respondents is not necessarily a representative sample of the entire population, namely passengers departing from AAS, the results correspond with the results of a market research performed by KLM Royal Dutch Airlines in 2007. In this research, passengers could identify whether they would use any of the four following services:

- Pickup of baggage at home and delivery at a destination airport
- Pickup of baggage at home and delivery at final destination
- Drop-off of baggage at central location and delivery at destination airport
• Drop-off of baggage at central location and delivery at Amsterdam Airport Schiphol

Thirty percent of the passengers indicated that they would use the first service, 23 percent would use the second service and less than 15 percent indicated they would like to use any of the latter two services. Furthermore, the respondents indicated that they would find a price between € 15,- and € 31,- acceptable for a pickup service.

A study performed by Merten (2009), among 1400 passengers at Berlin airports has indicated that over fifty percent of the passengers are willing to use a baggage pick-up service and are willing to pay for it, while less than forty percent is willing to pay for a service in which baggage can be checked in at central drop-off locations.

Based on the SWOT analyses from the perspectives of the three most important stakeholders, airport, airline, and passengers, and based on the passenger preference identified in three surveys, the Baggage Collection Service appears to be the most suitable and promising concept for the situation at Amsterdam Airport Schiphol. However, there are still some weaknesses and threats that need to be overcome. In the following chapters, the Baggage Collection Service will be subject to further development with respect to logistics and costs.
Chapter 5 – Process Improvements

In the previous chapter, the Baggage Collection Service has been identified as the most suitable concept for the situation in the Netherlands. The final phase of this research will be focused on how to organize the service. The service can be provided by a third-party logistics provider with an extensive logistics network, but it can also be performed by an airline such as KLM Royal Dutch Airlines. The final sub-research question defined in the Introduction is focused on this question. The following chapters will be focused on how to organize the service when it will be performed by the airline. Before going into the logistical and financial aspects of operating the service, this chapter will be devoted to describing the activities that need to be performed by the service provider. However, first some improvements to the process described in the previous chapter will be suggested.

The SWOT analysis performed for the Baggage Collection Service has revealed some weaknesses and threats in the original service concept that need to be dealt with. In Table 16, the results of the SWOT analysis are presented again. In this section, possible solutions for the weaknesses and threats will be discussed. To arrive at these possible solutions, analogous systems that have dealt with similar problems have been identified. Furthermore, information gathered from the interviews with stakeholder representatives as discussed earlier has been used.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>High service level for passenger</td>
<td>Passenger has to check-in baggage a day prior to departure</td>
</tr>
<tr>
<td>Baggage arrives early at airport</td>
<td>High initial investments</td>
</tr>
<tr>
<td>Significant target group</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>Easy to expand the service</td>
<td>Possible interference with baggage after check-in</td>
</tr>
<tr>
<td>Possibly promote green image</td>
<td>Uncertainty regarding the process</td>
</tr>
</tbody>
</table>

High Investments

Because the investments in fixed assets such as vans, trucks and IT infrastructure will be relatively high, starting the service is costly and not without risks. In order to minimize this risk, it is possible to outsource the service to a third-party logistics provider. Besides outsourcing the service, it is also possible to start a pilot service in specific area, such as the Randstad. Both options will decrease the initial investments required and therefore minimize the risks of introducing the service. In the following section, these options will be addressed. Investments in hardware such as label printers can be minimize by using a central label printer at Amsterdam Airport Schiphol. For all passengers that have applied for the service on a particular day, labels are printed at the airport. Drivers that depart to the different regions will bring along the labels for the specific regions. Downside of this might be that if labels are damaged during transport to the region, no alternative label can be printed.
Early Baggage Hand-In
A possible weakness of the Baggage Collection Service is that passengers have to hand in their baggage one day prior to departure. Some of the respondents of the web-based passenger survey commented that this would be a disadvantage of the service.

A solution to this problem might be the introduction of two different pick-up moments. For the flights that depart before 14.00 hours, baggage will be collected on the evening prior to departure. However, for flights departing after 14.00 hours, passengers can choose for either pick-up on the evening prior to departure, or pick-up in the morning on the day of departure. In this way, passengers do not necessarily have to hand in their baggage a day prior to departure and less investment in equipment such as vans for collection is required.

Interference with Baggage
The most severe threat to the service is the possibility of interference with baggage after the check-in. Valuable items could be stolen from passengers, or drugs could be placed in people’s baggage. In the current situation, passengers can use seals to protect their baggage from interference. This concept can also be used for the Baggage Collection Service. Baggage that is collected by a driver can be sealed in the presence of the passenger, using a unique number or barcode. When the baggage is delivered at the airport, a representative of the airline checks whether all seals are intact and signs for acceptance. In this way, the threat of interference is reduced significantly.

Uncertainty Regarding the Process
One of the critical issues with respect to introducing off-airport baggage check-in is transparency. Passengers need to know what will happen with their baggage before they will use the service (Sharp, 2004). Therefore it is necessary to clearly specify the process and all requirements and restrictions to it on the website of the airline. Furthermore, it is recommended that passengers are notified once the baggage has arrived at the airport and is entered into the baggage handling system, for example via SMS. Finally, after a pre-specified period, the results of the service with respect to mishandled baggage should be published.

Besides the threats and weaknesses identified in the SWOT analysis, opportunities have also been revealed. Below, suggestions to exploit these opportunities will briefly be discussed.

Distribution Centers
Because of the large size of the target group, almost all departing passengers, the flow of baggage might become very large. Dividing the country into different regions with cross-dock locations can help dealing with the flow. At these cross-dock locations, baggage will be unloaded from the vans and loaded into trucks. Therefore, a parking place that can accommodate the vans and trucks will be sufficient. From here on, the cross-dock locations will be called distribution centers. If transport of baggage from the distribution centers to the airport is performed with trucks instead of vans, the pollution of the service can be decreased and the green image of the airline can be improved. For these reasons, the introduction of distribution centers will be incorporated in the design of the logistics network.
Train Ticket
Because passengers do not have to carry baggage to the airport, they might be more willing to use the train as mode of transport. Therefore it might be interesting to involve the Dutch Railways in the service concept and offer the service in combination with a railway ticket.
Because introducing such a combination would require additional time and resources and would mean developing a new business model, this option will not be taken into consideration in the rest of this research. Nevertheless, it is an interesting option that can examined in the follow-up of this research.

Process Description
Based on the suggestions to improve the concept of the Baggage Collection Service, the process can be described using the Structured Analysis and Design Technique. The first two levels (A-0 and A0) of the SADT model will be developed for the service. The A0 representation of the SADT model can be found in Figure 18. The full model can be found in Appendix M. The main purpose of the SADT model will be to identify all activities that an airline needs to perform in case it does not use a third-party logistics provider. Below, the activities of the A0 representation are briefly discussed.

Label Printing & Vehicle Routing
Before drivers are sent to collect baggage of passengers that have applied for the service, labels for each of the passengers are printed. Furthermore, routes for the drivers that perform the collection activities are determined using vehicle routing software.

Driving to Distribution Centers
Empty trucks drive to the different distribution centers. As mentioned, truck drivers will transport the baggage labels.

Driving to Collection Areas
From each of the distribution centers, vans will drive to specific areas in which they will perform the baggage collections. These areas are determined by the vehicle routing software.

Performing Collection
During the time window of two hours, the drivers will perform a number of collections at the addresses specified by the passengers. Passengers will identify themselves, baggage will be labeled and sealed and a claim tag will be given to the passenger. The baggage will be loaded into the vans.

Driving back to Distribution Centers
Once all collections have been performed, the drivers will return to the distribution centers with the baggage of the passengers.

Cross-Docking at Distribution Centers
At the distribution center, the vans will be unloaded. The truck driver will use a check-list to assess whether all baggage is in good condition, without damage to the seals, and the baggage will be loaded into the truck.
Driving back to Amsterdam Airport Schiphol
The truck driver will drive back to the airport with the baggage of the passengers.

Unloading the Trucks
At the airport, the driver unloads the truck and presents the baggage to another airline representative. Again, a checklist will be used to assess whether all baggage is present and in good condition. Once accepted, the baggage will be entered into the BHS of the airport.

Based on the SWOT analysis performed for the Baggage Collection Service, possible improvements to the concept have been identified. Using SADT, these improvements have been incorporated in an activity model for the service. The steps described above need to be performed by KLM Royal Dutch Airlines if they decide to perform the service themselves. To assess whether or not this is financially feasible, the costs of operating the service will be determined for different scenarios. In Chapter 7, these scenarios will be developed and in Chapter 8, the scenarios will be analyzed using Activity Based Costing. The activities described above will be used for the ABC analysis. However, before going into the financial aspect, the following chapter will focus on developing the logistics network that will be used for the Baggage Collection Service.
Chapter 6 – Logistics Network Design

In any off-airport baggage check-in service, the logistics are of vital importance. If baggage does not arrive on time and misses the flight of the passenger, passengers will become reluctant to use the service. Furthermore, logistics costs account for a large part of the total costs of executing the service. In this chapter, a logistics network will be designed for executing the Baggage Collection Service.

Different logistics network design methods exist. McDermott (1993) uses simulations for the design of a network. Hagdorn suggests a framework for logistics network design which uses different scenarios for external factors and internal business factors in the design decisions (Hagdorn - van der Meijden, 1996). In this research however, scenarios will not be used in the design phase, but in the analysis phase. In this research, the phased approach to logistics network design as suggested by Mourits and Evers will be used (Mourits and Evers, 1995).

Arrangement Stage

More specifically, the focus will be on the arrangement stage of distribution network design. According to the definition of Mourits and Evers, the arrangement stage “focuses on the geographical arrangement or layout of the distribution network. Here the required number, location and size of facilities and the assignment of customers and suppliers to warehouses are determined” (Mourits and Evers, 1995).

Many different mathematical methods exist for deciding on location of and allocation to facilities in a logistics network. The most suitable method depends on several factors, such as the types of products that need to be transported through the network, the capacity limitations of locations, the desired number of echelons and the optimization objective. Aikens (1985) presents an overview of different kinds of models that can be used for facility location decisions. Based on their review of 45 different papers on location – allocation methods, Current et al. (1990) conclude that identifying an appropriate objective function is very important in deciding on an allocation method. Common optimization objectives are transportation costs, inventory costs, profit maximization, and customer responsiveness (Nozick and Turnquist, 2000). Based on the 4P’s of the marketing mix (Product, Price, Place, and, to a lesser extent, Promotion) for the service, an optimization objective can be defined (Kotler and Armstrong, 2001).

In case of the Baggage Collection Service, the marketing mix is mainly focused on price, as identified in Table 17. Though as mentioned earlier service level is important for the success of the concept, responsiveness is of little importance. Passengers apply for the service online and routes for vans are known in advance. Furthermore, because baggage for morning flights is collected on the evening prior to departure, time pressure on the transport is negligible. Place is an important issue. Locations of facilities will influence the costs and therefore the price of the service. Locations of customers are also important, especially in the design of the logistics network. Finally, promotion will be of importance for the success of the service; however it will have little influence on the design of the logistics network.
Table 17 - Marketing Mix for Baggage Collection Service

<table>
<thead>
<tr>
<th>Marketing Mix Aspect</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>Baggage must arrive at the airport on time</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>The service must be affordable for passengers</td>
</tr>
<tr>
<td><strong>Place</strong></td>
<td>Collection at the specified address</td>
</tr>
<tr>
<td></td>
<td>Distribution through cross-dock locations</td>
</tr>
<tr>
<td><strong>Promotion</strong></td>
<td>Online promotion</td>
</tr>
</tbody>
</table>

Based on the marketing mix, it can be concluded that the costs of operating the service are important in the logistics network design. Since no inventory will be kept, it can be assumed that the main part of the costs can be attributed to the transportation of baggage. In this case, the costs are mainly determined by the distances that need to be traveled. One algorithm that can optimize location decisions based on distances that need to be covered is the so-called center of gravity approach (Reid and Sanders, 2007). This approach minimizes the so-called load-distance factor in a certain service area according to the following equation:

$$x_{cog} = \frac{\sum x_i l_i}{\sum l_i}; \quad y_{cog} = \frac{\sum y_i l_i}{\sum l_i}$$

In which:

- \(i = \) number of pickup location \(i\in[1-N]\) with \(N\) being the total number of pick-up locations
- \(x_i = x\)-coordinate of pickup location \(i\)
- \(l_i =\) load at pickup location \(i\)
- \(y_i = y\)-coordinate of pickup location \(i\)
- \(x_{cog} = x\)-coordinate of center of gravity
- \(y_{cog} = y\)-coordinate of center of gravity

The load at a pickup location can be considered as the (relative) number of bags that need to be picked up at a certain location.

As mentioned above, the center of gravity can be applied for finding a suitable location for a distribution center in a certain service area. The following section will focus on identifying suitable service areas for the Baggage Collection Service.

**Service Area Decision**

For the design of the logistics network, it is necessary to divide the Netherlands into different regions that will be served by each of the distribution centers. For deciding on the number of regions that will be used and the size of these regions, analogous distribution networks will be analyzed. Based on the structures of these networks, choices will be made with regard to the number of regions and distribution centers for the Baggage Collection Service.
Albert Heijn Distribution Network
Albert Heijn is a company that has approximately 750 supermarkets throughout the Netherlands, of which 200 are franchised (Albert Heijn, 2010). The supermarkets are supplied with different products throughout the day. For the supply, Albert Heijn uses an extensive distribution network with eight different distribution centers.

For the distribution of the main products however, Albert Heijn has divided the country into four parts, each consisting of approximately 175 supermarkets as shown in Figure 19. Each of these areas has its own Regional Distribution Center (RDC) as indicated with the red dots. Besides the RDCs, Albert Heijn has a National Distribution Center (NDC) located in Geldermalsen, which is indicated with the blue dot in Figure 19. For fresh and frozen products, Albert Heijn has separate distribution centers. These have not been identified in Figure 19.

C1000 Distribution Network
Schuitema is a company with many supermarkets throughout the country. Schuitema is the organization behind the 371 C1000 supermarkets in the Netherlands (Schuitema, 2010). As Albert Heijn does, Schuitema divides the country into four regions. Each of the regions is served by a distribution center. Furthermore, a national distribution center is located in Elst. In Figure 20, the distribution network of Schuitema is presented. Again, the red dots represent the RDCs; the blue dot represents the NDC.

While the Albert Heijn distribution network divides the country in four regions with equal numbers of supermarkets, as indicated by the black lines in Figure 19, Schuitema divides the country in the regions North, East, South and West.
**TNT Distribution Network**

Third-party logistics provider and postal service provider TNT has a distribution network that is rather different from the networks of Albert Heijn and Schuitema. In the Netherlands, TNT uses four main depots and six support depots (Podsada, 2007a). The locations of these depots are presented in Figure 21. The main depots are connected to the international hubs of the TNT network. Because many different products need to be transported to many different customers, several cross-dock and storage facilities are being used. The locations of the main depots are partially based on the location of important hubs, such as Schiphol Airport, Port of Rotterdam, the TNT Roadhub in Duiven, and the TNT Airhub in Liège.

**Retail Distribution Networks**

Many retail companies in the Netherlands have less extensive distribution networks than the ones described above. For instance De Bijenkorf uses one single distribution center in Woerden, HEMA uses a distribution center in Utrecht and Kruidvat uses only one distribution center located in Heteren (Lijftogt, 2006; Dohmen, 2007; Stad, 2009). All of these distribution centers are located close to the middle of the Netherlands and supply all the stores in the country. In Figure 22, the different distribution centers are presented.

![Figure 21 - Distribution Network of TNT (Based on: Podsada, 2007a)](image1)

![Figure 22 - Distribution Centers of De Bijenkorf, HEMA, and Kruidvat](image2)

The examples above show that though all the companies serve customers located throughout the Netherlands, different distribution networks are used.
The pickup activities for the Baggage Collection Service will be rather similar to the distribution activities of TNT and the supermarkets, only in opposite direction. Because volumes are smaller than those that TNT processes, the Baggage Collection Service will not require the support depots that TNT uses. The Netherlands will be divided into four regions of approximately equal sizes. Because of the rather small volumes in many COROP regions and the time window of two hours, using small vans for pickups will be more appropriate than using large trucks. Therefore, only one distribution center will not be sufficient. On the other hand, the because of the similarity in products and the common destination (AAS), more than one distribution center per region will not be necessary.

In Table 18, the four regions that will be used for the Baggage Collection Service are defined. Per region, the numbers of the COROP areas included in that region are specified, as is the total surface of the region. The fourth column presents the total percentage of passengers departing from each of the regions. In Figure 23, the four regions are shown on the map of the Netherlands.

<table>
<thead>
<tr>
<th>Region</th>
<th>COROP numbers</th>
<th>Approximate Size</th>
<th>Passenger percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>1-10</td>
<td>9500 km²</td>
<td>5 %</td>
</tr>
<tr>
<td>East</td>
<td>11-16, 40</td>
<td>8500 km²</td>
<td>9 %</td>
</tr>
<tr>
<td>South</td>
<td>31-39</td>
<td>8800 km²</td>
<td>9 %</td>
</tr>
<tr>
<td>West</td>
<td>17-30</td>
<td>8400 km²</td>
<td>77 %</td>
</tr>
</tbody>
</table>

Figure 23 - Four Service Regions for Baggage Collection Service
Location Decision

For each of the regions, a location for the distribution center will be determined using the Center-of-Gravity approach as described above. However, this approach will find the theoretical ideal location for minimizing transportation. The final decision on the location of the distribution centers will depend on other factors such as the proximity to highways and availability of space.

For the calculations, the geographical distribution of passengers has been simplified. In each of the COROP regions the largest municipality has been selected as the so-called mass-center. For calculations it has been assumed that all departing passengers in a COROP region depart from that specific municipality. Though in reality passengers are distributed over the entire region, it can be assumed that the most passengers will depart from the largest municipality. Furthermore, because most of the largest municipalities are not located on the edge of a COROP region, it is assumed that the average distance between pick-up locations in a COROP region and the location of the distribution center is approximately equal to the distance between the largest municipality in that COROP region and the distribution center. Nevertheless, this simplification might result in minor errors in the theoretical optimal location for the distribution centers. In Appendix E.2 the largest municipalities of each of the COROP regions are presented. For each of these municipalities, GPS coordinates are determined. The longitudinal GPS coordinate will be the x-coordinate in Equation 3, while the latitudinal coordinate will be the y-coordinate. Using these coordinates, the center of gravity for each region can be calculated. The results are presented in Table 19.

<table>
<thead>
<tr>
<th>Region</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>6.291255</td>
<td>52.975500</td>
<td>Oosterwolde</td>
</tr>
<tr>
<td>East</td>
<td>5.955255</td>
<td>52.147620</td>
<td>Apeldoorn</td>
</tr>
<tr>
<td>South</td>
<td>5.150033</td>
<td>51.503100</td>
<td>Biest-Houtakker</td>
</tr>
<tr>
<td>West</td>
<td>4.786428</td>
<td>52.253960</td>
<td>Aalsmeer</td>
</tr>
</tbody>
</table>

Combining the results of the center-of-gravity approach with the factors mentioned earlier, the most suitable locations for distribution centers can be determined. Below, for each region the most suitable location will be identified.

**North**

The center of gravity for the northern region is just below Oosterwolde. Oosterwolde is located in between three highways (A7, A28, and A32). From Oosterwolde, these three highways are easily reachable via N381 and N351. So the most suitable location for a distribution center in the northern region will be close to Oosterwolde.

**East**

Just below Apeldoorn is the village of Beekbergen. This is the center of gravity for the eastern region. Beekbergen is a little west of the intersection between highways A1 and A50, two important highways in the East of the Netherlands. Therefore it would be logical to locate the distribution center somewhere close to this intersection.
South
For the southern region, the center of gravity is located near Biest-Houtakker. A little north of Biest-Houtakker is the intersection between highways A65 and A58. This is near the village of Hilvarenbeek. From Hilvarenbeek, it is easy to access both highways. In the north of Hilvarenbeek is an industrial area that would be suitable for the distribution center. Therefore, Hilvarenbeek will be chosen as the most suitable place for the distribution center.

West
The theoretical location for the distribution center in the region west would be close to Aalsmeer. This location is only 4.1 kilometers away from Amsterdam Airport Schiphol. Therefore it has been decided not to use a distribution center in the western region, but to let the vans that perform the pickups drive directly to the airport to drop-off the collected baggage.

![Map showing distribution centers and AAS in four regions](image)

**Figure 24 - Locations of the distribution centers and AAS in the four regions**

So based on the center-of-gravity approach for minimizing average transportation distances and accounting for factors such as proximity to highways and availability of land, the locations for the three
distributions centers have been determined. In Figure 24, these locations are presented with red dots. The location of Amsterdam Airport Schiphol is presented with a blue dot.

**Operations Stage**

As mentioned above, this chapter has focused on the arrangement stage of logistics network design. The service areas have been defined, as have the locations of the distribution centers. Mourits and Evers define three other stages, of which the last stage is the operations stage. This stage is concerned with actually operating the network.

One of the activities identified in Figure 18 is vehicle routing. Vehicle routing is an activity that is typically performed in the operations stage of logistics network design. Many different vehicle routing algorithms exist (Beullens, van Wassenhove et al., 2002). For the Baggage Collection Service, a vehicle routing algorithm that includes a time window is required (Desrochers, Desrosiers et al., 1992). These types of algorithms are used by many vehicle routing software manufacturers. Software packages such as SHORTREC are suitable for vehicle routing with fixed time windows and are being used by companies such as DHL and TNT (Ortec, 2010). However, because little information is known about the exact geographical location of passengers using the service, vehicle routing will be left out of scope in this research. Nevertheless, the costs of such a software package will be included in the cost calculations.

These cost calculations will be the subject of Chapter 8. Before the Activity Based Costing technique will be applied to assess the costs of operating the Baggage Collection Service, different scenarios that will be analyzed will be developed. In the following Chapter, these scenarios will be described.
Chapter 7 – Scenario Development

In order to analyze the financial aspects of the logistics network as designed in Chapter 6, assumptions must be made about the number of passengers that will use the service. Forecasting this number is difficult, especially since no historical data are available. Scenario analysis is an approach aimed at developing potential futures and analyzing the effects of these possible scenarios (Ratcliffe, 2000).

In this chapter, different scenarios will be constructed for analyzing the costs of the logistics network. According to Börjeson et al. (2006) three types of scenarios can be developed:

- Predictive Scenarios – What will happen?
- Explorative Scenarios – What can happen?
- Normative Scenarios – How can a specific target be reached?

Predictive scenarios can be divided into Forecasts and What-if scenarios. In this research, what-if scenarios will be used. These scenarios focus on the consequences under the condition of some specified events (Börjeson, Höjer et al., 2006). Below, the seven-step approach proposed by Ratcliffe (2000) for developing scenarios will be elaborated.

Step 1: Task Identification and Analysis
The goal of the scenario analysis is to determine the costs of operating the Baggage Collection Service in the logistic network as designed in the previous chapter. Ultimately, the scenario analysis will guide in making the make-or-buy decision for the collection service. For doing so, a time horizon for the scenarios needs to be defined. According to Börjeson et al (2006), the time horizon for what-if scenarios is rather short compared to other scenario types. In order to analyze the solution based on a steady-state demand, the horizon will be set to the third year after possible implementation.

Step 2: Key Decision Factor Appraisal
The factors that will influence the make-or-buy decision specified in step 1 need to be identified. These factors are mostly external factors that cannot be controlled by the stakeholders involved. In case of the Baggage Collection Service, the key decision factor that will affect the make-or-buy decision is the costs per piece of baggage for operating the service. Especially these costs compared to the costs of outsourcing the service to a third-party logistics provider will be decisive in the decision whether or not to outsource the service.

Step 3: Driving Forces
The third step focuses on identifying the forces that influence the key decision factor defined above. Many different factors influencing the costs of the service can be identified. Some of the factors have a significant impact on the costs, others are less important. Below, a list of driving forces is presented. In the following step, these forces will be ranked based on their importance and uncertainty.
Driving Forces:

- Number of passengers using the service
- Variation in weight and size of baggage passengers check in
- Geographical distribution of passengers using the service
- Dispersion of passengers over a region
- Fuel prices
- Congestion on the road network

Step 4: Ranking

The driving forces need to be ranked based on their importance on the success or failure of the key decision as identified in step 1 and on the uncertainty surrounding these forces (Ratcliffe, 2000). Factors that are both important and uncertain are important for the scenario development, because these are the factors that account for the significant difference between the scenarios. Factors that are rather certain but have a high impact on the key decision factor need to be incorporated as well. In Table 20, the forces defined in step 3 are presented in a matrix that ranks them based on importance and uncertainty.

<table>
<thead>
<tr>
<th>Forces Ranking Matrix</th>
<th>Forces of high importance</th>
<th>Forces of low importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forces with high uncertainty</strong></td>
<td>Number of passengers using the service</td>
<td>Congestion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel price</td>
</tr>
<tr>
<td><strong>Forces with low uncertainty</strong></td>
<td>Geographical distribution of passengers</td>
<td>Variations in weight and size of baggage</td>
</tr>
<tr>
<td></td>
<td>Dispersion of passengers over a region</td>
<td></td>
</tr>
</tbody>
</table>

One driving force has been identified as a force that is rather certain and has a low impact on the key decision factor. The variations in weight and size of baggage will probably influence the fuel usage and loading capacity of vans and trucks. However, because the baggage weight and dimensions are approximately normally distributed, it is expected that the impact on average will be rather low (See Appendix N).

Two forces have been identified as being of high importance, but rather certain. The geographical distribution of passengers departing from Amsterdam Airport Schiphol is well known. Over the past five years, this distribution has not changed significantly. Therefore it is safe to assume that this distribution will remain similar when the service is introduced. Nevertheless, variations in the distribution of passengers over the country are of high importance for the costs of the service. Therefore, the costs of operating the service will be calculated for each of the four regions identified in Chapter 6. Besides the distribution over the country, which is based on COROP regions, the dispersion of passengers within a COROP region will have its effects on the costs of the service. This dispersion will determine the number of pick-ups a driver can perform within two hours. The numbers of habitants of the municipalities within a COROP region are known, so the dispersion over such a region can be based
on these numbers. The effects of the dispersion will be incorporated in the cost calculations for the different scenarios. In Chapter 8, this will be further elaborated.

Congestion of the road network and fuel price are factors in the quadrant with low impact and high uncertainty. Because transportation will account for a significant part of the costs, congestion can certainly affect the total costs. However, because pickups will be performed during the early afternoon and in the evening, the congestion problems will be limited. Only occasional accidents and maintenance operations will cause congestion problems. Especially the accidents are unpredictable, but due to the fact that these are occasional, the effect on total costs will be limited.

Fuel costs will also account for part of the total costs. However, the effect of fuel costs is significantly less than the labour costs as shown in Appendix F.3. Therefore the impact of variations in fuel prices will be limited.

Finally, one driving force is located in the high impact – high uncertainty quadrant. The single most important force that will affect the costs of operating the service will be the number of passengers that use the service. The variation in scenarios will therefore be mainly based on variations in the number of passengers that use the service.

**Step 5: Alternative Projections**

Based on the ranking of the driving forces as shown in Table 20, the different scenarios can be quantified. The forces that will have high impact on the total costs of operating the service will be taken into account in the different scenarios.

As mentioned, the geographical distribution of passengers will be taken into account by calculating the costs for each of the regions identified in Chapter 6 separately.

The dispersion of passengers in a certain region will affect the average driving time and distance between two pick-up addresses. To take this into account, the minimum and maximum average time and distance between two addresses will be determined for each of the regions, based on the dispersion of passengers in a representative COROP region. In Chapter 8, this will be elaborated further.

Finally, the number of passengers using the service will be the main driving force behind the costs of the service. In order to assess the influence of this number, three different scenarios will be developed; a pessimistic scenario, a baseline scenario and an optimistic scenario. In Table 21, the numbers of passengers using the service for each of the scenarios are presented.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Percentage of passengers using the service</th>
<th>Number of passengers using the service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pessimistic</td>
<td>5 %</td>
<td>427 per day</td>
</tr>
<tr>
<td>Baseline</td>
<td>15 %</td>
<td>1282 per day</td>
</tr>
<tr>
<td>Optimistic</td>
<td>25 %</td>
<td>2137 per day</td>
</tr>
</tbody>
</table>
Step 6: Scenario Development
For each of the three scenarios identified above, a short description will be presented below.

Scenario 1: Disappointing Numbers
The Baggage Collection Service has been introduced, but has not turned out to be the success KLM Royal Dutch Airlines had hoped for. Though the rate of mishandled baggage has not increased with the Baggage Collection Service, passengers appear to be reluctant to use the service. Perhaps the passengers do not see the advantages of the service or due to the continuing economic crisis that started in 2008 they are not willing to pay for the additional service. Especially passengers travelling for business purposes try not to bring along hold baggage and therefore do not need to use the service. The problems are similar throughout the country; in all four regions the interest in the service is below expectations. Only five percent of all departing passengers flying with KLM use the Baggage Collection Service.

Scenario 2: Foreseen Results
The introduction of the Baggage Collection Service has been a success. Many passengers have used the service, and most of them are satisfied. Mishandled baggage rates have gone down and passengers have experienced the advantages of the service. However, competitors have witnessed the success of the service and currently, many similar services are being offered. The growth of the service has come to a halt and the distribution centers are still not fully utilized. However, fifteen percent of all departing KLM passengers use the service, which has been the aim from the start.

Scenario 3: Unexpected Successes
The Baggage Collection Service has been flourishing from the start. Perhaps due to the economic growth that started in 2010, perhaps due to the marketing efforts of KLM Royal Dutch Airlines, but the success of the service has exceeded all expectations. Passengers are extremely satisfied with the service and within the first year, approximately 25 percent of all departing passengers use the service. Though the distribution network is utilized at its maximum capacity, hardly any errors are being made. Though some competitors have tried to start similar service concepts, none of them has succeeded.

Step 7: Scenario Interpretation
In the following chapter, these three scenarios will be analyzed based on costs. As mentioned earlier, for each scenario the geographical distribution and dispersion of passengers will be incorporated in the analyses. The results of the analyses will serve as guidelines in deciding on how to organize the Baggage Collection Service financially.
Chapter 8 – Cost Structures

The final sub-question that needs to be answered is “What is a suitable business model for the service?” The main issue that needs to be dealt with is the so-called make-or-buy decision. As identified in Chapter 5, the risks associated with high initial investments can be mitigated by outsourcing the service, or by starting a pilot case in a certain region. In this chapter, the costs of performing the service will be analyzed for the three different scenarios defined in Chapter 7. Based on the outcomes of these analyses, a suitable business model for the service can be developed. For the calculations, different assumptions have been made with regard to the value of certain variables. Where possible, these assumptions have been based on values that are used by KLM Royal Dutch Airlines and Amsterdam Airport Schiphol. For the values that were not available, assumptions have been based on information gathered by experts from QuinTech Engineering Innovations. To account for the possible effects of these assumptions, sensitivity analyses will be performed in the Reflection.

Activity Based Costing

Before going into the actual interpretation of the scenarios, the method that is used will briefly be described. As mentioned, Activity Based Costing will be used to determine the costs of the service. The activities identified in Figure 18 will be used for developing the cost structure of the cost object (van Damme, 2001). The cost object is, as was the case in Chapter 4, the execution of the Baggage Collection Service. The activities that need to be performed for the cost object are identified in Table 22. In Table 23, resources, resource drivers and resource costs are presented. The activities of Table 22 are linked to the resources that are utilized for the activities.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Required Resources</th>
<th>Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label Printing &amp; Vehicle Routing</td>
<td>Labour, Labels</td>
<td>Central Location</td>
</tr>
<tr>
<td>Driving to Distribution Centers</td>
<td>Labour, Fuel</td>
<td>North, East, and South</td>
</tr>
<tr>
<td>Driving to Collection Areas</td>
<td>Labour, Fuel</td>
<td>All</td>
</tr>
<tr>
<td>Performing Collection</td>
<td>Labour, Fuel, Seals</td>
<td>All</td>
</tr>
<tr>
<td>Driving back to Distribution Centers</td>
<td>Labour, Fuel</td>
<td>North, East, and South</td>
</tr>
<tr>
<td>Cross-Docking at Distribution Centers</td>
<td>Labour</td>
<td>North, East and South</td>
</tr>
<tr>
<td>Driving back to AAS</td>
<td>Labour, Fuel</td>
<td>All</td>
</tr>
<tr>
<td>Unloading</td>
<td>Labour</td>
<td>All</td>
</tr>
</tbody>
</table>

Based on the resource drivers, the costs of performing the different activities can be determined. Besides the costs of the activities, the fixed costs will be incorporated as well. The total costs of operating the BCS will therefore be determined by the fixed costs and the costs of the different activities. The activity driver, that will be used to assign activity costs to the total costs will be the main variable in the different scenarios; the number of passengers using the service.

Besides the numbers defined in Table 23, the following assumptions have been used:

- The geographical distribution of passengers using the service is similar to the geographical distribution of all departing passengers of Amsterdam Airport Schiphol (Amsterdam Airport Schiphol, 2010a) (See Appendix E)
Forty percent of all departing passengers travels with KLM Royal Dutch Airlines or partners (Schiphol Group, 2009)
Sixty percent of all departing passengers is carrying hold luggage (vander Meûlen, 2010)
Checking in and sealing baggage will take an average of 6 minutes per piece of baggage (vander Meûlen, 2010)
Each day, two collection rounds will be made
Sixty percent will use the evening collection, forty percent the morning collection (Amsterdam Airport Schiphol, 2010b)
Unloading or cross-docking baggage, including finishing the checklist, will take an average of one minute per piece of baggage.
Vans and trucks are expected to drive with an average speed of 80 km per hour on the highway
Costs will be calculated for an average day, meaning 1/365\textsuperscript{th} of the annual costs
25 percent overhead will be accounted for
The costs of initial investments will be spread over a five year period

<table>
<thead>
<tr>
<th>Resource</th>
<th>Resource Driver</th>
<th>Resource Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>Hours of work</td>
<td>€ 22.\textsuperscript{-4} per hour (KLM, 2007)</td>
</tr>
<tr>
<td>Van Fuel</td>
<td>Kilometers</td>
<td>€ 0.151 \textsuperscript{5} per kilometer</td>
</tr>
<tr>
<td>Truck Fuel</td>
<td>Kilometers</td>
<td>€ 0.302 \textsuperscript{6} per kilometer</td>
</tr>
<tr>
<td>Labels</td>
<td>Pieces of baggage</td>
<td>€ 0.15 per piece of baggage (vander Meûlen, 2010)</td>
</tr>
<tr>
<td>Seals</td>
<td>Pieces of baggage</td>
<td>€ 0.15 per piece of baggage (vander Meûlen, 2010)</td>
</tr>
</tbody>
</table>

To determine the total costs per piece of baggage for the Baggage Collection Service, the following equation will be used:

\[
\text{Costs per Bag} = \frac{\sum \text{Costs of Activities} + \sum \text{Fixed Costs}}{\text{Total Number of Bags}}
\]

The fixed costs of Equation 4 are listed in Table 24. As mentioned, in the cost structure the daily costs will be used. This also applies to the fixed costs.

\footnote{The resource costs for labour include a fifteen percent overhead and five percent sick leave charge and are based on the monthly salary of an A-07 KLM Ground Employee in step 13}
\footnote{Based on fuel prices of July 7\textsuperscript{th} 2010 and an average usage of 1 liter of diesel for 8 kilometers}
\footnote{Based on fuel prices of July 7\textsuperscript{th} 2010 and an average usage of 1 liter of diesel for 4 kilometers}
Geographical Distribution

As mentioned in the previous chapter, the geographical distribution of passengers throughout the country can have high impact on the costs of the service. Therefore, besides the overall costs, the costs per region will be determined. In Table 22, it has been identified which activities will be performed in which of the regions. These activities will form the basis of the cost structures for the different regions.

For the cost structure per region, Equation 5 will be used.

\[
\text{Costs per Region} = \frac{\text{Labour Costs} + \text{Fuel Costs} + \text{Label Costs} + \text{Seal Costs} + \text{Fixed Costs} + \frac{1}{4} \text{IT Costs}}{\text{Number of Bags in Region}}
\]

In Equation 5, the fixed costs are the costs of leasing equipment such as vans, and trucks for the northern, eastern and southern region. Costs for the distribution centers are also included. In Table 25, the costs for the distribution centers are presented for each of the regions. The sizes of the distribution centers are based on the required space for accommodating the vans and trucks for the optimistic scenario of 25 percent using the service.

The IT costs are investments in IT infrastructure such as a website for the service and vehicle routing software. Because these costs are independent of the number of passengers using the service, the costs will be equally distributed over the four regions.

---

7 Based on (Kadaster, 2006).
8 Based on a license and maintenance contract for SHORTREC vehicle routing software for 5 years
9 Including costs for preparing the DC for asphalt based on data from BAM Wegen Asphalt
Geographical Dispersion

Besides the distribution over the country, the geographical dispersion of passengers in the different regions can have a high impact on the costs of the service. Therefore, this dispersion needs to be taken into account. The dispersion will mainly affect the driving time between two pick-ups and the distance that needs to be covered. Because of the differences in population density in the different regions, the effect of the dispersion will be analyzed for each region separately. In each of the four regions, a representative COROP region will be identified. For this region, the municipalities and their inhabitants will be listed. For each scenario, ten random samples will be drawn from the population in the COROP region. The sample sizes will be determined by the expected number of passengers in that region that will use the service. For each sample, the mean driving time and distance between two pick-up locations will be determined. From the ten samples, the minimum, the average and maximum will be selected. These numbers will be used to determine the minimum, average, and maximum costs of operating the service for each of the three scenarios. Below, the results of the samples for each of the four regions are presented.

North

The northern region is the least densely populated of the four regions. Only five percent of all departing passengers depart from the northern region. The region consists of ten different COROP regions. Approximately ten percent of all passengers from the northern region depart from the COROP region Zuidoost-Friesland. Based on this number and based on the size of the COROP region, as well as on the number of municipalities in the region, the Zuidoost-Friesland region can be considered representative for the entire northern region. Therefore, the effect of geographical dispersion in the northern region will be based on this COROP region.

Figure 25 - Population of Zuidoost-Friesland (Based on: Centraal Bureau voor de Statistiek, 2010c)

For each of the scenarios, ten samples have been drawn from the population and average driving times and distances between two pick-up locations have been determined. The municipalities and the
inhabitants are presented in Figure 25. The results of the driving times and distances are presented in Table 26.

Table 26 - Geographical Dispersion Analysis for Northern Region

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of pick-ups per round</th>
<th>Distance (km)</th>
<th>Driving Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Average</td>
</tr>
<tr>
<td>1 (5 %)</td>
<td>2</td>
<td>1.9</td>
<td>22.0</td>
</tr>
<tr>
<td>2 (15 %)</td>
<td>5</td>
<td>12.4</td>
<td>17.0</td>
</tr>
<tr>
<td>3 (25 %)</td>
<td>9</td>
<td>7.1</td>
<td>9.9</td>
</tr>
</tbody>
</table>

From Table 26 it becomes clear that when the sample size increases, the differences between minima and maxima decrease. Especially for two pick-ups, the pessimistic scenario, the minimum driving distance is extremely low and the maximum is over twice as high as for the other scenarios. These effects will be incorporated in calculating the costs of the Baggage Collection Service in the northern region.

East

The eastern region can be divided into 7 COROP regions. In total, approximately nine percent of all passengers depart from the eastern region. Based on the departing passengers and the size of the region, the COROP region Twente is representative for the eastern region. Therefore, geographical dispersion in the east will be based upon the dispersion in this region.

Figure 26 - Population of Twente (Based on: Centraal Bureau voor de Statistiek, 2010c)

In Figure 26, the municipalities and inhabitants of Twente are shown. From this population, ten random samples have been drawn for each scenario. The resulting minimum, maximum and average distances and driving times are presented in Table 27.
Table 27 - Geographical Dispersion Analysis for Eastern Region

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of pick-ups per round</th>
<th>Distance (km)</th>
<th>Driving Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Average</td>
</tr>
<tr>
<td>1 (5 %)</td>
<td>5</td>
<td>5.3</td>
<td>15.6</td>
</tr>
<tr>
<td>2 (15 %)</td>
<td>15</td>
<td>8.1</td>
<td>9.6</td>
</tr>
<tr>
<td>3 (25 %)</td>
<td>26</td>
<td>6.1</td>
<td>6.9</td>
</tr>
</tbody>
</table>

From Table 27, one can conclude that the differences between the scenarios are significantly smaller than for the northern region. This is mainly because even in the pessimistic scenario, 5 pick-ups in the region need to be performed.

South

For the southern region, nine COROP regions have been reviewed. Approximately 9 percent of all passengers depart from the southern region. Approximately one percent of all passengers depart from the Midden-Noord-Brabant region. Furthermore, as with most of the COROP regions in the south, the Midden-Noord-Brabant region has one central city which is significantly larger than all other municipalities. Therefore, this region has been selected for the determination of the minimum, average and maximum driving time and distance between two pick-ups in the southern region.

The population from which the samples have been drawn is represented in Figure 27. In Table 28, the results of the analysis are presented.

![Figure 27 - Population of Midden-Noord-Brabant (Based on: Centraal Bureau voor de Statistiek, 2010c)](image)

As mentioned, most of the passengers from the COROP region Midden-Noord-Brabant live in Tilburg. Therefore it is assumed that most passengers that use the service will specify a pick-up address in Tilburg.
West

The western region consists of fourteen COROP regions. The four largest cities of the Netherlands, Amsterdam, Rotterdam, Utrecht and Den Haag, are located in the west. Based on the numbers of departing passengers from the entire region, and on the number of municipalities in the region, the COROP region Agglomeratie ʼs-Gravenhage appears to be representative for the western region. Therefore, this region has been selected for determining the distances and driving times between two pick-ups in the west.

Again, for each scenario ten random samples have been drawn from the population in the western region. A representation of the population can be found in Figure 28. For each sample, the mean driving time and distance between two pick-ups has been determined. For each scenario, the minimum, maximum and average mean driving time and distance has been selected. The results are presented in Table 29.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of pick-ups per round</th>
<th>Distance (km)</th>
<th>Driving Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Average</td>
</tr>
<tr>
<td>1 (5 %)</td>
<td>5</td>
<td>4.5</td>
<td>12.0</td>
</tr>
<tr>
<td>2 (15 %)</td>
<td>14</td>
<td>7.3</td>
<td>9.3</td>
</tr>
<tr>
<td>3 (25 %)</td>
<td>24</td>
<td>6.7</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Figure 28 - Population of Agglomeratie ʼs-Gravenhage (Based on: Centraal Bureau voor de Statistiek, 2010c)
Table 29 shows that the differences between the three scenarios for the western region are relatively small. This can be attributed to the fact that even for the pessimistic scenario the sample size is larger than for the optimistic scenario in the other regions. Table 29 also shows that, due to the large number of pick-ups, the average distance and driving time between two pick-ups is significantly smaller than in the other regions.

**Scenario Analysis**

In this section, the three different scenarios described in Chapter 7 will be analyzed as described above. For each of the scenarios, the geographical dispersion will be taken into account as defined above. Furthermore, results for each of the four regions will be presented separately, to account for geographical distribution of passengers. The results of the analysis will form the basis for the answer to the final sub-question.

**Scenario 1: Disappointing Numbers**

For the pessimistic scenario, in which only 5 percent of all departing passengers use the Baggage Collection Service, the costs of operating the service have been determined. As discussed above, the dispersion of passengers will be incorporated. Therefore, the costs per piece of baggage have been determined for the minimum, average and maximum dispersion. Furthermore, the costs per region are presented in Table 30, the results of the scenario analysis are shown.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>€ 61.44</td>
<td>€ 82.43</td>
<td>€ 95.61</td>
</tr>
<tr>
<td>East</td>
<td>€ 37.86</td>
<td>€ 50.40</td>
<td>€ 53.71</td>
</tr>
<tr>
<td>South</td>
<td>€ 41.44</td>
<td>€ 48.46</td>
<td>€ 58.80</td>
</tr>
<tr>
<td>West</td>
<td>€ 13.98</td>
<td>€ 15.19</td>
<td>€ 15.26</td>
</tr>
<tr>
<td>Overall</td>
<td>€ 20.65</td>
<td>€ 24.30</td>
<td>€ 26.16</td>
</tr>
</tbody>
</table>

From Table 30, it shows that the costs per bag in the western region are significantly lower than in the other three regions. Two reasons for this difference can be identified. First of all, the western region is more densely populated than the other regions. The average distance between two pick-ups in this region is much smaller than in other regions, as shown earlier. Besides that, the western region does not use a distribution center. Therefore, the fixed costs in this region are lower.

Because most of the passengers depart from the western region, the costs per bag are mainly determined by this region. Therefore, the overall costs per bag are relatively low. In Appendix O, the costs of the individual activities are presented.

**Scenario 2: Foreseen Results**

As described in Chapter 7, in this scenario 15 percent of all passengers use the Baggage Collection Service.
Table 31 - Analysis of Scenario 2

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>€ 40.97</td>
<td>€ 47.54</td>
<td>€ 51.56</td>
</tr>
<tr>
<td>East</td>
<td>€ 27.01</td>
<td>€ 29.91</td>
<td>€ 30.20</td>
</tr>
<tr>
<td>South</td>
<td>€ 28.87</td>
<td>€ 32.03</td>
<td>€ 32.24</td>
</tr>
<tr>
<td>West</td>
<td>€ 13.78</td>
<td>€ 13.82</td>
<td>€ 15.04</td>
</tr>
<tr>
<td>Overall</td>
<td>€ 17.52</td>
<td>€ 18.38</td>
<td>€ 19.56</td>
</tr>
</tbody>
</table>

The results in Table 31, are significantly different from the results in Table 30. Especially in the three regions that use a distribution center, the costs per bag have decreased significantly compared to scenario 1. This is mainly because of scale advantages; vans and trucks are used more efficient and the fixed costs of the distribution centers can be distributed over a higher number of bags. Nevertheless, the costs in the western region remain significantly lower than in the other regions. In Appendix O, the costs per activity are presented for the second scenario.

Scenario 3: Unexpected Successes
The third scenario is the scenario in which 25 percent of all passengers use the service. The capacity of the distribution centers is based on this scenario. The results of the analysis are presented in Table 32.

Table 32 - Analysis of Scenario 3

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>€ 29.18</td>
<td>€ 31.94</td>
<td>€ 34.47</td>
</tr>
<tr>
<td>East</td>
<td>€ 22.19</td>
<td>€ 23.89</td>
<td>€ 24.02</td>
</tr>
<tr>
<td>South</td>
<td>€ 25.46</td>
<td>€ 25.56</td>
<td>€ 25.74</td>
</tr>
<tr>
<td>West</td>
<td>€ 13.67</td>
<td>€ 13.72</td>
<td>€ 15.00</td>
</tr>
<tr>
<td>Overall</td>
<td>€ 16.16</td>
<td>€ 16.49</td>
<td>€ 17.62</td>
</tr>
</tbody>
</table>

From Table 32 it can be concluded that the effects of the dispersion of passengers decrease when the number of passengers increases. The difference between the minimum and maximum costs per bag is significantly smaller than in the other two scenarios. Furthermore, the costs in the regions with distribution centers have decreased compared to scenario 2. Again, this can be attributed to an increase in efficiency and the fact that fixed costs can be distributed over a larger number of bags.

The costs presented in this chapter are the costs per bag, based on the average number of passengers flying with KLM from AAS on an average day. For the baseline and the optimistic scenario, expected costs are even lower than those determined in Chapter 4. Two reasons can be identified for the lower costs. First of all, the average number of pick-ups that can be performed by a driver within two hours used in Chapter 4 is lower than the number of pick-ups that can be performed in the western region. Besides that, the use of the distribution centers in the other regions lowers the fuel and labour costs.

Though the costs presented in the tables above are promising, some remarks must be made. First of all, the costs are based on average daily costs. In months such as March and December, when the number of passengers is below average, the costs per bag might be higher due to underutilization of vans and trucks. Besides that, peak loads are not incorporated in the calculations. In July and August, when the number of passengers is above average, additional vans are probably required for the pick-ups. To
accommodate this, short-term lease contracts can be used. This will result in an increase of the costs per bag. Finally, though costs are not too high, the initial investments required are substantial. Especially the investments in the distribution centers, as presented in Table 25, are rather high.

So the most suitable business model for the Baggage Collection Service depends on several factors. First of all, the price at which a third party can offer the service is important. If an external company can provide the service at lower prices than those calculated in this Chapter, it will probably be cheaper to outsource the service. However, transaction costs need to be taken into account when the service is outsourced (Walker and Weber, 1984).

Besides the costs of outsourcing the service, the availability of money is of importance for the business model. As mentioned, the initial investments required for the service are significant. If the money for the investments is not available at the airline, it will be difficult for KLM to perform the service by itself.

Finally, the costs of the service need to be covered. Both the willingness to pay of passengers and the possible savings on other operations will contribute to this. The passenger survey performed by KLM indicated that passengers are willing to pay a fee between € 15 and € 31 for the Baggage Collection Service. To assess whether the service will be a success, a study needs to be performed into possible savings on other operations if the Baggage Collection Service is implemented.

These three factors will affect the form of the most suitable business model for the Baggage Collection Service in the Netherlands.
Chapter 9 – Conclusions and Discussions

Solutions to the congestion problems in airport terminals suggested in literature have been limited to changes inside the terminal. Introducing different counters for different types of passengers or introducing common use check-in counters are solutions that have been presented in literature (Gatersleben and van der Weij, 1999; Daniel, 2000; Joustra and Dijk, 2001; Takakuwa and Oyama, 2003; Bouland, 2007). Amsterdam Airport Schiphol has also introduced services such as self-service baggage check-in in order to reduce waiting time in the terminal. In this research however, the proposed solution to the congestion problems in airport terminals has been based on a supply chain oriented approach to baggage flows. The flow from the passenger’s home address to the airport is seen as the inbound side of the baggage supply chain. The focus of the research has been to develop a service concept for the most suitable point for handing over baggage from passenger to airline, limited to a location outside of the airport terminal. For this off-airport baggage check-in service, a logistics network and a business model have been developed by following a four-phased approach based on the Innovation Model of in ‘t Veld (2002). In the eight chapters that have formed the core of this report, answers to the sub-research questions formulated in the Introduction have been presented. In this chapter, the answers presented in this report will be summarized. Furthermore, the answer to the main research question will be given.

Conclusions

The main research question formulated in the early stages of this research is:

“What is a suitable logistics network and a suitable business model for an off-airport baggage check-in solution for Amsterdam Airport Schiphol?”

Answering the sub-questions that have been formulated in the Introduction leads to the answer to this main research question.

In literature, many different examples of off-airport baggage check-in solutions can be found. The concept is certainly not new. Examples of intermodal links between railways and airport, including baggage check-in at train stations, have been introduced at many airports around the world. At Disneyworld, passengers can check-in their baggage in the park on the day of departure. Similar services are offered at cruise terminals in Vancouver, Miami and Venice; passengers check-in their baggage inside the cruise terminal on the day of their flight. This allows them to spend the day without the hassle of carrying baggage.

Some of the examples have failed, like many of the air-rail links, while others still exist. Different factors that might result in failure of off-airport baggage check-in concepts have been identified. In off-airport baggage check-in, different stakeholders are involved. The most important, and most powerful, stakeholders are the airport, airline, and the passengers. Furthermore, third parties that provide the service can be involved, as can national railway organizations. Disagreement among stakeholders on funding the service is one of the main factors that have resulted in failure of projects during the initiation. Financial aspects are not only important during the initiation phase; many of the concepts, such as the check-in in an intercity train in the Netherlands, have been abandoned because of financial reasons. Furthermore, some of the earlier off-airport baggage check-in solutions have failed because of
design issues. Passengers are reluctant to use a service if they have to make an additional journey or have to deviate from their natural route. Finally, transparency is a very important issue. Passengers might have concerns about mishandled baggage and therefore might be reluctant to use the service. However, most of the early examples of remote check-in services have been abandoned because of changes in security regulations after the terrorist attacks of 2001. Especially services offered in and to the US were subject to these regulatory changes and most of them have been stopped.

As mentioned, the most important stakeholders are the airport, the airline, and passengers. From the perspective of Amsterdam Airport Schiphol, the most important requirements with respect to off-airport baggage check-in services are that the services function according to specifications, comply with existing security regulations, and do not conflict with other operations at the airport. For KLM Royal Dutch Airlines, the main requirements are that the service must comply with security regulations, that clear agreements are made on responsibility and liability, and that the service has added value for the passengers. Finally, from a passenger perspective it is important that the service is clear and transparent, that it is not too costly, and that the service reduces the hassles of travelling by airplane.

Based on these main requirements and on examples of earlier initiatives, a set of possible concepts for off-airport baggage check-in services has been developed in a creative brainstorm session. For each of the concepts, the activities that need to be performed have been modeled using the Structured Analysis and Design Technique. Based on SWOT analyses of the different concepts, simplified cost structures, and passenger preference surveys, the Baggage Collection Service has been identified as the most suitable concept for the situation at Amsterdam Airport Schiphol.

The remainder of the research has focused on the Baggage Collection Service. This is a service that can be provided by KLM Royal Dutch Airlines, but it can also be outsourced to a third-party logistics provider as TNT or DHL. The main factor that will affect this decision is costs. Therefore, the costs of operating the service for KLM Royal Dutch Airlines have been the main focus.

For providing the service, a logistics network is required. Based on analogous networks in the Netherlands, such as distribution networks of supermarkets and the logistics network of TNT Express, the country has been divided into four regions. For three of the four regions, locations for a distribution center have been determined using the center-of-gravity approach. From these distribution centers, trucks will transport baggage to the airport. For the northern region, the distribution center will be located in Oosterwolde. The eastern distribution center will be located in Beekbergen. In the south, the location of the distribution center is Hilvarenbeek. For the western region, no distribution center will be used. The vans that are used for collection will drive directly to the airport.

To analyze the costs of operating the service through this network, Activity Based Costing has been used. However, because no information is available on the number of passengers that will use the service, except for the outcomes of a survey performed by KLM, different scenarios have been developed. The costs of operating the Baggage Collection Service have been determined for a pessimistic, a baseline and an optimistic scenario. The average costs per bag range from € 16.16 to € 26.16 for the different scenarios and different rates of dispersion of passengers. Though these estimates
are rather promising, actual costs will probably be higher during peak months because of additional vans required. Furthermore, the initial investments required in the logistics network are significant.

The form of the most suitable business model for the service will depend on different factors. The price charged by a third-party logistics provider and transaction costs are important. Furthermore, the availability of money for the investments affects the business model. Finally, passengers’ willingness to pay and the possible savings on other operations will determine the feasibility of the business model. If the service is performed by KLM itself, and the money for the investments is available, the logistics network as designed in this research should be used.

The Baggage Collection Service as designed in the research can be a possible solution to the congestion problems described in the Introduction. While most of the suggested and implemented solutions have focused on changes inside the airport terminal, the collection service takes the bottleneck process out of the terminal. From a supply chain perspective, the baggage handover point should be located at the departure point of the passenger. This will increase the service level for the passengers and can reduce congestion problems in the terminal.

**Reflection**

The congestion problem as identified in the Introduction is a problem that is faced by many large airports and airlines around the world. However, because of the significant differences between airports, this research has been focused on the case of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines. In this section, the methodology applied to the case study will be reflected upon. The influence of assumptions made will be discussed, and the applicability of the methodology to other case studies will be analyzed.

**Reflection on Methodology**

As mentioned, Amsterdam Airport Schiphol is not the only airport in the world that faces congestion problems in the terminal. The problem has often been addressed in literature, and most often the check-in process has been identified as the bottleneck (Gatersleben and van der Weij, 1999; Takakuwa and Oyama, 2003). However, the suggested solutions in literature have been sought in changes inside the airport terminal. In this research, a wider, supply chain oriented approach has been used. The entire process, from the passenger’s home address until the departure of the flight can be seen as the inbound side of a supply chain. The point of handover of baggage, from passenger to airline, can be considered as the baggage handover point. Though the optimal location of the baggage handover point is dependent on the specific conditions of the case under investigation, the supply chain approach is an approach that can be applied to similar cases around the world.

The steps of the Innovation Model (in 't Veld, 2002) that have been followed for the case of Amsterdam Airport Schiphol and KLM Royal Dutch Airlines can be applied to many different innovation processes. For designing off-airport baggage check-in solutions for other airports, the four phases as described in the Introduction can be applied. These phases can serve as a generalized roadmap for the execution of similar case studies. In Table 33, an overview of the phases in the roadmap is presented.
Table 33 - Roadmap for Off-Airport Baggage Check-in Design

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Scanning Environment &amp; Setting Goals</td>
<td>Literature study on previous initiatives</td>
</tr>
<tr>
<td></td>
<td>Identification of critical factors</td>
</tr>
<tr>
<td></td>
<td>Identification of stakeholders and design</td>
</tr>
<tr>
<td></td>
<td>requirements</td>
</tr>
<tr>
<td>2. Developing Alternatives</td>
<td>Developing possible concepts</td>
</tr>
<tr>
<td>3. Evaluating Alternatives</td>
<td>ABC analysis of concepts</td>
</tr>
<tr>
<td></td>
<td>SWOT analysis of concepts</td>
</tr>
<tr>
<td></td>
<td>Identifying most suitable concept</td>
</tr>
<tr>
<td>4. Further Development</td>
<td>Improving chosen concept</td>
</tr>
<tr>
<td></td>
<td>Designing logistics network</td>
</tr>
<tr>
<td></td>
<td>Scenario analysis and ABC analysis</td>
</tr>
<tr>
<td></td>
<td>Designing business model</td>
</tr>
</tbody>
</table>

Not only the developed roadmap can be used for other case studies. Based on the conclusions drawn from the case study of Amsterdam Airport Schiphol, some general statements can be derived. First of all, the literature study on previous initiatives and the identification of critical factors in off-airport baggage check-in concepts are activities that have been performed in this research are not limited to the case study of AAS and the critical factors can be applied in general.

Furthermore, with respect to the concept development, it can be concluded that available infrastructure is important. For instance, the railway infrastructure determines the suitability of using train stations for check-in services. Dedicated city-airport railways can be suitable as shown in Hong-Kong and Vienna. Besides this infrastructural aspect, it can be assumed that many of the design requirements for large airports and high-end airlines are similar to those for AAS and KLM. Especially the interviewees of KLM Royal Dutch Airlines, who had already been involved in earlier research into off-airport baggage check-in, could identify critical issues for the airline and for passengers. Nevertheless, cultural and environmental differences between airports and airlines might cause minor shifts in design requirements. Therefore it will be necessary to execute a stakeholder analysis for each individual case study.

While passenger preferences have been based on a study performed by KLM, which was limited to passengers flying with that airline, the outcomes correspond with the outcomes of the SITA World Passenger Self-Service Survey. Since this survey has been performed at six major airports around the world, it can be assumed that the preferences are widely applicable. Therefore, it is safe to conclude that a collection service, as the Baggage Collection Service, will be preferred by many passengers. Since many large European airports are having the same problems as AAS, and security regulations that have been incorporated in this research were based on the European regulations, the Baggage Collection Service can probably be applied in most European countries.

Based on the case study results, it can be concluded that there is a clear relationship between the passenger distribution and dispersion and the costs of operating a collection service. Especially in the western region in the Netherlands, where the concentration of passengers per square kilometer is
rather high, the costs of operating the Baggage Collection Service are significantly lower than in the other regions. When focusing only on the collection activities, differences in costs per bag are clearly visible. Obviously, when the densely populated region is close to the airport, the costs are reduced even more. So based on these findings, it can be concluded that a collection service is most suitable for large airports and high-end airlines and is a service that possibly can be performed by the airline itself in densely populated areas.

Even though a collection service appears to be suitable for many large airports and high-end airlines, it cannot simply be copied to other cases. First of all, it is preferable to execute a passenger preference survey. Due to limited resources, the passenger survey for this research has been executed with a limited number of respondents. It is desirable to use a significantly larger group of respondents, in order to draw statistically valid conclusions from the survey.

Furthermore, the logistics network needs to be designed for each case specifically. The arrangement stage of Logistics Network Design, as defined by Mourits and Evers (1995), is a suitable methodology for designing the distribution network. For the evaluation of the network, the costs of operating the service through the network have been determined by combining Activity Based Costing with scenario analyses. This combination allows the researcher to account for uncertainties in future events and to assess the costs of each of the activities, and it provides a detailed insight into the effects of the variations in the scenarios on the costs of the activities. This can be very helpful in optimizing the service and assessing the risks involved (Podsada, 2007b). Based on the combination of these analyses, the business model for the off-airport baggage check-in service can be developed.

Finally, the scripts developed in Matlab for the Activity Based Costing analysis of the Baggage Collection Service can be easily adapted to different cases. For each of the regions, a separate script has been developed. Adding a region to the service can be done by duplicating one of the scripts and providing the variables with a different index. All data that is used for the calculations is stored in separate data files. These files can easily be adapted to the specific case under investigation. This can be very useful for QuinTech Engineering Innovations if they will ever perform a similar study for another airport or airline.

Reflection on Assumptions
Because the subject of off-airport baggage check-in is hardly discussed in existing literature, and because much of the required information is not publically available, many assumptions have been made in this research. In this section, the influence of these assumptions on the results will be discussed.

Location of Passengers
Some of the most important assumptions that have been made in this research concern the locations of passengers that will use the off-airport baggage check-in service. The most important assumption that has been used for all concepts is the assumption that the passengers that use the service are similarly distributed throughout the country as are all departing passengers. As shown in Chapter 8, this assumption is very important for the results of the scenario analyses. For example, the costs of
operating the service will significantly increase if passengers from the region west will not use the Baggage Collection Service. Therefore, a thorough market research is desirable.

Besides the distribution throughout the country, the dispersion of passengers within each of the four regions can have an effect on the costs of the service. The dispersion of passengers has been analyzed by using a minimum, an average, and a maximum dispersion based on the population within a representative COROP region. Nevertheless, to assess the possible effects of errors in the estimated dispersion, some sensitivity analyses have been performed. For each of the regions, and for the total service, the effects of the following variations on the costs of the service have been determined:

1. Decreasing the minimum dispersion with 25 percent
2. Increasing the minimum dispersion with 25 percent
3. Decreasing the maximum dispersion with 25 percent
4. Increasing the maximum dispersion with 25 percent

In Table 34, the results of the sensitivity analysis are shown for the extreme cases, in which the error of 25 percent occurs in all regions. In Appendix P, the results per region are shown.

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion − 25 %</td>
<td>− 4.78 %</td>
<td>− 8.15 %</td>
<td>− 8.80 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 11.03 %</td>
<td>+ 10.58 %</td>
<td>+ 9.76 %</td>
</tr>
<tr>
<td>3. Maximum dispersion − 25 %</td>
<td>− 9.31 %</td>
<td>− 10.45 %</td>
<td>− 10.07 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 11.47 %</td>
<td>+ 12.42 %</td>
<td>+ 12.88 %</td>
</tr>
</tbody>
</table>

Though the effects are significant, especially when the dispersion is increased with 25 percent, the total costs per bag would in all cases remain below € 30-. So even in the worst case scenario, the costs per bag are not too sensitive to errors in the dispersion that has been used for the calculations.

The final assumption concerning locations of passengers using the service has been used for the determination of the locations of the distribution centers. As described, for the center-of-gravity approach so-called mass centers have been used. For each COROP region, the largest municipality has been used as the location of all departing passengers. This assumption has only been used in the center-of-gravity approach and therefore only affected the location decision. To assess the impact of the assumption on the total costs, the effect of increasing the average distance to a distribution center has been analyzed for all scenarios. The results are shown in Table 35. Another possible effect of the assumption might be that the distribution centers should be located in a more expensive area. In Table 36, the effects of doubling the fixed costs of the distribution center are shown. From both Table 35 and Table 36, it can be concluded that the effects of the assumption on the total costs per bag are fairly limited.
Table 35 – Increase in Costs per Bag when Increasing Average Driving Distance to Distribution Center with 50 Percent

<table>
<thead>
<tr>
<th>Dispersion</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>4.63 %</td>
<td>6.19 %</td>
<td>7.18 %</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>5.52 %</td>
<td>6.26 %</td>
<td>6.11 %</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>5.22 %</td>
<td>5.49 %</td>
<td>5.28 %</td>
</tr>
</tbody>
</table>

Table 36 - Increase in Costs per Bag when Doubling the Fixed Costs of the Distribution Centers

<table>
<thead>
<tr>
<th>Dispersion</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>3.49 %</td>
<td>2.97 %</td>
<td>2.76 %</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>1.37 %</td>
<td>1.31 %</td>
<td>1.23 %</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>0.89 %</td>
<td>0.87 %</td>
<td>0.82 %</td>
</tr>
</tbody>
</table>

**Other Assumptions**

One assumption that is closely related to the previous assumption concerning the location of distribution centers is the assumption that land can be purchased for the distribution centers at the locations identified. All three locations are near or on industrial areas. Nevertheless, it might very well be possible that no space is available for the distribution centers. This needs to be investigated. As shown above, moving the distribution centers will have a limited effect on the costs.

Another assumption that has been made is that passengers will use the Baggage Collection Service even if there is no service available for the return journey. This assumption is based on the survey performed by KLM Royal Dutch Airlines, in which no return service was mentioned. Nevertheless, it would be desirable to conduct a survey to verify this assumption.

**Reflection on Research**

This research has been initiated by QuinTech Engineering Innovations BV. Their initial goal has been to gain insight into the possible future developments of baggage check-in processes. Especially the role of remote check-in, as a possible solution to the congestion problems at airports and as an additional part of the hassle free journey for passengers, has been the focus from the start of this research.

It turned out, little had been published by the scientific community on baggage and passenger flows outside the airport terminals. Nevertheless, the concept of off-airport baggage check-in is definitely not a new one. Different airports and airlines around the world have initiated baggage check-in services. Based on the many different services that were introduced, and the different success and failure factors that could be identified, it became clear that it would be very difficult to develop a solution that fits all airports. Therefore, it has been decided to focus on Amsterdam Airport Schiphol. Based on a request from QuinTech, the main focus has been on developing a service that could be suited to the needs of KLM Royal Dutch Airlines, the major airline at AAS.

To structure this research, the Innovation Model of in ‘t Veld has been used. This model was chosen because it has been used in other researches that focused on innovating logistics processes. Though this model played a minor part in the research, it proved to be a useful guideline in structuring the research approach.
Since this research has been performed for neither AAS, nor KLM, it has sometimes proved to be rather difficult to obtain critical information from some of the stakeholders. Based on already existing contacts of QuinTech Engineering Innovations with KLM and AAS, it was not too difficult to find suitable subjects for the interviews. However, the interviewees could not provide all the information that was needed, because some of the information was confidential. Furthermore, in retrospect it would have been useful to interview someone from the airport who had already been involved in earlier researches into off-airport baggage check-in solutions. The subjects at KLM and TNT all had already been involved in such projects and therefore could address the difficulties more specifically.

Furthermore, because the research has been focused on a single case study, it was sometimes rather difficult to maintain the academic focus in the research. Especially generalizing some of the conclusions was a difficult task. For the external validity of the research, it is desirable to execute a similar research for other cases. Based on these cases, the analytic generalization of the research conclusions could be improved (Yin, 2003). Nevertheless, the research has resulted in promising outcomes for the case study and a roadmap for executing similar case studies has been derived. It has proposed a solution to the congestion problems in airport terminals that is different from other solutions in literature because it applies a supply-chain perspective to the passenger and baggage flows. Because of the existing similarities between many large airports and high-end airlines, some general conclusions could be drawn from the case study research. Furthermore, it has identified opportunities for further research into the area of baggage and passenger flows outside of the airport terminal.

**Recommendations**

As with any research, this research has answered questions, but has also raised new questions. The actual execution of the service as designed in this research has been left out of scope. Nevertheless, some recommendations for airlines that intend to execute an off-airport baggage check-in service can be given. As described in the Introduction, this research aims to contribute to existing scientific literature by extending the scope of baggage flows to outside the airport. Recommendations for the academic society with respect to this research will be presented as well. Finally, some recommendations for QuinTech Engineering Innovations, the initiator of this research, will be given.

**Recommendations for Airlines**

For large, high-end airlines as KLM Royal Dutch Airlines, this research can serve as a first step in introducing an off-airport baggage check-in service. However, several steps need to be taken before any collection service based on this research can be introduced.

First of all, as mentioned in the Reflection, this research has been based on assumptions with respect to the distribution of passengers using the service. The scenario analyses show that the service is significantly more costly in certain areas than in others. Therefore, it is important to have a good understanding of where passengers that will use the service are located. Because of this, it is advisable to perform an extensive market research among passengers to gather information on their locations. The results of the market research can be used for obtaining more reliable cost assessments.
Furthermore, as mentioned in the Conclusions, the form of the most suitable business model for the service will depend on the price charged by a possible third party logistics provider. To develop the business model, it is necessary for an airline to gather information on prices that 3PL’s will charge for executing the collection service.

Finally, it might be advisable to first start a pilot service. As shown in Chapter 8, costs differ significantly per region. A suitable region can be selected based on both the market research that needs to be performed and on the results for the different regions as presented in this research.

**Recommendations for the Academic Society**

Scientific literature on baggage and passengers flows has been limited to flows inside the airport terminal. This research has aimed to contribute to existing literature by extending the scope to flows outside the terminal. A supply chain oriented approach has been used to the case study of Amsterdam Airport Schiphol. Based on this case study, recommendations for further research can be given.

First of all, this research has aimed to develop a roadmap for executing similar case studies at other airports. The roadmap as presented in Table 33 can be applied to other cases as discussed in the Reflection. Applying this roadmap to other cases can improve the external validity of the research and the analytic generalization of the research conclusions.

One limitation of the service as developed in this research is that it does not incorporate return flows. This might discourage passengers to travel to the airport by train and reduce the added value for passengers. Therefore, it is very interesting to start a research that is focused on the return flow of baggage to the passengers’ home addresses.

Another limitation might be that this research only builds on existing literature to a limited extend. This is due to the fact that little has been published on passenger and baggage flows outside of the airport terminal. Since many large airports face problems with congestion in terminal, further research into the future of passenger and baggage processing, including processes outside of the terminal, is desirable. It is therefore recommended to initiate further research into this direction.

Because the initial problem that has resulted in this research is the congestion problem in large airport terminals, the final recommendation for further research is to initiate a research to assess the effects of introducing an off-airport baggage check-in service on this congestion problem. A simulation analysis can be used to assess the effects of the scenarios as discussed in Chapter 7 on the congestion in the airport terminal during peak hours.

**Recommendations for QuinTech Engineering Innovations**

Finally, some recommendations for QuinTech Engineering Innovations, the initiator of this research, will be given with respect to off-airport baggage check-in.

Based on the high investments required in any off-airport baggage check-in service, and based on the large number of employees needed, it is not advisable that QuinTech will execute such a service itself. The main purpose of this research is to provide information and insight into possibly successful concepts.
with respect to off-airport baggage check-in. This information can be used in consultancy projects for airlines and airports. QuinTech can help setting up a collection service based on this research.

Furthermore, the results of this research that can be generalized, as discussed in the Reflection, can be useful in consultancy projects for other airlines and airports. Especially high-end airlines that serve a densely populated customer area are suitable candidates for offering a collection service. For this purpose, the mathematical models for calculating the costs per bag can be easily adjusted to other cases. In this way, the costs per bag can be assessed quickly for other airlines.

So even though there is no active role for QuinTech in off-airport baggage check-in solutions, the knowledge gathered through this research can be used in consultancy projects for airports and airline throughout Europe.
References


Amsterdam Airport Schiphol (2010a). Herkomst Verdeling
Amsterdam Airport Schiphol (2010b). Verdeling over het jaar.


KLM Royal Dutch Airlines (2007). Remote Baggage Check-In: Research Results. Schiphol, Air-France KLM.


List of Figures

Figure 1 - Annual Distribution of Passengers Departing from Amsterdam Airport Schiphol in 2009 (Amsterdam Airport Schiphol, 2010b) ................................................................. 21
Figure 2 - Average Daily Distribution of Passengers Departing from Amsterdam Airport Schiphol in 2009 (Amsterdam Airport Schiphol, 2010b) ................................................................. 21
Figure 3 - Steps in Departure Process (Based on: Wiegerinck, 2007) ................................................. 25
Figure 4 - The Innovation Model (Based on: in ’t Veld, 2002) ......................................................... 26
Figure 5 - Applied Innovation Model ............................................................................................... 28
Figure 6 - Research Model .............................................................................................................. 32
Figure 7 - Departure Halls and Gates of Amsterdam Airport Schiphol (Schiphol Group, 2010c) .......... 36
Figure 8 - SADT Model Example .................................................................................................. 52
Figure 9 - Baggage Handling Area of AAS with backbone (Based on: Schiphol Group, 2010a) ........ 56
Figure 10 - The Activity Based Costing Approach (Based on: van Damme, 2001) ......................... 60
Figure 11 - Costs of Operating Baggage Collection Service ......................................................... 62
Figure 12 - Costs of Operating Train Station Service .................................................................. 67
Figure 13 - Costs of Operating Schiphol Parking Lot Service ....................................................... 69
Figure 14 - Costs of Operating Schiphol Station Service .............................................................. 71
Figure 15 - Costs of operating the different service concepts ........................................................ 73
Figure 16 - Results of Passenger Preference Survey Question 5 .................................................. 75
Figure 17 - Results of Passenger Preference Survey Question 6 .................................................. 75
Figure 18 - A0 of Baggage Collection Service .............................................................................. 80
Figure 19 - Distribution Network of Albert Heijn .......................................................................... 83
Figure 20 - Distribution Network of Schuitema (Based on: Schuitema, 2010) .............................. 83
Figure 21 - Distribution Network of TNT (Based on: Podsada, 2007a) ........................................... 84
Figure 22 - Distribution Centers of De Bijenkorf, HEMA, and Kruidvat ......................................... 84
Figure 23 - Four Service Regions for Baggage Collection Service ............................................... 85
Figure 24 - Locations of the distribution centers and AAS in the four regions .............................. 87
Figure 25 - Population of Zuidoost-Friesland (Based on: Centraal Bureau voor de Statistiek, 2010c) ..... 96
Figure 26 - Population of Twente (Based on: Centraal Bureau voor de Statistiek, 2010c) ............... 97
Figure 27 - Population of Midden-Noord-Brabant (Based on: Centraal Bureau voor de Statistiek, 2010c) ......................................................................................................................... 98
Figure 28 - Population of Agglomeratie ‘s-Gravenhage (Based on: Centraal Bureau voor de Statistiek, 2010c) ......................................................................................................................... 99
Figure 29 - Marketing Strategy AAS ............................................................................................... 135
Figure 30 - COROP Regions in the Netherlands (Based on: CBS) .................................................. 137
Figure 31 - Baggage Collection Service - Service Provider - A-0 .................................................. 139
Figure 32 - Baggage Collection Service - Service Provider - A0 .................................................... 140
Figure 33 - Baggage Collection Service - Service Provider - A1 .................................................... 141
Figure 34 - Baggage Collection Service - Service Provider - A2 .................................................... 142
Figure 35 - Baggage Collection Service - Service Provider - A3 .................................................... 143
Figure 36 - Baggage Collection Service - Service Provider - A4 .................................................... 144
Figure 37 - Baggage Collection Service - Passenger - A-0 ................................................................. 145
Figure 38 - Baggage Collection Service - Passenger - A0 ............................................................... 146
Figure 39 - Baggage Collection Service - Passenger – A1 ............................................................... 147
Figure 40 - Local Drop-Off Service - Service Provider - A-0 ............................................................ 149
Figure 41 - Local Drop-Off Service - Service Provider - A0 ............................................................ 150
Figure 42 - Local Drop-Off Service - Service Provider - A1 ............................................................ 151
Figure 43 - Local Drop-Off Service - Service Provider - A2 ............................................................ 152
Figure 44 - Local Drop-Off Service - Service Provider - A3 ............................................................ 153
Figure 45 - Local Drop-Off Service - Passenger - A-0 ................................................................. 154
Figure 46 - Local Drop-Off Service - Passenger - A0 ................................................................. 155
Figure 47 - Local Drop-Off Service - Passenger - A1 ................................................................. 156
Figure 48 - Local Drop-Off Service - Passenger - A2 ................................................................. 157
Figure 49 - Train Station Service - Service Provider - A-0 ............................................................. 159
Figure 50 - Train Station Service - Service Provider - A0 ............................................................. 160
Figure 51 - Train Station Service - Service Provider - A1 ............................................................. 161
Figure 52 - Train Station Service - Service Provider - A2 ............................................................. 162
Figure 53 - Train Station Service - Service Provider - A3 ............................................................. 163
Figure 54 - Train Station Service - Passenger - A-0 ................................................................. 164
Figure 55 - Train Station Service - Passenger - A0 ................................................................. 165
Figure 56 - Train Station Service - Passenger - A1 ................................................................. 166
Figure 57 - Train Station Service - Passenger - A2 ................................................................. 167
Figure 58 - Schiphol Parking Lot Service - Service Provider - A-0 .................................................. 169
Figure 59 - Schiphol Parking Lot Service - Service Provider - A0 .................................................. 170
Figure 60 - Schiphol Parking Lot Service - Service Provider - A1 .................................................. 171
Figure 61 - Schiphol Parking Lot Service - Service Provider - A2 .................................................. 172
Figure 62 - Schiphol Parking Lot Service - Service Provider - A3 .................................................. 173
Figure 63 - Schiphol Parking Lot Service - Passenger - A-0 ........................................................ 174
Figure 64 - Schiphol Parking Lot Service - Passenger - A0 ........................................................ 175
Figure 65 - Schiphol Parking Lot Service - Passenger - A1 ........................................................ 176
Figure 66 - Schiphol Parking Lot Service - Passenger - A2 ........................................................ 177
Figure 67 - Schiphol Station Service - Service Provider - A-0 ......................................................... 179
Figure 68 - Schiphol Station Service - Service Provider - A0 ......................................................... 180
Figure 69 - Schiphol Station Service - Service Provider - A1 ......................................................... 181
Figure 70 - Schiphol Station Service - Service Provider - A2 ......................................................... 182
Figure 71 - Schiphol Station Service - Passenger - A-0 ................................................................. 183
Figure 72 - Schiphol Station Service - Passenger - A0 ................................................................. 184
Figure 73 - Schiphol Station Service - Passenger - A1 ................................................................. 185
Figure 74 - Schiphol Station Service - Passenger - A2 ................................................................. 186
Figure 75 - Passenger Distribution over COROP Region ............................................................... 189
Figure 76 - Results of Passenger Preference Survey Question 1 ....................................................... 193
Figure 77 - Results of Passenger Preference Survey Question 2 ....................................................... 193
Figure 78 - Results of Passenger Preference Survey Question 3 ....................................................... 193

118
List of Tables
Table 1 - Data Collection Methods ........................................................................................................... 31
Table 2 - Literature Overview ..................................................................................................................... 31
Table 3 - Critical Issues in Off-Airport Baggage Check-In .......................................................................... 42
Table 4 - Most Important Design Requirements .......................................................................................... 49
Table 5 – Resources, Resource Drivers, and Resource Costs ...................................................................... 60
Table 6 - Activities for Baggage Collection Service ..................................................................................... 61
Table 7 - SWOT Analysis for Baggage Collection Service ........................................................................... 63
Table 8 - Activities for Local Drop-Off Service ............................................................................................ 64
Table 9 - SWOT analysis for Local Drop-Off Service .................................................................................. 65
Table 10 - Activities for Train Station Service .............................................................................................. 66
Table 11 - SWOT Analysis for the Check-In Service at Major Train Stations ............................................. 68
Table 12 - Activities for Schiphol Parking Lot Service ................................................................................ 69
Table 13 - SWOT Analysis for the Schiphol Parking Lot Service ................................................................. 70
Table 14 - Activities for Schiphol Station Service ......................................................................................... 71
Table 15 - SWOT Analysis for the Schiphol Station Service ....................................................................... 72
Table 16 - SWOT Analysis for Baggage Collection Service ....................................................................... 77
Table 17 - Marketing Mix for Baggage Collection Service ....................................................................... 82
Table 18 - Regions for Baggage Collection Service ..................................................................................... 85
Table 19 - Center of Gravity per Region ....................................................................................................... 86
Table 20 - Forces Ranking Matrix .............................................................................................................. 90
Table 21 - Quantification of Scenarios ......................................................................................................... 91
Table 22 - Activities and Resources for Baggage Collection Service .......................................................... 93
Table 23 - Resources, Resource Drivers and Resource Costs for Baggage Collection Service .................. 94
Table 24 - Fixed Assets and Fixed Costs for Baggage Collection Service .................................................. 95
Table 25 - Investment Costs for Distribution Centers .................................................................................. 95
Table 26 - Geographical Dispersion Analysis for Northern Region ............................................................. 97
Table 27 - Geographical Dispersion Analysis for Eastern Region ............................................................... 98
Table 28 - Geographical Dispersion Analysis for Southern Region ............................................................ 99
Table 29 - Geographical Dispersion Analysis for Western Region ............................................................. 99
Table 30 - Analysis of Scenario 1 ................................................................................................................ 100
Table 31 - Analysis of Scenario 2 ................................................................................................................ 101
Table 32 - Analysis of Scenario 3 ................................................................................................................ 101
Table 33 - Roadmap for Off-Airport Baggage Check-in Design .................................................................... 106
Table 34 - Effects of Variations on Total Costs per Bag ............................................................................. 108
Table 35 – Increase in Costs per Bag when Increasing Average Driving Distance to Distribution Center with 50 Percent ........................................................................................................... 109
Table 36 - Increase in Costs per Bag when Doubling the Fixed Costs of the Distribution Centers ............. 109
Table 37 – Passenger Distribution over COROP Regions (AAS) .................................................................. 138
Table 38 - Cost Structure of Baggage Collection Service Concept .............................................................. 148
Table 39 - BCS Cost Structure of Activity 1 ................................................................................................. 148
Appendix A – Interview with AAS Representative

Appendix A.1 – Protocol for Interview with AAS Representative

During the interview, the following issues will be addressed:

1. Goals for AAS in off-airport baggage check-in
2. Requirements from AAS
3. Passenger wishes
4. Possible Concepts
5. Problems and critical issues
6. (Dis)advantages for passengers
7. (Dis)advantages for AAS

The structure of the interview will be rather open in order to obtain as much information as possible without steering in a certain direction. The first two items in the protocol form the focal issues of the interview, which is to obtain the design requirements from the perspective of Amsterdam Airport Schiphol. The other issues in the protocol will be used to gather inside on other aspects of the research and to compare the ideas of AAS with ideas of other stakeholders.
Appendix A.2 – Transcript of Interview with AAS Representative (In Dutch)
Datum: 26-03-2010
Aanwezig:
Dhr. O. Van Reeden, Manager Traffic & Transportation Amsterdam Airport Schiphol
Dhr. R. Vander Meûlen, QuinTech Engineering Innovations
Dhr. R. van Zundert, student Management of Technology

*Mogelijke Benefits voor AAS:*
- Extra service bieden aan passagiers
- Toename van de capaciteit van de terminal (in theorie)
- Imago & Branding van de luchthaven (creëren van Look & Feel van Schiphol, innovatieve oplossingen)

*Eisen vanuit de luchthaven:*
- De oplossing moet logistiek gezien kloppen
- De oplossing mag niet hinderend zijn voor andere activiteiten van de luchthaven
- De doelstellingen van alle partners in de oplossingen moeten op één lijn gebracht worden om belangenverstrengeling en opportunistisch gedrag te voorkomen.
- De oplossing moet uiteraard aan alle veiligheidseisen voldoen

*Eisen vanuit de passagier:*
- De oplossing moet zekerheid bieden voor passagiers op verschillende manieren:
  - De passagier moet vooraf geinformeerd worden over het proces.
  - Na elke fase moet de passagier bevestiging krijgen (bijv. Per sms) dat alles met de bagage in orde is.
  - De passagier moet de mogelijkheid hebben de bagage in geval van nood uit het systeem te halen (medicijnen ingepakt oid)
  - Bij problemen moet er duidelijkheid zijn voor de passagier, dus 1 aanspreekpunt voor de passagier (meest logisch waarschijnlijk de airline).
- De oplossing moet comfort bieden aan de passagier (de toegevoegde waarde), dus geen koffers meer om mee te zeulen, makkelijker overstappen van trein.
- De oplossing moet goedkoop zijn
- De oplossing moet dissatisfiers (zoals wachtrijen) wegnemen voor passagiers

*Voorbeelden van mogelijkheden:*
- Bagage afgifte op stations & vervoer via trein. Bagage gaat in apart compartiment van de trein en wordt ingevoerd in het BHS van Schiphol door afhandelaar. Niet geschikt voor Nederlandse situatie want:
- In Nederland geen dedicated trein service van en naar Schiphol station, NS station heeft hub functie
- In- en uitleden kost teveel tijd en geld (verbouwen station) en neemt flexibiliteit (spoorwijzigingen) weg van NS
- Treinen naar Schiphol zitten vaak al vol
- Geen operationeel voordeel want bagage arriveert niet eerder
- Transavia business model: Passagiers leveren koffer vroegtijdig (dag voor vertrek?) af op een centraal punt. Vanuit dit punt wordt de bagage vervoerd naar de luchthaven en daar tijdens rustige momenten verwerkt.
  - Operationeel voordeel vanwege mogelijke piekafvlakking
  - Minder service want passagiers moeten een extra reismoment inplannen voor bagage-afgifte

Passagiers maken afweging van comfort & zekerheid vs. prijs die ze ervoor betalen. Dit is een aspect dat in het ontwerp moet worden meegenomen.
Appendix B – Interview with KLM Representatives

Appendix B.1 – Protocol for Interview with KLM Representatives

During the interview, the following issues will be addressed:

1. Goals for KLM in off-airport baggage check-in
2. Requirements from KLM
3. Passengers wishes
4. Realistic concepts
5. Problems and critical issues
6. (Dis)advantages for passengers
7. (Dis)advantages for KLM
8. Financial aspects

The structure of the interview will be rather open in order to obtain as much information as possible without steering in a certain direction. The first two items in the protocol form the focal issues of the interview, which is to obtain the design requirements from the perspective of KLM Royal Dutch Airlines. The other issues in the protocol will be used to gather inside on other aspects of the research and to compare the ideas of KLM with ideas of other stakeholders.
Appendix B.2 – Transcript of Interview with KLM Representatives (In Dutch)
Datum: 26-03-2010
Aanwezig:
Dhr. V. Vaessen, Manager Product Development KLM
Dhr. E. Okèl, Product Manager, Passenger Services KLM
Dhr. R. Vander Meûlen, QuinTech Engineering Innovations
Dhr. R. van Zundert, student Management of Technology

Mogelijke doelstellingen van off-airport baggage check-in:

- Hassle-free reizen → passagiersgedreven service aanbieden
  o Passagiers willen geen extra reisbeweging maken
  o Passagiers willen niet teveel extra betalen (ordegrootte €10-15 voor thuis ophalen is reëel)
  o Meeste passagiers willen bagage niet te lang voor de reis afgeven (evt. Avond voor vertrek, eerder niet)
- Piekafvlakking, beter gebruik maken van capaciteit & personeel → operationeel
- Gebruik van openbaar vervoer stimuleren (bereikbaarheid, catchment area, MVO)

Algemene problematiek met invoeren:

- Security problemen
  o Reconciliation (bagage mag alleen aan boord van een vliegtuig als de bijbehorende passagier aan boord is)
  o Veilig bewaren van bagage (na inchecken gaat de bagage niet meteen het systeem in, dus moet er voorkomen worden dat derden bij de bagage kunnen en er bijvoorbeeld drugs in kunnen stoppen)
  o Identiteits controle
- Aansprakelijkheid, meerdere partijen betrokken in de oplossing
- Problemen met odd-size of overweight bagage (betalen, anders vervoeren)
- IT problemen (label printen op afstand)

Note: aansprakelijkheid en security zijn geen onoverkomelijke problemen, moeten wel heel duidelijke afspraken over worden gemaakt.

Mogelijke oplossingen & voor- en nadelen:

- Parkeerterreinen: Bagage inchecken op lang-parkeren
  o Passagiers hoeven niet met bagage naar terminal te lopen
  o Geen operationeel voordeel
  o Niet in lijn met MVO (stimuleert autogezin)
- Op NS station Schiphol
  o Passagiers hoeven niet met bagage naar terminal te lopen
o Station en treinen niet op ingericht
o Geen oplossing voor passagiers met overstap
o NS verliest flexibiliteit
o Station heeft hub-functie, treinen kunnen niet lang stil blijven staan
o Geen operationeel voordeel

- Op andere NS stations
  o Passagiers met directe trein kunnen wel zonder bagage reizen
  o Stations en treinen niet op ingericht
  o NS verliest flexibiliteit
  o Kost veel tijd
  o Geen operationeel voordeel

- Lokale afgiftepunten (TNT punten, Albert Heijn, Reisbureau)
  o Operationeel voordeel
  o Passagier reist op vertrekdag zonder bagage
  o Logistiek netwerk bestaat al
  o Passagier moet extra reisbeweging maken

- Thuis ophalen
  o Echte service voor passagiers
  o Operationeel voordeel wanneer bagage op de avond voor vertrek wordt opgehaald
  o Passagiers moeten waarschijnlijk extra betalen (meer dan bij andere services)

De algemene problematiek geld voor de meeste van bovenstaande oplossingen en zal moeten worden opgelost. Thuis ophalen lijkt de meest veelbelovende optie, lokale afgiftepunten zijn eventueel ook mogelijk.

Om tot een uiteindelijke oplossing te komen is het van belang om integraal naar de business case te kijken. Hierbij zijn de volgende aspecten ook van belang:

- Mogelijkheid tot uitstellen van extra terminal capaciteit bijbouwen op de luchthaven (en de besparingen die hiermee gepaard gaan)
- Groei in reizigers die met openbaar vervoer (veelal trein) naar de luchthaven gaan reizen als ze zonder bagage reizen en de extra opbrengsten voor de NS (en vermindering in uitstoot)
- De rol van de 3PL (TNT/DHL)
- De operationele voordelen voor de airline en de toegevoegde waarde van de service voor de passagier

Om tot een mogelijke off-airport baggage check-in oplossing te komen is het zaak om de algemene problemen met veiligheid, security e.d. op te lossen en met een geloofwaardige, integrale business case te komen.
Appendix C – Interview with TNT Representative

Appendix C.1 – Protocol for Interview with TNT Representative (In Dutch)

Local Drop-Off Concept
In dit concept kunnen vertrekkende passagiers de dag (of avond) voor hun vlucht hun bagage inchecken bij een lokaal check-in punt. De bagage wordt voor de passagiers in de avond naar de luchthaven vervoerd en in het bagage-systeem ingevoerd.

Dit zou een service kunnen zijn waarbij TNT betrokken kan worden, aangezien TNT beschikt over service punten in vrijwel alle gemeenten en een uitgebreid logistiek netwerk heeft. Hieronder staat een aantal punten die ik zou willen bespreken mbt dit concept:

- Aantal TNT Service Punten
- Capaciteit van Service Punten (Opslag)
- Aantal distributiecentra & Capaciteit
- Beschikbare personeel (TNT of airline?)
- Veiligheid/Aansprakelijkheid
- Kosten

Baggage Collection Service
In dit concept kunnen vertrekkende passagiers zich online aanmelden voor de service. Zij geven een adres op waar de bagage de avond voor vertrek opgehaald kan worden. De bagage wordt aan de deur ingecheckt en wordt in de avond/nacht vervoerd naar de luchthaven.

Dit zou ook een service kunnen zijn waarbij TNT betrokken kan worden, aangezien TNT beschikt over het logistieke netwerk en de juiste equipment voor het vervoer. Hieronder staan wat punten die ik zou willen bespreken mbt dit concept:

- Capaciteit van vervoersmiddelen
- Kritieke massa voor het gebruik van distributiecentra
- Locatie distributiecentra
- Beschikbaarheid personeel
- Veiligheid/Aansprakelijkheid
- Combinatie met andere services (pakketjes wegbrengen)
- Kosten

Naast deze twee concepten zou ik nog wat andere, algemene punten willen bespreken:

- Algemene interesse voor een dergelijke service
- ARBO regels
Appendix C.2 – Transcript with TNT Representatie (In Dutch)

Datum: 03-06-2010

Aanwezig:
M. Schipper
R. Vander Meûlen
R. Van Zundert

Concept met KLM (2008)
Passagiers checken online in (of per telefoon) en melden zich aan voor de service. Bagagelabels worden uitgeprint en opgehaald door TNT. Afhankelijk van het tijdstip van de vlucht komt een TNT medewerker op een bepaalde tijd de bagage ophalen. Passagier wordt geïdentificeerd (door middel van foto van legitimatie in combinatie met boarding pass) en de bagage wordt gewogen. Als er iets niet klopt (overgewicht, geen identificatie) dan wordt de bagage niet ingenomen en wordt de passagier aangeraden contact op te nemen met KLM.

Als alles in orde is wordt een label aangebracht. Vervolgens wordt de bagage in een doorzichtige zak geplaatst en gesealed. De zak heeft een uniek nummer dat de passagier op een claim tag krijgt. De passagier tekent voor akkoord en de bagage wordt ingeladen.

Op de luchthaven geeft de chauffeur de bagage af. Als alles in goede conditie is (dus geen seals gebroken) dan tekent een KLM medewerker voor akkoord en voert de bagage in het bagage systeem. De passagiers kan de bagage weer ophalen op de reclaim band op de luchthaven van bestemming.

Dit concept was gericht op de Privium passagiers van KLM. Het is niet doorgegaan door gebrek aan investeringen van KLM (met name voor printers en personeel).

Andere problemen waren onder andere met de identificatie van buitenlandse passagiers, die bijvoorbeeld vele verschillende visa hebben en waarbij dingen als geldigheid en identificatie moeilijk te controleren zijn.

Bagage als pakket
Bagage als pakket versturen heeft zowel voor airline als voor passagier voordelen. Voor airlines scheelt het in gewicht in het vliegtuig wanneer bagage hier niet mee vervoerd hoeft te worden. Daardoor kan een airline ofwel goedkoper vliegen (minder kerosine) ofwel betaalde cargo vervoeren; beiden leveren financiële voordelen op voor de airline.

Voor passagiers is een door-to-door service ook een extra service. De vraag is echter of passagiers extra willen betalen voor zo’n service tov de service van deur tot aan luchthaven van bestemming. Heel veel meer hoeft het niet te kosten gezien de schaalvoordelen van het TNT netwerk; echter over grote afstanden blijft het duurder. Hierbij is het ook een vraag hoelang voor vertrek passagiers hun bagage af willen geven.

Security
Wat betreft veiligheid heeft TNT een uitgebreid systeem met x-ray apparatuur op de internationale depots. Daarnaast heeft TNT de TAPA-A certificering. Er zijn goede afspraken met douane en vaste
klanten over veiligheid en verklaringen mbt bommen, drugs e.d. Vrachtwagens die geladen worden om van een hub naar een depot te reizen worden gesealed. Wat betreft de deur tot airport service betreft moeten veiligheidsaspecten nog afgerond worden, echter lijkt het sealen wel aan de veiligheidseisen te voldoen.

**Overige punten**
- Tijd is een zeer belangrijke value driver
- Service kan gecombineerd worden met recovery service die TNT uitvoert
- Prijzen voor beide services liggen in de range van € 25 - € 100
- Local Drop-Off concept is waarschijnlijk geen markt voor
- LDO concept zal met TNT ook lastig zijn ivm gebrek aan security nu TNT punten in winkels zitten
- De capaciteit voor de bagage service naar de luchthaven is aanwezig, kritieke massa is niet noodzakelijk omdat men van bestaand systeem uit gaat
- Aansprakelijkheid moet goed geregeld worden; TNT heeft verzekeringen volgens Warschau conventie, bijverzekeren kan
- ARBO regels hoeven geen probleem te vormen, bagage weegt gemiddeld minder dan 20 kg.
- Retourstroom kan op eenzelfde wijze ingericht worden als recovery stroom, maar automatisering is dan wel noodzakelijk
Marketingstrategie gebaseerd op twee pijlers

- 'Serving The Netherlands'
- Schiphol als belangrijke driver voor de economie en het vestigingsklimaat
- Schiphol als betrouwbare en efficiënt multimodaal knooppunt dat Nederland verbindt met de rest van de wereld
- Anticiperen op toekomstige selectieve groei door anticyclisch investeren in capaciteit en kwaliteit
- Verantwoord ondernemen
  - Veiligheid
  - Duurzaamheid
  - Innovatie
  - Draagvlak
  - Mens & maatschappij
- Uitvoering Aldersakkoord: Groei naar 580k vliegtuigbewegingen (510k AAS, 70k RELU)

Geen beursgang, maar financieel management wel onderworpen aan de eisen van de financiële markt

Marketingdoel A:
Een optimaal bestemmingen netwerk creeren met een brede portfolio van luchten en luchthavens en relaties met
passagiersmaatschappijen

Marketingdoel B:
Voldoende kritische massa van vliegtuigbewegingen en
passagiersaantallen creëren

- Competitieve en innovatieve bedrijfsvoering, pro-actief, klantgericht, lean & mean, geïnspireerd en gastvrij
- Financieel gezonde bedrijfsvoering op corporate niveau
- Voor de korte termijn sterk inzetten op kostendaling, voor langere termijn op daling kosten per WLU
- Tariefstelling Aviation inzetten als instrument voor een betere concurrerende positie in Europa
- Variabiliteit in rendement Aviation is acceptabel, mits op langere termijn WACC wordt gehaald
- Consumers en Real Estate dienen economic profit te realiseren

Hoe gaat het met Schiphol?
Appendix E – Geographical Distribution of Passengers

Appendix E.1 – COROP Regions in the Netherlands

Figure 30 - COROP Regions in the Netherlands (Based on: CBS)
### Appendix E.2 – Passenger Distribution over COROP Regions

#### Table 37 – Passenger Distribution over COROP Regions (AAS)

<table>
<thead>
<tr>
<th>COROP Nr.</th>
<th>COROP Name</th>
<th>Main Municipality</th>
<th>Percentage of Pass.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oost-Groningen</td>
<td>Stadskanaal</td>
<td>0.2 %</td>
</tr>
<tr>
<td>2</td>
<td>Delfzijl e.o.</td>
<td>Delfzijl</td>
<td>0.1 %</td>
</tr>
<tr>
<td>3</td>
<td>Overig Groningen</td>
<td>Groningen</td>
<td>1.2 %</td>
</tr>
<tr>
<td>4</td>
<td>Noord-Friesland</td>
<td>Leeuwarden</td>
<td>0.7 %</td>
</tr>
<tr>
<td>5</td>
<td>Zuidoost-Friesland</td>
<td>Sneek</td>
<td>0.3 %</td>
</tr>
<tr>
<td>6</td>
<td>Zuidoost-Friesland</td>
<td>Heerenveen</td>
<td>0.4 %</td>
</tr>
<tr>
<td>7</td>
<td>Noord-Drenthe</td>
<td>Assen</td>
<td>0.3 %</td>
</tr>
<tr>
<td>8</td>
<td>Zuidoost-Drenthe</td>
<td>Emmen</td>
<td>0.3 %</td>
</tr>
<tr>
<td>9</td>
<td>Zuidoost-Drenthe</td>
<td>Hoogeveen</td>
<td>0.3 %</td>
</tr>
<tr>
<td>10</td>
<td>Noord-Overijssel</td>
<td>Zwolle</td>
<td>0.8 %</td>
</tr>
<tr>
<td>11</td>
<td>Zuidoost-Overijssel</td>
<td>Deventer</td>
<td>0.4 %</td>
</tr>
<tr>
<td>12</td>
<td>Twente</td>
<td>Enschede</td>
<td>1.2 %</td>
</tr>
<tr>
<td>13</td>
<td>Veluwe</td>
<td>Apeldoorn</td>
<td>2.2 %</td>
</tr>
<tr>
<td>14</td>
<td>Achterhoek</td>
<td>Doetinchem</td>
<td>0.6 %</td>
</tr>
<tr>
<td>15</td>
<td>Arnhem/Nijmegen</td>
<td>Nijmegen</td>
<td>2.1 %</td>
</tr>
<tr>
<td>16</td>
<td>Zuidoost-Gelderland</td>
<td>Tiel</td>
<td>0.7 %</td>
</tr>
<tr>
<td>17</td>
<td>Utrecht</td>
<td>Utrecht</td>
<td>7.5 %</td>
</tr>
<tr>
<td>18</td>
<td>Kop van Noord-Holland</td>
<td>Hoorn</td>
<td>1.6 %</td>
</tr>
<tr>
<td>19</td>
<td>Alkmaar e.o.</td>
<td>Alkmaar</td>
<td>1.3 %</td>
</tr>
<tr>
<td>20</td>
<td>IJmond</td>
<td>Heemskerk</td>
<td>0.9 %</td>
</tr>
<tr>
<td>21</td>
<td>Agglomeratie Haarlem</td>
<td>Haarlem</td>
<td>2.2 %</td>
</tr>
<tr>
<td>22</td>
<td>Zaanstreek</td>
<td>Zaanstad</td>
<td>0.8 %</td>
</tr>
<tr>
<td>23</td>
<td>Groot-Amsterdam</td>
<td>Amsterdam</td>
<td>39.4 %</td>
</tr>
<tr>
<td>24</td>
<td>Het Gooi en Vechtstreek</td>
<td>Hilversum</td>
<td>2.0 %</td>
</tr>
<tr>
<td>25</td>
<td>Agglomeratie Leiden en Bollenstreek</td>
<td>Leiden</td>
<td>3.5 %</td>
</tr>
<tr>
<td>26</td>
<td>Agglomeratie ‘s-Gravenhage</td>
<td>Den Haag</td>
<td>7.0 %</td>
</tr>
<tr>
<td>27</td>
<td>Delft en Westland</td>
<td>Delft</td>
<td>0.9 %</td>
</tr>
<tr>
<td>28</td>
<td>Oost-Zuid-Holland</td>
<td>Gouda</td>
<td>1.5 %</td>
</tr>
<tr>
<td>29</td>
<td>Groot-Rijnmond</td>
<td>Rotterdam</td>
<td>7.5 %</td>
</tr>
<tr>
<td>30</td>
<td>Zuidoost-Zuid-Holland</td>
<td>Dordrecht</td>
<td>1.4 %</td>
</tr>
<tr>
<td>31</td>
<td>Zeeuwsch-Vlaanderen</td>
<td>Terneuzen</td>
<td>0.1 %</td>
</tr>
<tr>
<td>32</td>
<td>Overig Zeeland</td>
<td>Vlissingen</td>
<td>0.6 %</td>
</tr>
<tr>
<td>33</td>
<td>West-Noord-Brabant</td>
<td>Breda</td>
<td>1.7 %</td>
</tr>
<tr>
<td>34</td>
<td>Midden-Noord-Brabant</td>
<td>Tilburg</td>
<td>1.1 %</td>
</tr>
<tr>
<td>35</td>
<td>Noordoost-Noord-Brabant</td>
<td>Den Bosch</td>
<td>2.1 %</td>
</tr>
<tr>
<td>36</td>
<td>Zuidoost-Noord-Brabant</td>
<td>Eindhoven</td>
<td>2.1 %</td>
</tr>
<tr>
<td>37</td>
<td>Noord-Limburg</td>
<td>Venray</td>
<td>0.3 %</td>
</tr>
<tr>
<td>38</td>
<td>Midden-Limburg</td>
<td>Roermond</td>
<td>0.3 %</td>
</tr>
<tr>
<td>39</td>
<td>Zuid-Limburg</td>
<td>Maastricht</td>
<td>0.5 %</td>
</tr>
<tr>
<td>40</td>
<td>Flevoland</td>
<td>Lelystad</td>
<td>1.8 %</td>
</tr>
</tbody>
</table>
Appendix F – Baggage Collection Service Concept

Appendix F.1 – Baggage Collection Service Logistical Model – Service Provider

Figure 31 - Baggage Collection Service - Service Provider - A-0
Figure 32 - Baggage Collection Service - Service Provider - A0
Figure 33 - Baggage Collection Service - Service Provider - A1
Figure 34 - Baggage Collection Service - Service Provider - A2
Figure 35 - Baggage Collection Service - Service Provider - A3
Figure 36 - Baggage Collection Service - Service Provider - A4
Appendix F.2 – Baggage Collection Service Logistical Model – Passenger

Purpose:
To identify all logistical activities that a passenger needs to undertake when using the baggage collection service

Viewpoint:
Passenger

Figure 37 - Baggage Collection Service - Passenger - A-0
Figure 38 - Baggage Collection Service - Passenger - A0
Figure 39 - Baggage Collection Service - Passenger – A1
### Appendix F.3 – Cost Structure per Activity

#### Table 38 - Cost Structure of Baggage Collection Service Concept

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
<th>Activity 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 3.979,88</td>
<td>€ 8.517,32</td>
<td>€ 3.979,88</td>
<td>€ 156,56</td>
</tr>
<tr>
<td>20</td>
<td>€ 7.030,12</td>
<td>€ 16.198,63</td>
<td>€ 7.030,12</td>
<td>€ 313,11</td>
</tr>
<tr>
<td>30</td>
<td>€ 10.367,76</td>
<td>€ 24.011,95</td>
<td>€ 10.367,76</td>
<td>€ 469,67</td>
</tr>
<tr>
<td>40</td>
<td>€ 13.284,33</td>
<td>€ 31.649,26</td>
<td>€ 13.284,33</td>
<td>€ 626,22</td>
</tr>
<tr>
<td>50</td>
<td>€ 16.621,97</td>
<td>€ 39.462,58</td>
<td>€ 16.621,97</td>
<td>€ 782,78</td>
</tr>
</tbody>
</table>

#### Table 39 - BCS Cost Structure of Activity 1

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Fuel Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 3.979,88</td>
<td>€ 1.253,26</td>
<td>€ 2.726,63</td>
</tr>
<tr>
<td>20</td>
<td>€ 7.030,12</td>
<td>€ 2.213,77</td>
<td>€ 4.816,35</td>
</tr>
<tr>
<td>30</td>
<td>€ 10.367,76</td>
<td>€ 3.264,79</td>
<td>€ 7.102,98</td>
</tr>
<tr>
<td>50</td>
<td>€ 16.621,97</td>
<td>€ 5.234,22</td>
<td>€ 11.387,75</td>
</tr>
</tbody>
</table>

#### Table 40 - BCS Cost Structure of Activity 2

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Fuel Costs</th>
<th>Labor Costs</th>
<th>Label Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 8.517,32</td>
<td>€ 1.349,22</td>
<td>€ 7.040,00</td>
<td>€ 128,09</td>
</tr>
<tr>
<td>20</td>
<td>€ 16.198,63</td>
<td>€ 2.698,45</td>
<td>€ 13.244,00</td>
<td>€ 256,18</td>
</tr>
<tr>
<td>30</td>
<td>€ 24.011,95</td>
<td>€ 4.047,67</td>
<td>€ 19.580,00</td>
<td>€ 384,27</td>
</tr>
<tr>
<td>40</td>
<td>€ 31.649,26</td>
<td>€ 5.396,90</td>
<td>€ 25.740,00</td>
<td>€ 512,36</td>
</tr>
<tr>
<td>50</td>
<td>€ 39.462,58</td>
<td>€ 6.746,12</td>
<td>€ 32.076,00</td>
<td>€ 640,45</td>
</tr>
</tbody>
</table>

#### Table 41 - BCS Cost Structure of Activity 3

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Fuel Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 3.979,88</td>
<td>€ 1.253,26</td>
<td>€ 2.726,63</td>
</tr>
<tr>
<td>20</td>
<td>€ 7.030,12</td>
<td>€ 2.213,77</td>
<td>€ 4.816,35</td>
</tr>
<tr>
<td>30</td>
<td>€ 10.367,76</td>
<td>€ 3.264,79</td>
<td>€ 7.102,98</td>
</tr>
<tr>
<td>50</td>
<td>€ 16.621,97</td>
<td>€ 5.234,22</td>
<td>€ 11.387,75</td>
</tr>
</tbody>
</table>

#### Table 42 - BCS Cost Structure of Activity 4

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 156,56</td>
<td>€ 156,56</td>
</tr>
<tr>
<td>20</td>
<td>€ 313,11</td>
<td>€ 313,11</td>
</tr>
<tr>
<td>30</td>
<td>€ 469,67</td>
<td>€ 469,67</td>
</tr>
<tr>
<td>40</td>
<td>€ 626,22</td>
<td>€ 626,22</td>
</tr>
<tr>
<td>50</td>
<td>€ 782,78</td>
<td>€ 782,78</td>
</tr>
</tbody>
</table>
Appendix G – Local Drop-Off Service Concept
Appendix G.1 – Local Drop-Off Service Logistical Model – Service Provider

Unchecked Baggage

Purpose:
To identify all logistical activities, constraints and required resources for operating the local drop-off service

Viewpoint:
Service Provider

Figure 40 - Local Drop-Off Service - Service Provider - A-0
Figure 41 - Local Drop-Off Service - Service Provider - A0
Figure 42 - Local Drop-Off Service - Service Provider - A1
Figure 43 - Local Drop-Off Service - Service Provider - A2
Figure 44 - Local Drop-Off Service - Service Provider - A3
Figure 45 - Local Drop-Off Service - Passenger - A-0
Figure 47 - Local Drop-Off Service - Passenger - A1
Figure 48 - Local Drop-Off Service - Passenger - A2
Appendix H – Train Station Service Concept

Appendix H.1 – Train Station Service Logistical Model – Service Provider

Figure 49 - Train Station Service - Service Provider - A-0
Figure 50 - Train Station Service - Service Provider - A0
Figure 51 - Train Station Service - Service Provider - A1
Figure 52 - Train Station Service - Service Provider - A2
Figure 53 - Train Station Service - Service Provider - A3
Appendix H.2 – Train Station Service Logistical Model – Passenger

<table>
<thead>
<tr>
<th>USED AT:</th>
<th>AUTHOR: Rick van Zundert</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT: Train Station Service - Passenger</td>
<td>DATE: 4/27/2010</td>
</tr>
<tr>
<td>REV: 5/12/2010</td>
<td>WORKING</td>
</tr>
<tr>
<td>READER</td>
<td>DATE</td>
</tr>
<tr>
<td>CONTEXT:</td>
<td>TOP</td>
</tr>
<tr>
<td>NOTES: 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 54 - Train Station Service - Passenger - A-0**

The diagram represents the logistical model for train station service with passenger focus. It includes various nodes and arrows indicating the flow of processes. The main node is labeled "Train Station Service" with additional nodes for "Unchecked Baggage", "Check-In Procedures", "Other Regulations", "Passport & Boarding Pass", "Vehicle", and "Checked Baggage". The purpose is to outline all activities a passenger needs to undertake when using the train station service. The viewpoint is passenger-oriented.
Figure 55 - Train Station Service - Passenger - A0
Figure 56 - Train Station Service - Passenger - A1
Figure 57 - Train Station Service - Passenger - A2
Appendix H.3 – Cost Structure per Activity

Table 43 - Cost Structure of Train Station Service Concept

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 2.344,26</td>
<td>€ 7.514,21</td>
<td>€ 37,73</td>
</tr>
<tr>
<td>20</td>
<td>€ 2.378,52</td>
<td>€ 7.543,11</td>
<td>€ 75,46</td>
</tr>
<tr>
<td>30</td>
<td>€ 2.478,78</td>
<td>€ 7.687,61</td>
<td>€ 113,18</td>
</tr>
<tr>
<td>40</td>
<td>€ 2.711,04</td>
<td>€ 7.730,96</td>
<td>€ 150,91</td>
</tr>
<tr>
<td>50</td>
<td>€ 2.811,30</td>
<td>€ 7.788,77</td>
<td>€ 188,64</td>
</tr>
</tbody>
</table>

Table 44 - TSS Cost Structure of Activity 1

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
<th>Label Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 2.344,26</td>
<td>€ 2.310,00</td>
<td>€ 34,26</td>
</tr>
<tr>
<td>20</td>
<td>€ 2.378,52</td>
<td>€ 2.310,00</td>
<td>€ 68,52</td>
</tr>
<tr>
<td>30</td>
<td>€ 2.478,78</td>
<td>€ 2.376,00</td>
<td>€ 102,78</td>
</tr>
<tr>
<td>40</td>
<td>€ 2.711,04</td>
<td>€ 2.574,00</td>
<td>€ 137,04</td>
</tr>
<tr>
<td>50</td>
<td>€ 2.811,30</td>
<td>€ 2.640,00</td>
<td>€ 171,30</td>
</tr>
</tbody>
</table>

Table 45 - TSS Cost Structure of Activity 2

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Fuel Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 7.514,21</td>
<td>€ 2.366,21</td>
<td>€ 5.148,00</td>
</tr>
<tr>
<td>20</td>
<td>€ 7.543,11</td>
<td>€ 2.375,31</td>
<td>€ 5.167,80</td>
</tr>
<tr>
<td>30</td>
<td>€ 7.687,61</td>
<td>€ 2.420,81</td>
<td>€ 5.266,80</td>
</tr>
<tr>
<td>40</td>
<td>€ 7.730,96</td>
<td>€ 2.434,46</td>
<td>€ 5.296,50</td>
</tr>
<tr>
<td>50</td>
<td>€ 7.788,77</td>
<td>€ 2.452,67</td>
<td>€ 5.336,10</td>
</tr>
</tbody>
</table>

Table 46 - TSS Cost Structure of Activity 3

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 37,73</td>
<td>€ 37,73</td>
</tr>
<tr>
<td>20</td>
<td>€ 75,46</td>
<td>€ 75,46</td>
</tr>
<tr>
<td>30</td>
<td>€ 113,18</td>
<td>€ 113,18</td>
</tr>
<tr>
<td>40</td>
<td>€ 150,91</td>
<td>€ 150,91</td>
</tr>
<tr>
<td>50</td>
<td>€ 188,64</td>
<td>€ 188,64</td>
</tr>
</tbody>
</table>
Appendix I – Schiphol Parking Lot Service
Appendix I.1 – Schiphol Parking Lot Service Logistical Model – Service Provider

Figure 58 - Schiphol Parking Lot Service - Service Provider - A-0
Figure 59 - Schiphol Parking Lot Service - Service Provider - A0
Figure 60 - Schiphol Parking Lot Service - Service Provider - A1
Figure 61 - Schiphol Parking Lot Service - Service Provider - A2
Figure 62 - Schiphol Parking Lot Service - Service Provider - A3
Appendix I.2 – Schiphol Parking Lot Service Logistical Model – Passenger

Figure 63 - Schiphol Parking Lot Service - Passenger - A-0
Figure 64 - Schiphol Parking Lot Service - Passenger - A0
Figure 65 - Schiphol Parking Lot Service - Passenger - A1
Figure 66 - Schiphol Parking Lot Service - Passenger - A2
## Appendix I.3 – Cost Structure per Activity

### Table 47 - Cost Structure of Schiphol Parking Lot Service Concept

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 393,16</td>
<td>€ 7,09</td>
<td>€ 23,41</td>
</tr>
<tr>
<td>20</td>
<td>€ 412,31</td>
<td>€ 8,34</td>
<td>€ 46,83</td>
</tr>
<tr>
<td>30</td>
<td>€ 497,47</td>
<td>€ 13,34</td>
<td>€ 70,24</td>
</tr>
<tr>
<td>40</td>
<td>€ 626,62</td>
<td>€ 14,59</td>
<td>€ 93,65</td>
</tr>
<tr>
<td>50</td>
<td>€ 799,78</td>
<td>€ 19,59</td>
<td>€ 117,06</td>
</tr>
</tbody>
</table>

### Table 48 - SLS Cost Structure of Activity 1

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
<th>Label Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 393,16</td>
<td>€ 374,00</td>
<td>€ 19,16</td>
</tr>
<tr>
<td>20</td>
<td>€ 412,31</td>
<td>€ 374,00</td>
<td>€ 38,31</td>
</tr>
<tr>
<td>30</td>
<td>€ 497,47</td>
<td>€ 440,00</td>
<td>€ 57,47</td>
</tr>
<tr>
<td>40</td>
<td>€ 626,62</td>
<td>€ 550,00</td>
<td>€ 76,62</td>
</tr>
<tr>
<td>50</td>
<td>€ 799,78</td>
<td>€ 704,00</td>
<td>€ 95,78</td>
</tr>
</tbody>
</table>

### Table 49 - SLS Cost Structure of Activity 2

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Fuel Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 7,09</td>
<td>€ 4,30</td>
<td>€ 2,79</td>
</tr>
<tr>
<td>20</td>
<td>€ 8,34</td>
<td>€ 5,06</td>
<td>€ 3,28</td>
</tr>
<tr>
<td>30</td>
<td>€ 13,34</td>
<td>€ 8,09</td>
<td>€ 5,25</td>
</tr>
<tr>
<td>40</td>
<td>€ 14,59</td>
<td>€ 8,85</td>
<td>€ 5,74</td>
</tr>
<tr>
<td>50</td>
<td>€ 19,59</td>
<td>€ 11,88</td>
<td>€ 7,71</td>
</tr>
</tbody>
</table>

### Table 50 - SLS Cost Structure of Activity 3

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 23,41</td>
<td>€ 23,41</td>
</tr>
<tr>
<td>20</td>
<td>€ 46,83</td>
<td>€ 46,83</td>
</tr>
<tr>
<td>30</td>
<td>€ 70,24</td>
<td>€ 70,24</td>
</tr>
<tr>
<td>40</td>
<td>€ 93,65</td>
<td>€ 93,65</td>
</tr>
<tr>
<td>50</td>
<td>€ 117,06</td>
<td>€ 117,06</td>
</tr>
</tbody>
</table>
Appendix J – Schiphol Station Service

Appendix J.1 – Schiphol Station Service Logistical Model – Service Provider

Figure 67 - Schiphol Station Service - Service Provider - A-0
Figure 68 - Schiphol Station Service - Service Provider - A0
Figure 69 - Schiphol Station Service - Service Provider - A1
Figure 70 - Schiphol Station Service - Service Provider - A2
Appendix J.2 – Schiphol Station Service Logistical Model – Passenger

Figure 71 - Schiphol Station Service - Passenger - A-0
Figure 72 - Schiphol Station Service - Passenger - A0
Figure 73 - Schiphol Station Service - Passenger - A1
Figure 74 - Schiphol Station Service - Passenger - A2
### Appendix J.3 – Cost Structure of Schiphol Station Service Concept

**Table 51 - Cost Structure of Schiphol Station Service Concept**

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Activity 1</th>
<th>Activity 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 420,21</td>
<td>€ 56,48</td>
</tr>
<tr>
<td>20</td>
<td>€ 752,42</td>
<td>€ 112,96</td>
</tr>
<tr>
<td>30</td>
<td>€ 974,63</td>
<td>€ 169,44</td>
</tr>
<tr>
<td>40</td>
<td>€ 1,262,84</td>
<td>€ 225,92</td>
</tr>
<tr>
<td>50</td>
<td>€ 1,551,05</td>
<td>€ 282,40</td>
</tr>
</tbody>
</table>

**Table 52 - SSS Cost Structure of Activity 1**

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
<th>Label Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 420,21</td>
<td>€ 374,00</td>
<td>€ 46,21</td>
</tr>
<tr>
<td>20</td>
<td>€ 752,42</td>
<td>€ 660,00</td>
<td>€ 92,42</td>
</tr>
<tr>
<td>30</td>
<td>€ 974,63</td>
<td>€ 836,00</td>
<td>€ 138,63</td>
</tr>
<tr>
<td>40</td>
<td>€ 1,262,84</td>
<td>€ 1,078,00</td>
<td>€ 184,84</td>
</tr>
<tr>
<td>50</td>
<td>€ 1,551,05</td>
<td>€ 1,320,00</td>
<td>€ 231,05</td>
</tr>
</tbody>
</table>

**Table 53 - SSS Cost Structure of Activity 2**

<table>
<thead>
<tr>
<th>Percentage Using the Service</th>
<th>Total Costs</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>€ 56,48</td>
<td>€ 56,48</td>
</tr>
<tr>
<td>20</td>
<td>€ 112,96</td>
<td>€ 112,96</td>
</tr>
<tr>
<td>30</td>
<td>€ 169,44</td>
<td>€ 169,44</td>
</tr>
<tr>
<td>40</td>
<td>€ 225,92</td>
<td>€ 225,92</td>
</tr>
<tr>
<td>50</td>
<td>€ 282,40</td>
<td>€ 282,40</td>
</tr>
</tbody>
</table>
Appendix K – Pickup Capacity Assessment

To assess the number of pickups a driver can perform in two hours, an example has been developed for the COROP Region Zuidoost-Noord-Brabant, which can be considered an average region with 2.20% of all departing passengers.

For the calculations, the following assumptions have been used:

- Ten percent of the departing passengers uses the service; this is an average of 18 passengers per day from the Zuidoost-Noord-Brabant region
- The passengers are distributed over the 17 municipalities as shown with red dots in Figure 75
- The pickups are performed with two different vans

Figure 75 - Passenger Distribution over COROP Region
In Table 54 and Table 55 the driving times between each of the pickups in the northern and the southern part of the COROP region respectively, are presented. These are based on the route-calculator in Google Maps (Google, 2010).

### Table 54 - Drive Times Pickups in Northern Region

<table>
<thead>
<tr>
<th>Start Location</th>
<th>Pickup Location</th>
<th>Drive Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veldhoven</td>
<td>Eindhoven West</td>
<td>13 min.</td>
</tr>
<tr>
<td>Eindhoven West</td>
<td>Eindhoven East</td>
<td>12 min.</td>
</tr>
<tr>
<td>Eindhoven East</td>
<td>Nuenen</td>
<td>17 min.</td>
</tr>
<tr>
<td>Nuenen</td>
<td>Helmond</td>
<td>16 min.</td>
</tr>
<tr>
<td>Helmond</td>
<td>Gemert</td>
<td>17 min.</td>
</tr>
<tr>
<td>Gemert</td>
<td>Laarbeek</td>
<td>10 min.</td>
</tr>
<tr>
<td>Laarbeek</td>
<td>Breugel</td>
<td>16 min.</td>
</tr>
<tr>
<td>Breugel</td>
<td>Best</td>
<td>16 min.</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>15 min.</strong></td>
</tr>
</tbody>
</table>

### Table 55 - Drive Times Pickups in Southern Region

<table>
<thead>
<tr>
<th>Start Location</th>
<th>Pickup Location</th>
<th>Drive Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eersel</td>
<td>Bergeijk</td>
<td>9 min.</td>
</tr>
<tr>
<td>Bergeijk</td>
<td>Valkenswaard</td>
<td>13 min.</td>
</tr>
<tr>
<td>Valkenswaard</td>
<td>Heeze</td>
<td>10 min.</td>
</tr>
<tr>
<td>Heeze</td>
<td>Cranendonck</td>
<td>9 min.</td>
</tr>
<tr>
<td>Cranendonck</td>
<td>Someren</td>
<td>20 min.</td>
</tr>
<tr>
<td>Someren</td>
<td>Asten</td>
<td>6 min.</td>
</tr>
<tr>
<td>Asten</td>
<td>Geldrop</td>
<td>20 min.</td>
</tr>
<tr>
<td>Geldrop</td>
<td>Waalre</td>
<td>20 min.</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>14 min.</strong></td>
</tr>
</tbody>
</table>

On average, the driving time between two pickups is approximately 15 minutes. Assuming that the checking in of a piece of baggage on average takes 5 to 6 minutes (at a manual check-in counter in the airport it takes on average 105 seconds), a driver can perform on average six pickups in a time window of two hours. This number of six pickups will be used in further calculations.
Appendix L – Passenger Survey

Appendix L.1 – Passenger Survey Protocol

1. What is your gender?
   - Male
   - Female
2. What is your age?
   - 0 – 20 years
   - 21 – 40 years
   - 41 – 60 years
   - above 60 years
3. How often have you flown for leisure purposes in 2009 (there and back counts as 1 time)?
   - 0 times
   - 1 time
   - 2 times
   - 3 or more times
4. How often have you flown for business purposes in 2009 (there and back counts as 1 time)?
   - 0 times
   - 1 time
   - 2 times
   - 3 or more times

The following questions will concern a set of concepts for off-airport baggage check-in developed during my research. All concepts are aimed at checking in hold baggage at a location outside of the airport terminal. Passengers can check-in online and use the off-airport baggage check-in service. Passengers that use the service can travel to the airport without baggage and proceed directly to the security check.

Below, the five concepts will briefly be described:

a) Baggage Collection Service
   Passengers that check-in online can apply for the service and specify an address. Baggage will be collected at this address at the evening prior to departure and is transported to the airport during the night.

b) Local Drop-Off Service
   Passengers can check-in their baggage at a drop-off location in their hometown, such as TNT service points, on the day prior to departure. Baggage will be stored during the day and transported to the airport during the evening.

c) Train Station Service
   Passengers can check-in their baggage at one of the following train stations: Amsterdam Centraal, Den Haag Hollands Spoor, Utrecht Centraal, Rotterdam Centraal, Eindhoven, Arnhem, or Groningen. They can do so up to three (four for Groningen) hours prior to flight departure. Baggage will be transported to the airport once every hour.
d) Schiphol Parking Lot Service
   Passengers can check-in their baggage at the long-stay parking lots of Amsterdam Airport Schiphol. Baggage is transported to the baggage handling system.

e) Schiphol Station Service
   Passengers can check-in their baggage at Schiphol train station up to 1.5 hours prior to flight departure. Baggage is loaded into the baggage handling system.

5. Which of the concepts above would you consider using (multiple answers possible)?
   - Baggage Collection Service
   - Local Drop-Off Service
   - Train Station Service
   - Schiphol Parking Lot Service
   - Schiphol Station Service
   - None of the above

6. Which of the concepts would you prefer (only one answer possible)?
   - Baggage Collection Service
   - Local Drop-Off Service
   - Train Station Service
   - Schiphol Parking Lot Service
   - Schiphol Station Service
   - None of the above

7. Which of the concepts above would you consider using if you had to pay for it (multiple answers possible)?
   - Baggage Collection Service
   - Local Drop-Off Service
   - Train Station Service
   - Schiphol Parking Lot Service
   - Schiphol Station Service
   - None of the above

8. Which of the concepts would you prefer (only one answer possible)?
   - Baggage Collection Service
   - Local Drop-Off Service
   - Train Station Service
   - Schiphol Parking Lot Service
   - Schiphol Station Service
   - None of the above
Appendix L.2 – Passenger Survey Results

Figure 76 - Results of Passenger Preference Survey Question 1

Figure 77 - Results of Passenger Preference Survey Question 2

Figure 78 - Results of Passenger Preference Survey Question 3
Q4. How often have you flown for business purposes in 2009?

Figure 79 - Results of Passenger Preference Survey Question 4

Q5. Which of the concepts would you consider using?

Figure 80 - Results of Passenger Preference Survey Question 5

Q6. Which of the concepts would you prefer?

Figure 81 - Results of Passenger Preference Survey Question 6
Q7. Which of the concepts would you consider using if you had to pay for it?

N = 42

Figure 82 - Results of Passenger Preference Survey Question 7

Q8. Which of the concepts would you prefer if you had to pay for it?

N = 42

Figure 83 - Results of Passenger Preference Survey Question 8
Appendix M – SADT Model of Final Baggage Collection Service

Figure 84 - A-0 of Final Baggage Collection Service
Figure 85 - A0 of Final Baggage Collection Service
Appendix N - Baggage Weight and Volume Distribution

Figure 86 - Baggage Weight Distribution at AAS

Figure 87 - Baggage Volume Distribution at AAS
## Appendix O - Cost Structures for Scenario Analyses

### Table 56 - Costs per Activity for Scenario 1

<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Dispersion</th>
<th>Average Dispersion</th>
<th>Maximum Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€ 64.05</td>
<td>€ 64.05</td>
<td>€ 64.05</td>
</tr>
<tr>
<td>2</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>3</td>
<td>€ 783.97</td>
<td>€ 1027.85</td>
<td>€ 1155.54</td>
</tr>
<tr>
<td>4</td>
<td>€ 2909.5</td>
<td>€ 3668.53</td>
<td>€ 4051.10</td>
</tr>
<tr>
<td>5</td>
<td>€ 783.97</td>
<td>€ 1027.85</td>
<td>€ 1155.54</td>
</tr>
<tr>
<td>6</td>
<td>€ 70.21</td>
<td>€ 70.21</td>
<td>€ 70.21</td>
</tr>
<tr>
<td>7</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>8</td>
<td>€ 313.11</td>
<td>€ 313.11</td>
<td>€ 313.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 8826.96</strong></td>
<td><strong>€ 10385.34</strong></td>
<td><strong>€ 11182.78</strong></td>
</tr>
</tbody>
</table>

### Table 57 - Costs per Activity for Scenario 2

<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Dispersion</th>
<th>Average Dispersion</th>
<th>Maximum Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€ 192.14</td>
<td>€ 192.14</td>
<td>€ 192.14</td>
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<tr>
<td>2</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>3</td>
<td>€ 2495.54</td>
<td>€ 2684.50</td>
<td>€ 2914.51</td>
</tr>
<tr>
<td>4</td>
<td>€ 8287.75</td>
<td>€ 8798.96</td>
<td>€ 9543.64</td>
</tr>
<tr>
<td>5</td>
<td>€ 2495.54</td>
<td>€ 2684.50</td>
<td>€ 2914.51</td>
</tr>
<tr>
<td>6</td>
<td>€ 210.62</td>
<td>€ 210.62</td>
<td>€ 210.62</td>
</tr>
<tr>
<td>7</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>8</td>
<td>€ 939.33</td>
<td>€ 939.33</td>
<td>€ 939.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 22461.36</strong></td>
<td><strong>€ 23572.80</strong></td>
<td><strong>€ 25078.66</strong></td>
</tr>
</tbody>
</table>

### Table 58 - Costs per Activity for Scenario 3

<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Dispersion</th>
<th>Average Dispersion</th>
<th>Maximum Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€ 320.23</td>
<td>€ 320.23</td>
<td>€ 320.23</td>
</tr>
<tr>
<td>2</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>3</td>
<td>€ 3980.59</td>
<td>€ 4083.99</td>
<td>€ 4455.57</td>
</tr>
<tr>
<td>4</td>
<td>€ 12980.36</td>
<td>€ 13333.56</td>
<td>€ 14531.88</td>
</tr>
<tr>
<td>5</td>
<td>€ 3980.59</td>
<td>€ 4083.99</td>
<td>€ 4455.57</td>
</tr>
<tr>
<td>6</td>
<td>€ 351.04</td>
<td>€ 351.04</td>
<td>€ 351.04</td>
</tr>
<tr>
<td>7</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
<td>€ 471.58</td>
</tr>
<tr>
<td>8</td>
<td>€ 1565.56</td>
<td>€ 1565.56</td>
<td>€ 1565.56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 34536.95</strong></td>
<td><strong>€ 35236.95</strong></td>
<td><strong>€ 37663.80</strong></td>
</tr>
</tbody>
</table>
## Appendix P – Sensitivity Analyses per Region

### Table 59 - Effects of Variations in Northern Region on Total Costs per Bag

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.02 %</td>
<td>- 0.05 %</td>
<td>- 0.40 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 1.34 %</td>
<td>+ 1.66 %</td>
<td>+ 0.73 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 2.44 %</td>
<td>- 1.09 %</td>
<td>- 0.77 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 0.31 %</td>
<td>+ 0.20 %</td>
<td>+ 1.12 %</td>
</tr>
</tbody>
</table>

### Table 60 - Effects of Variations in Northern Region on Costs per Bag in Northern Region

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.12 %</td>
<td>- 0.48 %</td>
<td>- 4.81 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 9.77 %</td>
<td>+ 15.41 %</td>
<td>+ 8.85 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 14.53 %</td>
<td>- 9.01 %</td>
<td>- 8.55 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 1.83 %</td>
<td>+ 1.64 %</td>
<td>+ 12.44 %</td>
</tr>
</tbody>
</table>

### Table 61 - Effects of Variations in Eastern Region on Total Costs per Bag

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.06 %</td>
<td>- 1.07 %</td>
<td>- 0.89 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 2.53 %</td>
<td>+ 1.53 %</td>
<td>+ 0.87 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 1.34 %</td>
<td>- 1.66 %</td>
<td>- 1.11 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 0.44 %</td>
<td>+ 2.06 %</td>
<td>+ 1.74 %</td>
</tr>
</tbody>
</table>

### Table 62 - Effects of Variations in Eastern Region on Costs per Bag in Eastern Region

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.34 %</td>
<td>- 7.74 %</td>
<td>- 7.20 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 15.33 %</td>
<td>+ 11.03 %</td>
<td>+ 7.04 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 7.24 %</td>
<td>- 11.92 %</td>
<td>- 9.06 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 2.39 %</td>
<td>+ 14.82 %</td>
<td>+ 14.17 %</td>
</tr>
</tbody>
</table>

### Table 63 - Effects of Variations in Southern Region on Total Costs per Bag

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.05 %</td>
<td>- 1.54 %</td>
<td>- 1.99 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 2.60 %</td>
<td>+ 1.57 %</td>
<td>+ 1.36 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 1.37 %</td>
<td>- 1.69 %</td>
<td>- 1.15 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 4.54 %</td>
<td>+ 2.08 %</td>
<td>+ 1.42 %</td>
</tr>
</tbody>
</table>

### Table 64 - Effects of Variations in Southern Region on Costs per Bag in Southern Region

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>- 0.27 %</td>
<td>- 10.63 %</td>
<td>- 14.38 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+ 14.70 %</td>
<td>+ 10.84 %</td>
<td>+ 9.80 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>- 6.94 %</td>
<td>- 11.62 %</td>
<td>- 8.96 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+ 22.94 %</td>
<td>+ 14.37 %</td>
<td>+ 11.02 %</td>
</tr>
</tbody>
</table>
### Table 65 - Effects of Variations in Western Region on Total Costs per Bag

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>-4.65 %</td>
<td>-5.48 %</td>
<td>-5.37 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+4.57 %</td>
<td>+5.81 %</td>
<td>+6.65 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>-4.16 %</td>
<td>-6.02 %</td>
<td>-7.04 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+6.18 %</td>
<td>+8.07 %</td>
<td>+8.61 %</td>
</tr>
</tbody>
</table>

### Table 66 - Effects of Variations in Western Region on Costs per Bag in Western Region

<table>
<thead>
<tr>
<th>Variation</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minimum dispersion – 25 %</td>
<td>-8.87 %</td>
<td>-8.99 %</td>
<td>-8.19 %</td>
</tr>
<tr>
<td>2. Minimum dispersion + 25 %</td>
<td>+8.71 %</td>
<td>+9.53 %</td>
<td>+10.15 %</td>
</tr>
<tr>
<td>3. Maximum dispersion – 25 %</td>
<td>-9.21 %</td>
<td>-10.10 %</td>
<td>-10.67 %</td>
</tr>
<tr>
<td>4. Maximum dispersion + 25 %</td>
<td>+13.68 %</td>
<td>+13.55 %</td>
<td>+13.05 %</td>
</tr>
</tbody>
</table>