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ALOHA

Promising Aircraft Modifications for Low Handling Costs

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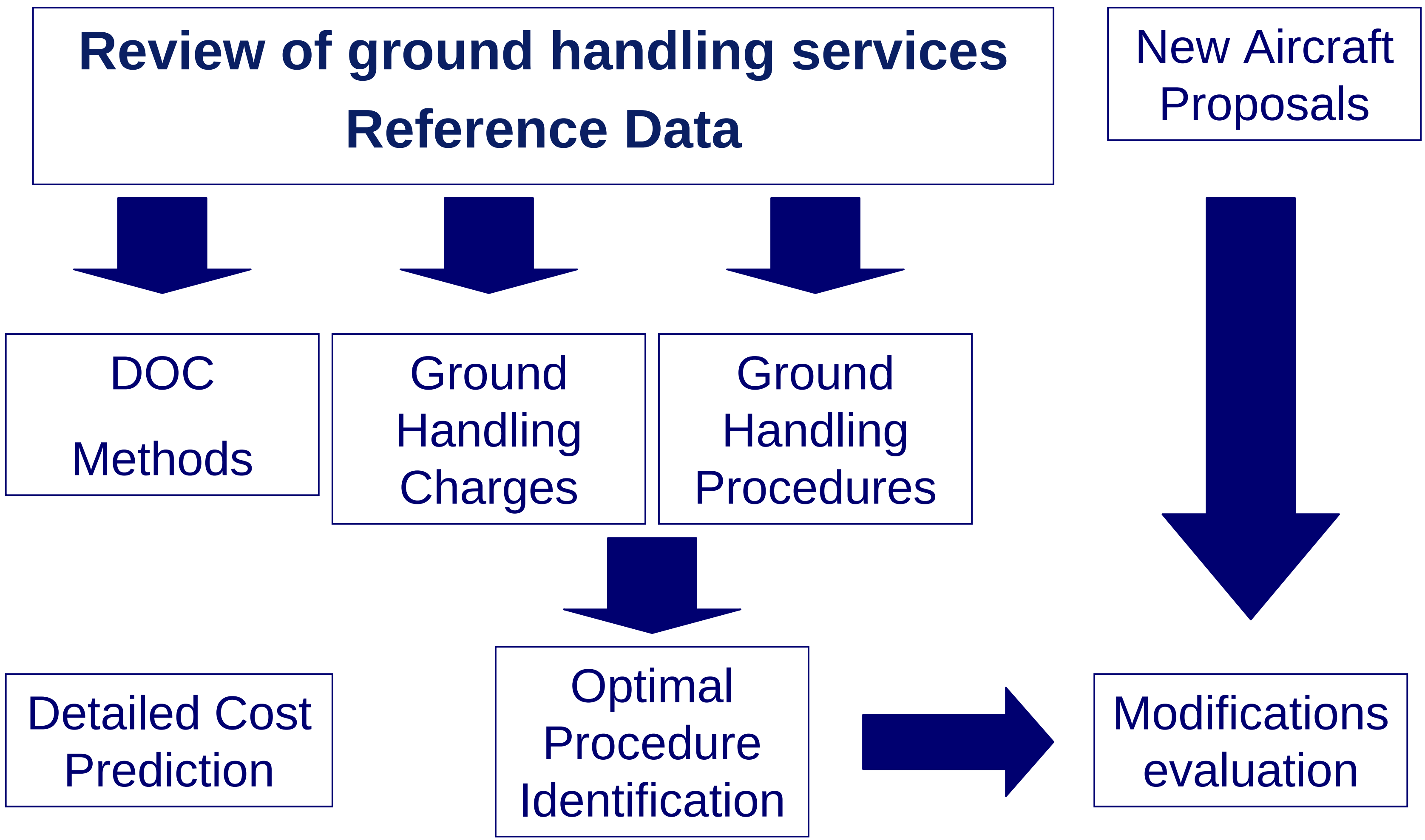
Overview


Review of ground handling services
Reference Data
New Aircraft Proposals
DOC Methods
Ground Handling Charges
Ground Handling Procedures
Detailed Cost Prediction
Optimal Procedure Identification
Modifications evaluation

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DOC Methods

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Ground Handling Activities - Classification

- Cabin service
- Ramp services
- Passenger services
- Field Operation Services

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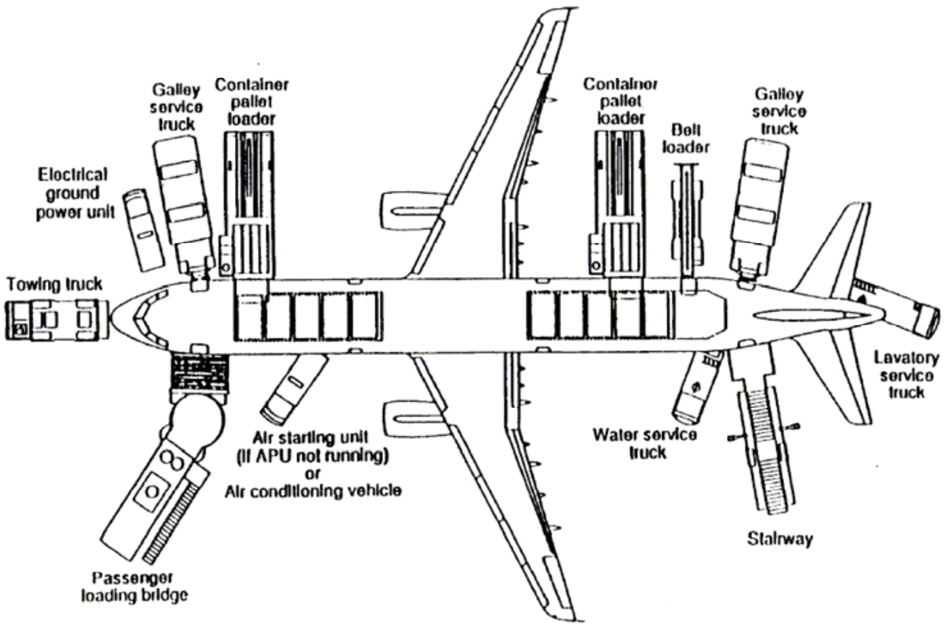
Ground Handling Activities – Ramp Services

- Cargo and Luggage Handling
- Catering
- GPU
- Refuelling
- Transport Passengers
- Pushback



Ground Handling Activities – GSE

Ground Support Equipment: ***Equipment that involve ground power operations, aircraft mobility, and loading operations.***

- Refuelers
- Tractors
- Ground power units
- Buses
- Container loader
- Transporters
- Potable water trucks
- Belt loader
- Passenger stairs
- Pushback tugs Container loader
- De-icing vehicles
- Air starter

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DOC Methods

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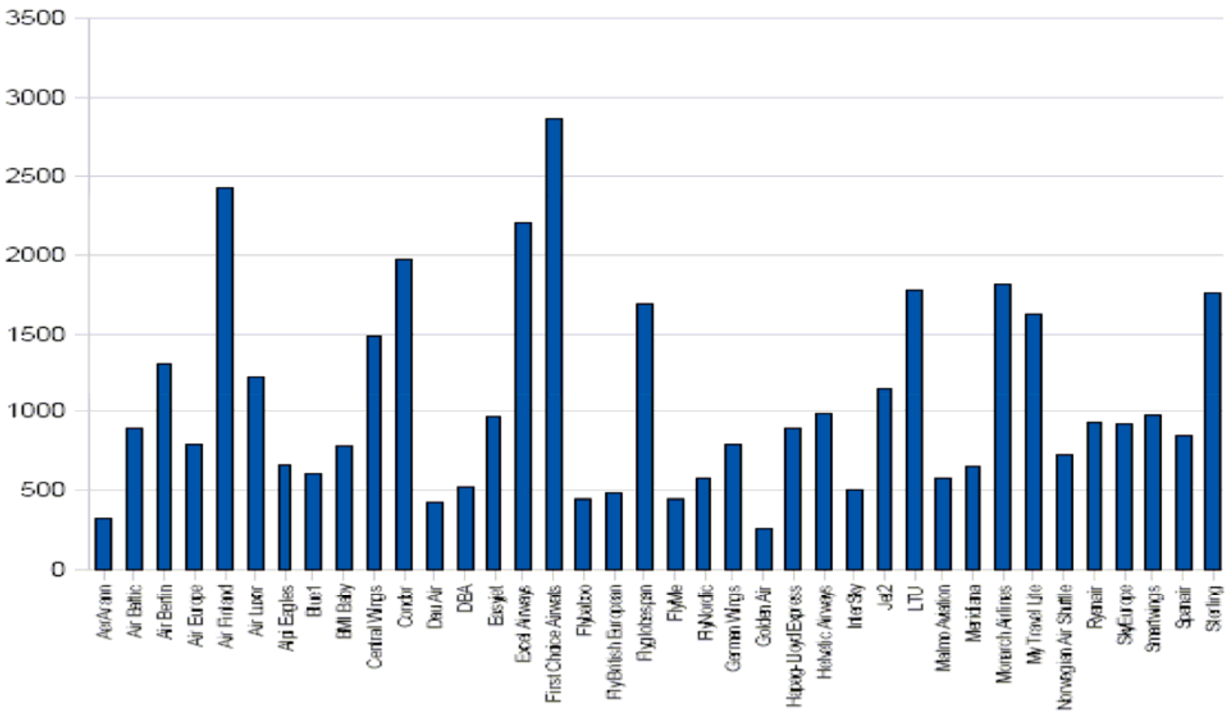
Reference Data: Aircraft

- **The Airbus A320 has been chosen, as it is the most commonly used Airbus aircraft at Low Cost Carriers.**

Reference Data: Mission

- **A research have been carried out in order to find the low cost airline’s average route length.**

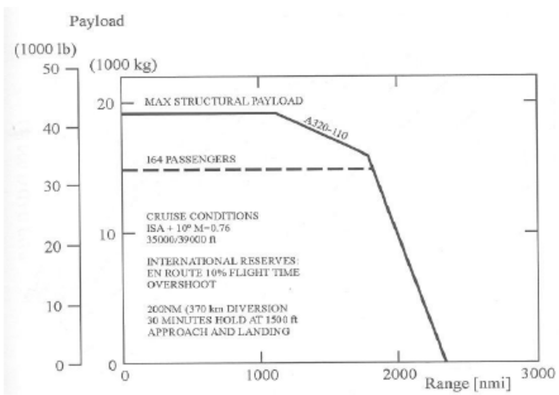


Average Length Distance of Low Cost Airlines (km)

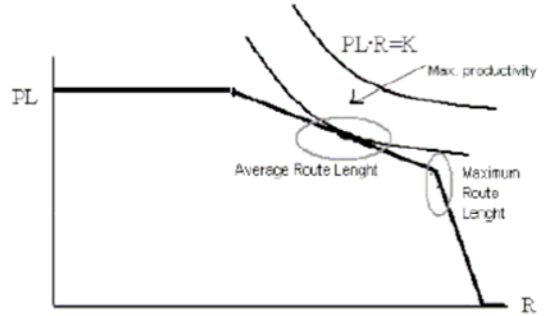
Reference Data: Mission

- **Low cost airline's average route length.**

Category	Average Route length (km)
Regional	560,08
Charter	1835,89
Original	911,05
Full Service	1034
All Airlines	1028,53
3 Main Airlines	1066,33

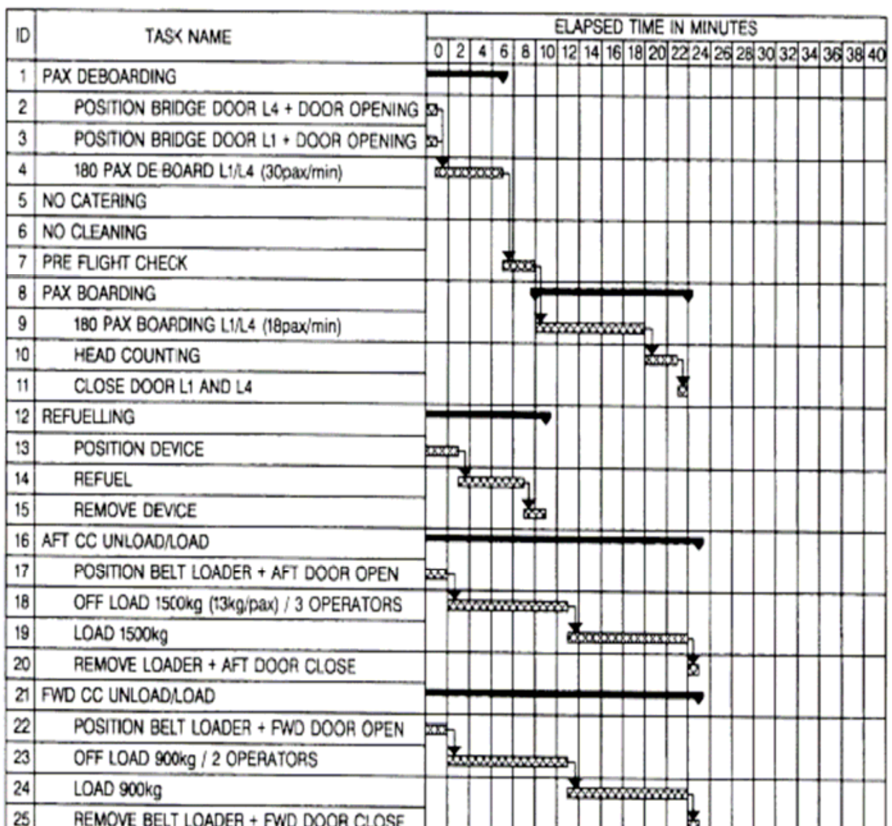


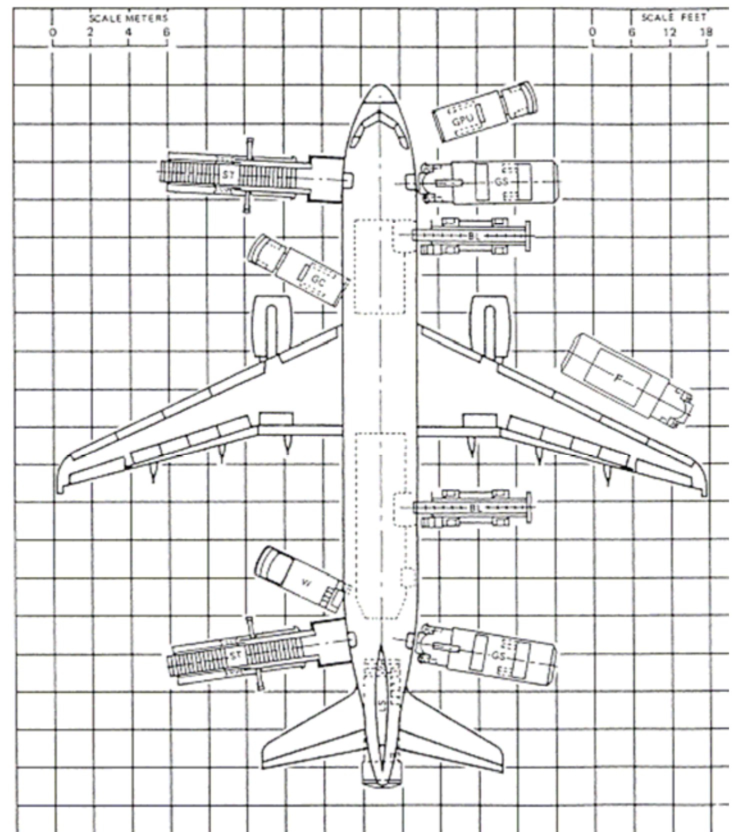
Average Length Distance of Low Cost Airlines
1028 km



Reference Data: Ground Handling Procedure

A320 manual





Overview

Review of ground handling services
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DOC Methods

Ground Handling Charges

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Detailed Cost Prediction

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Available DOC methods:

- AEA - $C_{FEE,GND} = K_1 \cdot m_{PL}$
- Boeing - $C_{FEE,GND} = \left(K_1 + K_2 \cdot K_3 \cdot \text{Seats}\right) \cdot 5{,}05 + FHC$
- AEA-Boeing - $C_{FEE,GND} = \left(K_3 + \text{Total Seats} \cdot K_4 \cdot K_5\right) \cdot K_6 + K_7 \cdot \dfrac{\text{Block Fuel}}{6{,}75}$
- Airbus - No Method
- American Airlines $C_{FEE,GND} = K_1 \cdot \text{seats} \cdot \dfrac{12{,}98}{\text{man}-\text{hour}} + K_2 \cdot \text{seats}$
- Lufthansa - Tables
- Fokker - $C_{FEE,GND} = K_1 + K_2 \cdot \text{seats}$

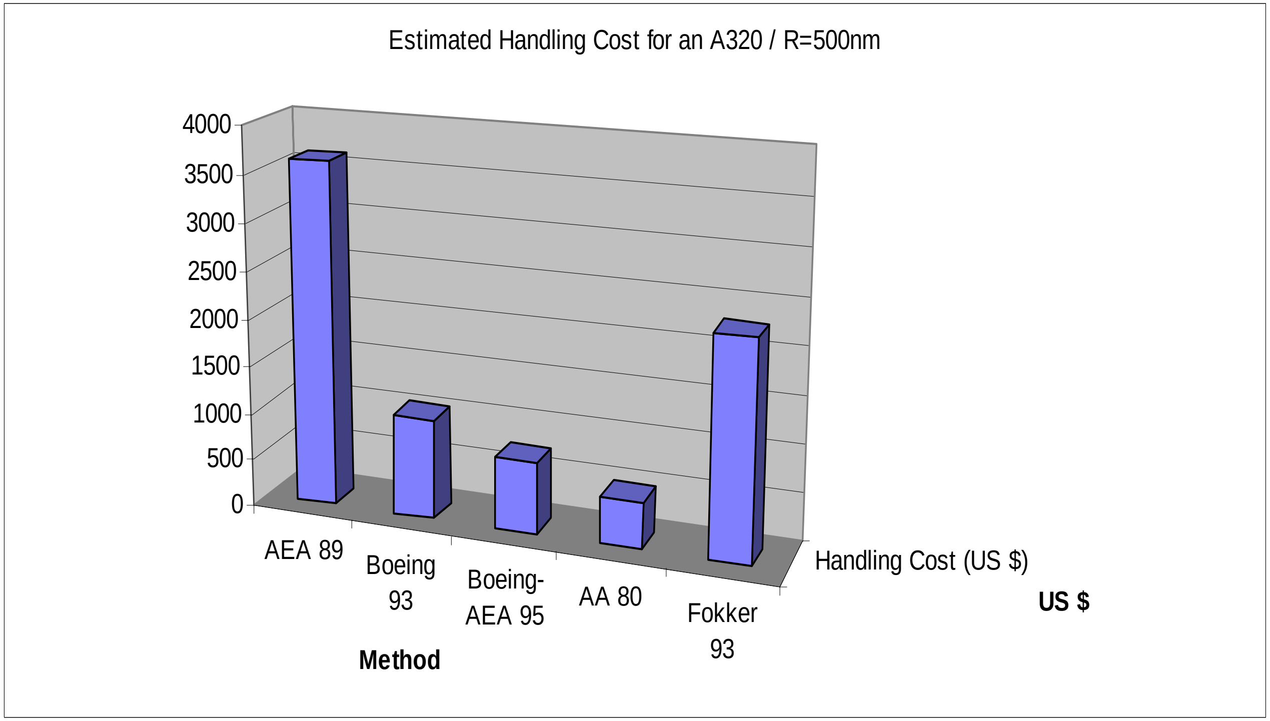
- Those constants depend on number of seats, range, type of airline and country.

DOC Methods

In general:

$$C_{GH} = K \cdot m_{PL}$$

$$C_{GH} = K \cdot n_{Pax}$$



- DOC methods for handling cost do not take into account detailed aircraft parameters
- Available DOC method cannot accurately predict the handling cost for all scenarios
- Influence of the A/C configuration on the GH costs cannot be studied with DOC methods

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Review of ground handling services
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DOC Methods

Ground Handling Charges

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Ground Handling Charges

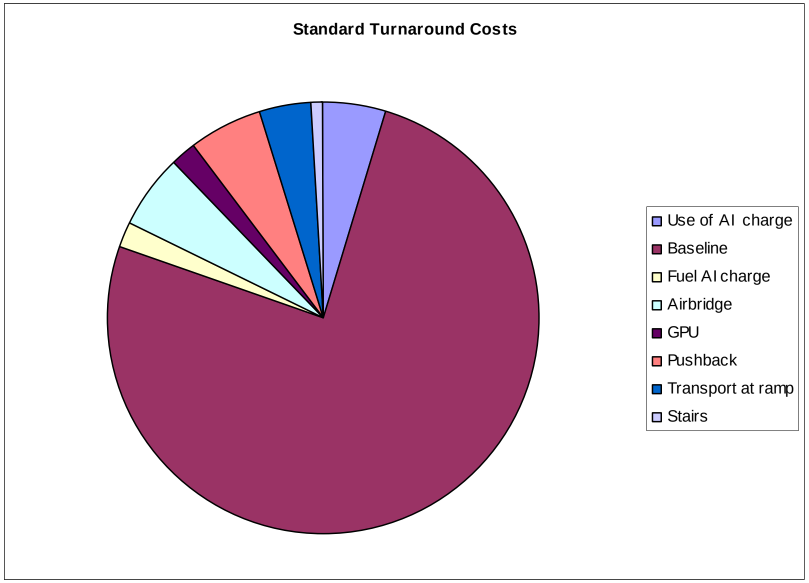
- Airport schedules of charges have been investigated.
- The charges can be divided in three categories:
  - Airport Infrastructure Charges
  - Baseline service
  - Additional services

$$C_{HC} = \sum C_{AI}(operation) + C_{BL}(MTOW, n_{pax}) + \sum C_{AD}(operation)$$

Ground Handling Costs: Airport Charges

These costs have been listed and a ground handling cost breakdown tool has been produced

Use of AI charge	100.3225
Baseline	1612.41
Fuel AI charge	42.97797
Airbridge	116.19
GPU	42.51
Pushback	114.43
Transport at ramp	86.235
Stairs	17.18



Ramp standard Service Cost for an A320

Airport	Ramp standard Service Cost (euros)
Madrid MAD (**AENA 2008**)	1756.27
Salzburg SZG (**Salzburg 2007**)	1280.00
Aarhus AAR (**Aarhus 2007**)	1620.86

Ground Handling Costs: Airport Charges

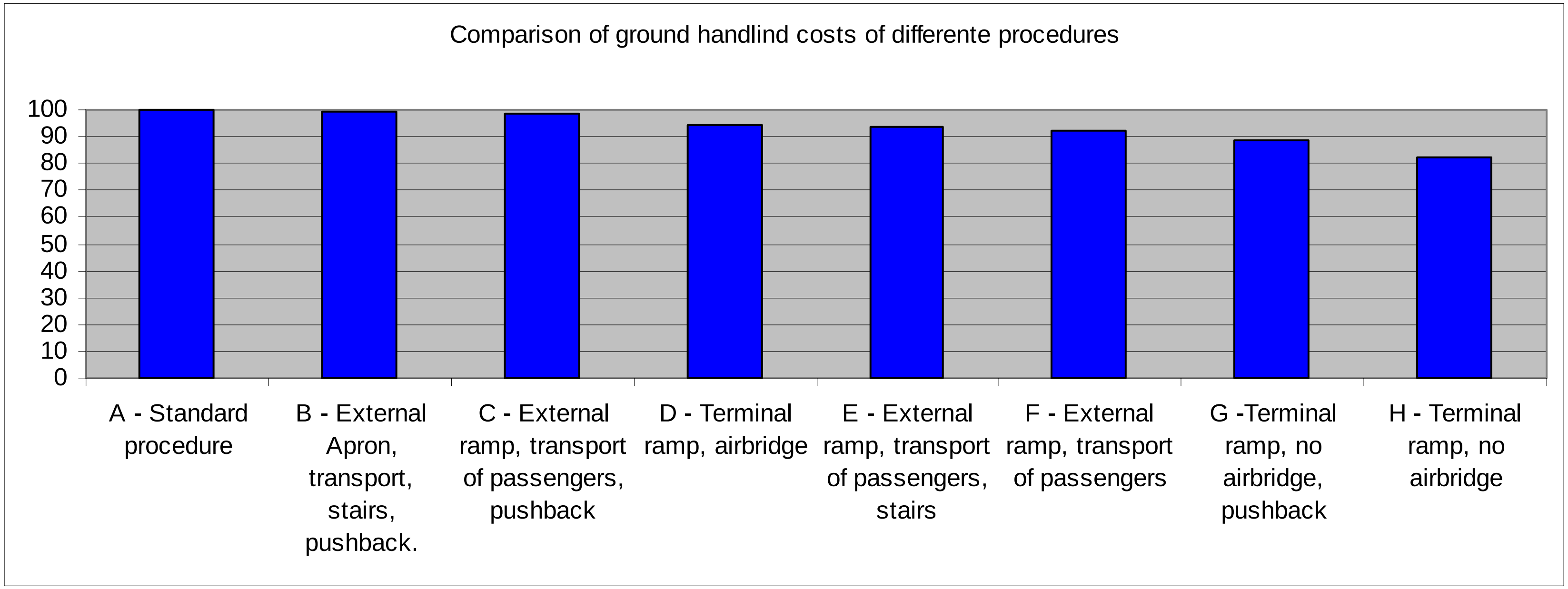
- These costs only depend on operational aspects (services and time)
- Aircraft parameters are also not taken into account.

Aircraft class	Airplane type	Aircraft class	Airplane type
4A	AEROSPATIALE AS350 Ecureuil CESSNA TWIN PISTON	71	AIRBUS 320
4B	AEROSPATIALE SN365 Dauphin AVIOCAR CN212-200	72	BOEING 727-200
4C	EMBRAER 120 BRASILIA AVIOCAR CN235	81	BOEING 757-300 AIRBUS A310
31	AEROSPATIALE ATR 42 DE HAVILLAND DHC-8	82	AIRBUS A300 B4/C4/F4 BOEING 767-300
41	AEROSPATIALE ATR 72 CANADAIR REGIONAL JET 900	83	AIRBUS 340-200 BOEING 777-200
51	BRITISH AEROSPACE 146-300 McDONNELL DOUGLAS DC-9	91	McDONNELL DOUGLAS MD-11 BOEING 777-300
61	BOEING 737 MCDONNELL DOUGLAS MD 83	93	BOEING 747-200/400 AIRBUS A340-600

MTOW	Coefficient
Aircraft between 0 and less than 16 Tons	13,16%
Aircraft between 16 and less than 22 Tons	17,51%
Aircraft between 22 and less than 38 Tons	28,04%
Aircraft between 38 and less than 56 Tons	77,88%
Aircraft between 56 and less than 72 Tons	100,00%
Aircraft between 72 and less than 86 Tons	120,33%
Aircraft between 86 and less than 121 Tons	135,30%
Aircraft between 121 and less than 164 Tons	150,28%
Aircraft between 164 and less than 191 Tons	179,37%
Aircraft between 191 and less than 231 Tons	202,50%
Aircraft between 231 and less than 300 Tons	264,81%
Aircraft over 300 Tons	314,64%

Ground Handling Costs: Airport Charges

However, different handling procedures can be compared with this tool.



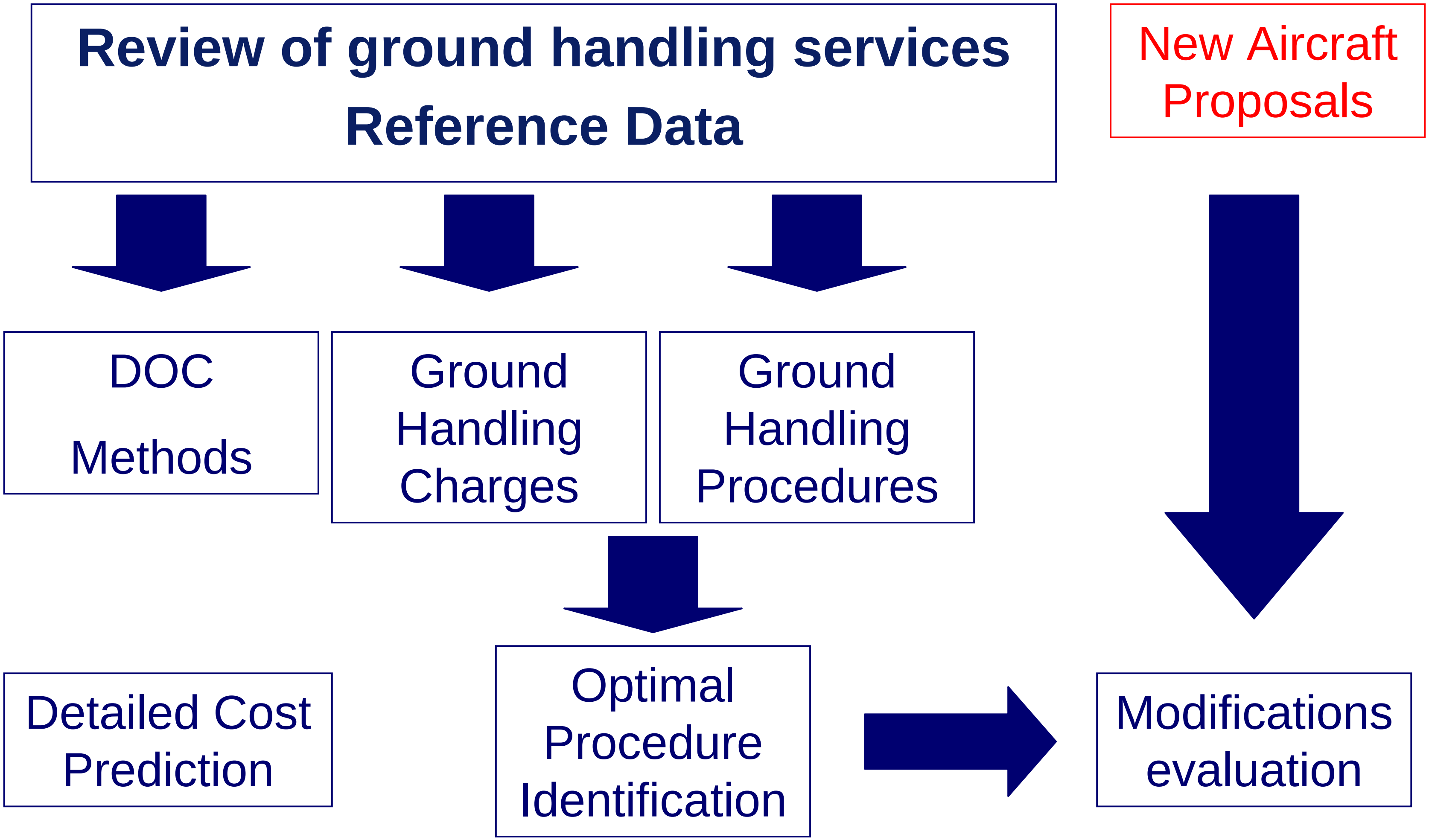
Ground Handling : Optimal GH procedure

- Handling is carried out at a terminal ramp without need of pushback or transporting passengers.
- This cost-efficient procedure in the most used by the LCA.
- Examples:

Ground Handling : Conclusions

- To decrease the ground handling costs, LCA avoid as much ground handling services as possible.
- In order to achieve this, a more automous aircraft are required.
- For example
  - Pushback can be avoided by Autonomous Pushback Systems
  - Airbridge use can be switched by stairs.

Overview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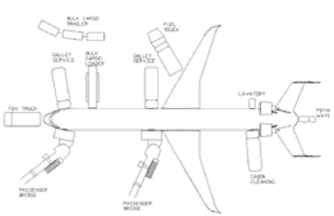
New aircraft proposals

Model	Developer	Criteria	Results
A2007	Delt University	Minimize turnaround	High wing, APS, Integrated stairs
StartXpress	Stuttgart University	More Electrial A/C.	High wing, New Engine
Orca	Stuttgart University	Minimize turnaound	New cofiguration. Double stairs at tail.
Larus	Stuttgart University	GH optimization	New configuration.
Globalspirit	Stuttgart University	DOC	High wing
Gastornis	Stuttgart University	GH and turnround	New systems. Fuel cell APU



There is no studies about Ground Handlig Costs

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DOC Methods

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Integrated Stairs

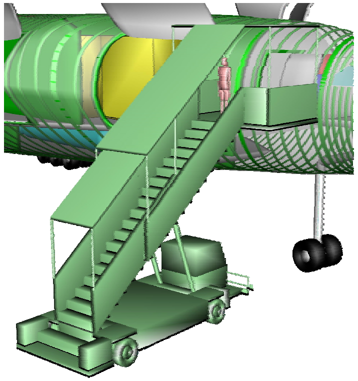
Weight Penalty of about 65kg.
Increase of DOC 0.06% (8USD/Trip)

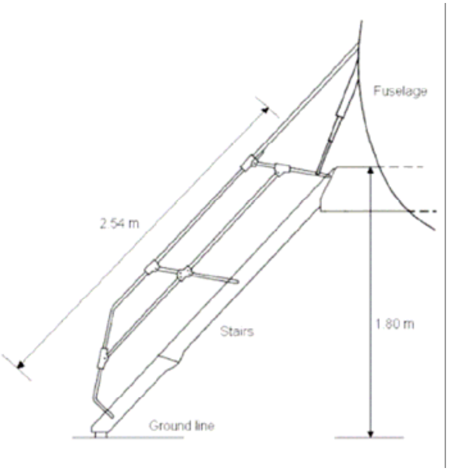
Avoid Delays and Utilization of Airport Equipement.
Stairs -> 20USD
Airbridge -> 110USD

Possibility of boarding using two doors

Compatibilty with airbrigdes.

A clear decrease on costs





Autonomous Pushback System

Weight Penalty of about 100kg.
Increase of DOC 0.1% (15USD/Trip)

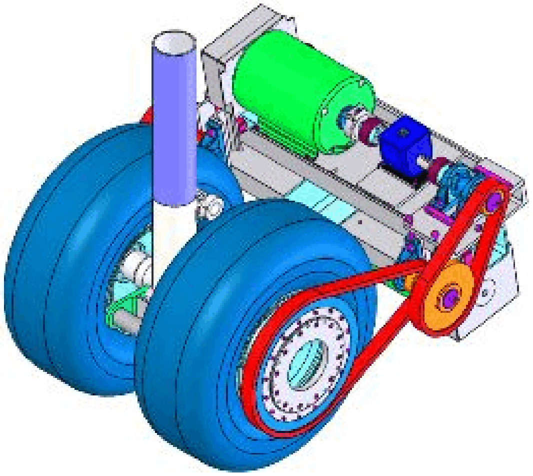
Small maintenance and depreciation cost.(5USD/trip)

Avoid Delays and Utilization of Airport Equipement.
Pushback -> 172USD/trip

It saves around 2 minutes in the turnaround time.

Potential to use fuel cells.

A clear decrease on costs

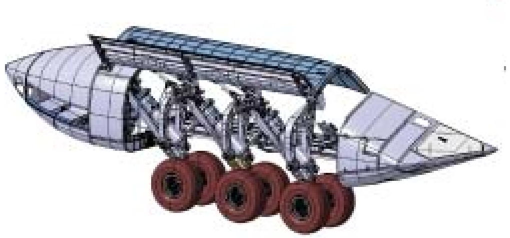


Wheeltug

Kneeling system

- Lower sill height leads to lower loading costs.
- Very high weight penalty.
- Difficult to asses loading activitiy improvement
  - Belt and container loaders can be adapted to different geometries already.
  - Containers and pallets have standard sizes.

- Do not save costs.



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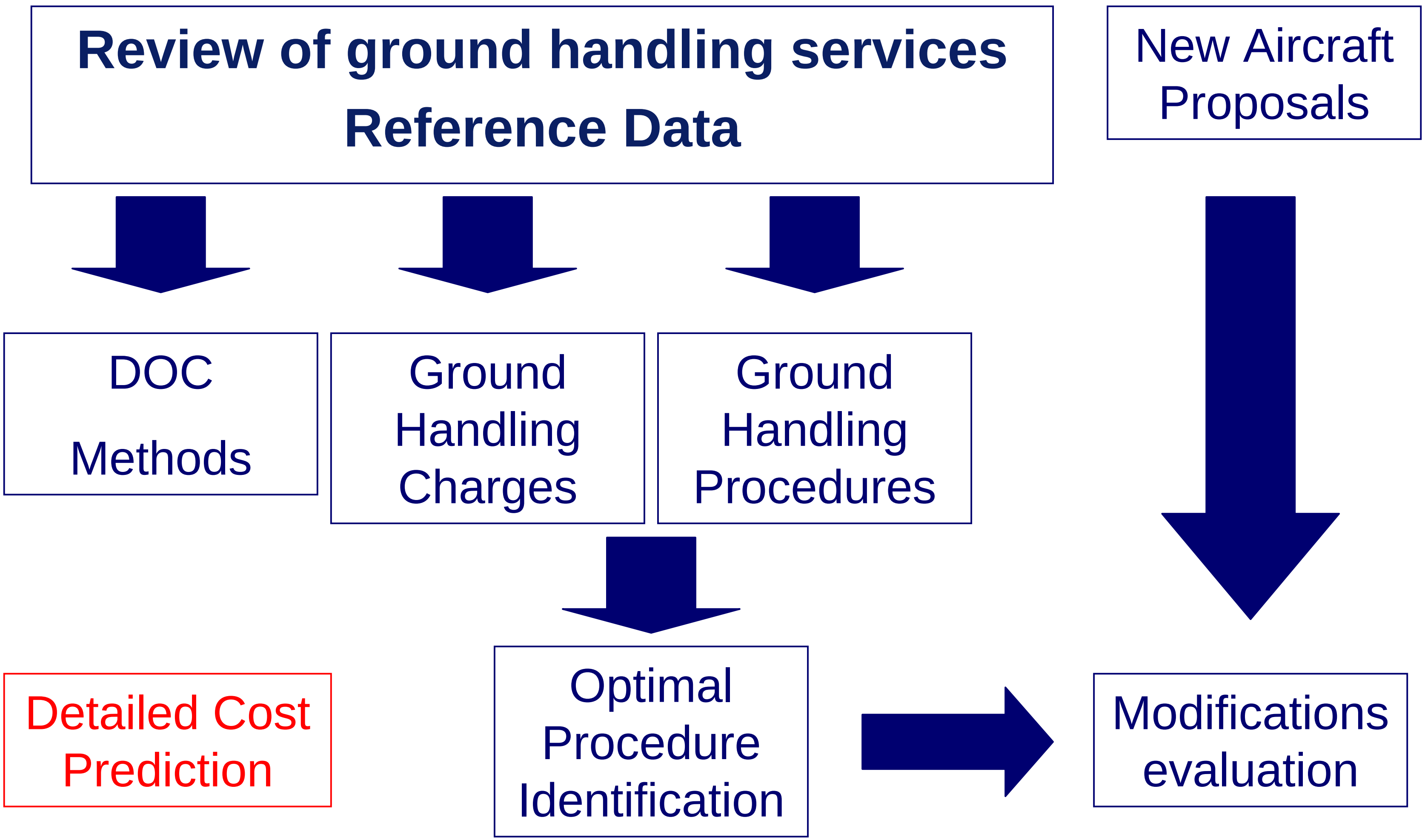
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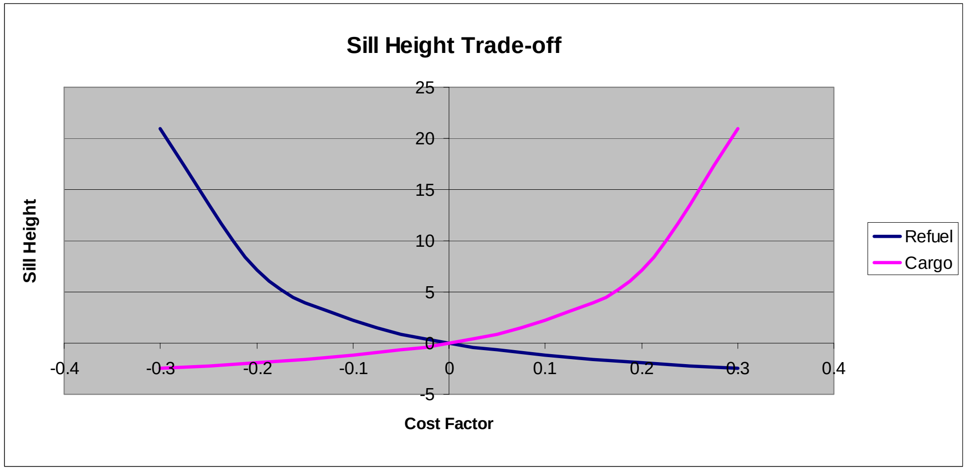
Summary and future steps

- **Despite these findings, aircraft configuration and geometry cannot be evaluated regarding GH costs yet.**
- **A new tool has to be developed for this purpose.**
  - **Ground Handling studies in detail.**
  - **Identification of Ground Handling parameters.** P_i
  - **Assign cost values to each element.** $C_i = C(P_1, P_{2,\ldots}, P_i)$
  - **Connection between GH costs and Aircraft parameters**
  - **Evaluation of different configurations**

Summary and future steps

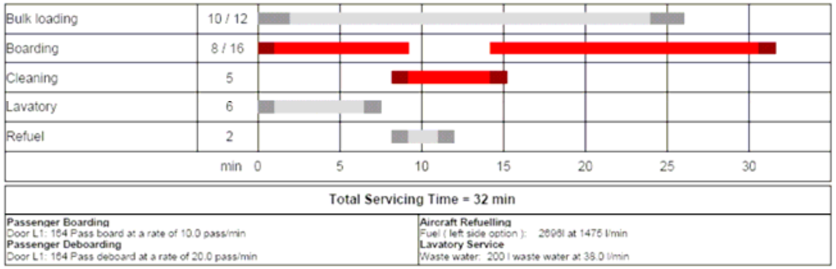
- A modelization of the ground handling costs is being carried out.
- Delays, geometrical compatibilities, staff, service precision parameteres are taken into account.

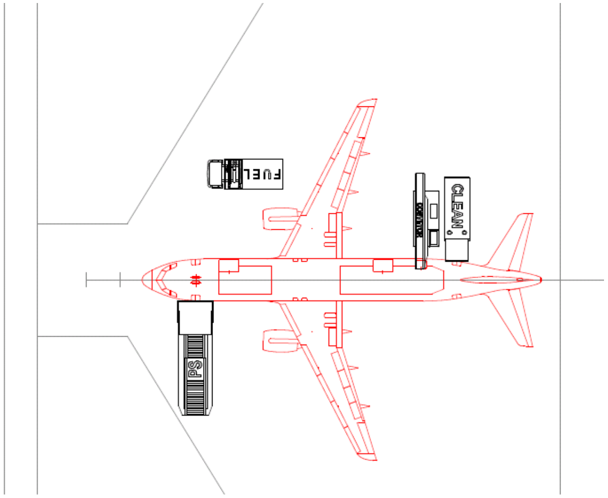


$$C_{GH} = C_1 \cdot C_2 \cdot C_3 \ldots C_i$$

Summary and future steps

- Software Simba 2D from ARC is able to perform ground handling simulations and calculate costs.
- Once the ground handling cost breakdown is totally defined, it is possible to calculate turn-around times and costs in parallel.





Thank you for your attention

Further information can be found on:

- http://ALOHA.ProfScholz.de
- http://Aero.ProfScholz.de