Modelling Project

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The report on the wheelchair problem of airline companies

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Chapter 1

Definition phase

1.1 Context

1.1.1 The Stakeholders and the keydrivers

The stakeholders are:

- KLM
- Escorts
- Passengers
- Employees
- Other airline companies and other airport
- constructors and maintainers of the wheelchairs.

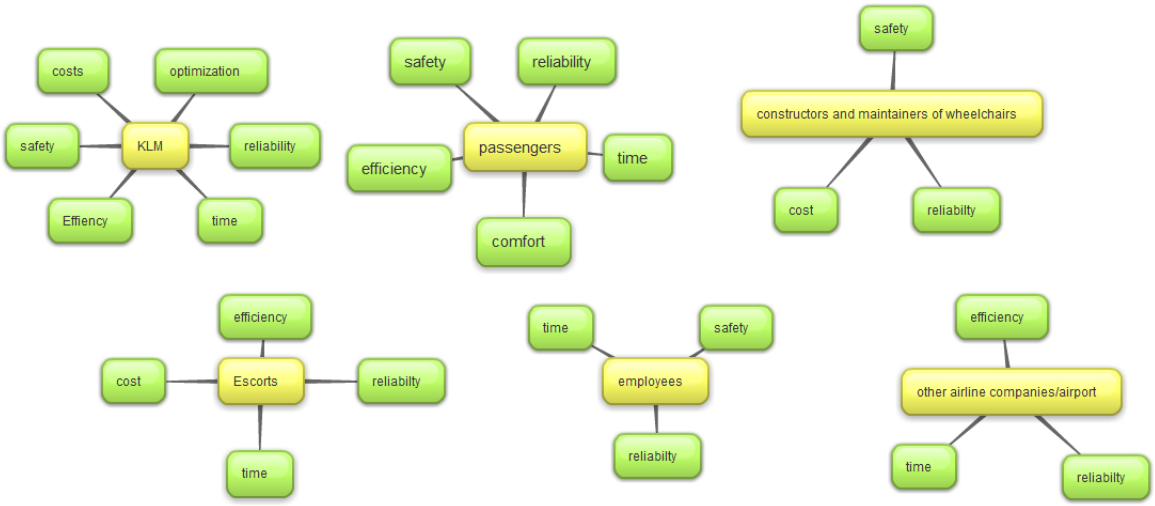
These person have got the greatest interest in the escort service in general, including if the service was optimized to be efficient in time and thus in costs. The people who guard the depot where the wheelchairs are stored and desk workers who check in the passengers are both taken into account in the employees. The keydrivers are:

- Efficiency
- Cost
- Optimization
- Comfort

- Time
- Safety
- Reliability

1.1.2 Relation between the stakeholders and keydrivers

If the Stakeholders are linked to the keydrivers, their relations could be summarized into this mind map:



1.1.2.1 KLM

One of the interests of KLM is the costs to keep them as low as possible, but not such that this is the main interest. The plane needs to leave on time, so there needs to be a minimum amount of money to realize the on time depart of the plane.
Safety is another interest, which deals with the safety of the escort service. This deals then with the safety of the trip, the safety of the wheelchairs etc. If the safety is not of a certain level, such that the reputation of the airline company suffers, people might rather use other airline companies to realize their trip.
The same reason holds for efficiency. Also, if the service is not efficient, not as many escorts by the same person can be taken care of, so the plane might leave late. Therefore an efficient solution with respect to time needs to be archived.

So as mentioned above, time is also a factor which is required to keep costs low and hence a high efficiency as result. The distance from the check-in desk to the gate can be considered in time for example.
Reliability of the service also deals with the safety reasons: KLM needs to be sure the service takes a certain time and it should be sure that the passengers arrive on time at the gate. Unreliable service leads to loss of money and reputation damage.
Finally, optimization is the most important interest for KLM, so the service gets optimized to cost minimally but that the plane can depart on time.

1.1.2.2 Escorts

The costs are also important for the escort itself. If the costs are getting too high, the might be a possibility that these people are fired or a drop in wage. So indirectly they have an interest in the costs of their service.
With respect to the efficiency, which is also a keydriver for the escorts, time is important. This relates to the costs (as mentioned above), because the more escorts executed, the more employees are required to perform all escorts, which means higher costs, hence in contradiction with the main goal.
Reliability is required by the escort, such KLM can assure the passengers that they will be on time at the gate, so again also to keep costs low. On the other hand, other personnel of the service needs to be sure that certain staff is at position x at time t, so efficiently using the resources and personnel of the service to optimize the service.
Efficiency follows then directly from the above mentioned relations in order to keep costs low of the service.

1.1.2.3 Passengers

The passengers are interested in having a comfortable, safe, efficient and reliable escort. Comfort can be archived by having a sufficient comfortable ride and wheelchair used to transport the person from the desk to the gate. Since the passenger does not want to see the whole airport, time is also in the interest of the passengers. This also relates to efficiency: the disabled passenger wants to be escorted in the shortest possible time, with as much comfort as possible. This means that some is required and hence the service needs to be efficient.
The reliability is of interest for the passengers, by the fact that the passenger wants to be sure to get the escort when request, which in generally happens. Also, the passenger want to be brought to a specific gate, at a specific time. Therefore the reliability of the escort service is also of interest for the pas-

sengers.
Finally, safety is also of interest, because the passenger wants to be escorted safely without injuries. Therefore the wheelchair needs to be safe to be used, and the quality of service of the escort needs to be of a certain level. This level requires a certain level of service from the personnel.

1.1.2.4 Employees

The interest of the employees, are the time (duration of the escort), reliability and the safety of the escort. The time is of interest, because of the fact that when a transfer has to be made, the escort is on time at the gate to get the passenger and is on time at the next gate to board the passenger such that the next plane (also) can leave on time. The employees guarding the depot on the other hand have got an interest in time as well. Their interest is to know how long a wheelchair is away from the depot, but also to be able to check if something happened with the escort or the wheelchair (i.e. lost or accident).
Safety is also of concerns of the employees, since if the goal of an airline company is to maintain quality and safety, all employees should be able to contribute in their way. The escorting persons therefore need to make sure the escorted person is moved safely from place A to place B.

1.1.2.5 Constructors and maintainers of the wheelchairs

The maintainers and constructors of the wheelchairs have interest in the safety, costs and reliability. They have to make sure the wheelchair is safe, in usage for both the disabled person and the escort service. The escort service could get a bad reputation if the escort service is not safe.
On the other hand, the costs should not be too high. So the people have to construct and maintain the wheelchairs in such a way to create good wheelchairs with not too high costs (both maintenance and product price). But the demand for low costs is opposed by the safety of the wheelchairs. If the construction is not solid enough so any[1] possible disabled person can be transferred safely. So the wheelchair also needs to be sufficiently solid built.

1.1.2.6 Other airline companies and other airports

Other airline companies and other airports also have an interest in the escort service in the following perspective. If the transfer is a transfer between two

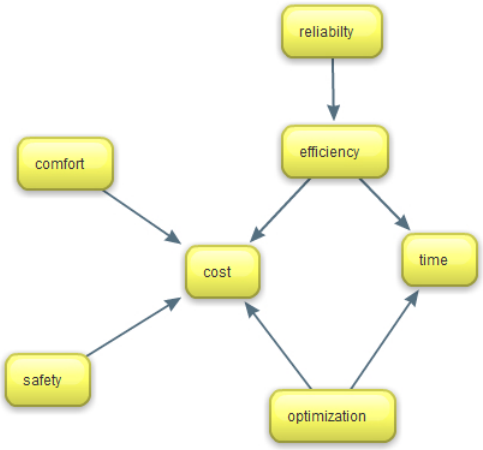
[1]Obviously not everyone should be taken into account, but i.e. obese people need tougher wheelchairs, hence some 'extremes' need to be taken care of in the construction, but not all.

different planes of different airline companies[2], the other company requiers a time efficient, reliable escort service such that this plane can depart on time. In the worst case, there is little time between arrival of plane 1 and depart of plane 2. A time efficient service would be necessary to realize this. Also an estimation on when a disables person with escort arrives is pleasant to know when an escort approximately arrives. Clearly, this should be as efficient as possible and hence efficiency is also an interest.
Reliability is also an interest for other airline companies and airports. Being sure when an escort arrives is necessary in order to make it possible for other airline companies to depart on time when there is a transfer with escort service. If it is uncertain if the passenger will arrive on time, it is cheaper for an airline company to let the plane depart and put the escorted person on a plane departing later than to miss the timeslot in which the plane was supposed to leave with all (worse) economic consequences as result. Therefore reliability of the escort service is also of interest for other aiports and other airline companies.

[2]Only from KLM to airline company X is considered

1.1.3 Relation between keydrivers

The keydrivers do also have a relation with other keydrivers than only with stakeholders. These can be summarized as follows:



The arrows should be read that keydriver k has in incoming arrow from k', and k' has and incoming arrow from k", k is in a relation with k". So there is transitivity between the elements.

1.1.3.1 Reliability

In order to have a reliable service, so the service is on time and there are no losses of money on the service, it can be said that reliability is linked to both cost and time in the respect of efficiency. Therefore by transitivity reliability is related to efficiency.

1.1.3.2 Efficiency

As stated by reliability, the costs should not be low and the escort should be time efficient. So in general the service needs to be both efficient in time and costs. Therefore efficiency has a relation with both cost and time.

1.1.3.3 Optimization

So both time and cost should be in relation with optimization. The cost should be kept as low as possible to give an time efficient reliable service. But then there should be optimization on time with costs reduction as a

result[3]. Therefore there needs to be a relation from optimization to both cost and time.

1.1.3.4 Safety

When safety is addressed, money is always a factor. Safety costs money, and the level of safety sets the costs in order to realize. If for example the wheelchair needs to be made that it has bumpers to take the impact and not the one sitting in the wheelchair. But this costs money to realize. This shows the direct relation between safety and cost, which therefore exists.

1.1.3.5 Comfort

The comfort also relates to money in the same respect as safety does. If the transported person is transported in a very relaxing wheelchair, then this wheelchair costs more money than a plain wheelchair. If the ride to the gate is desired to be more comfortable, then the duration needs to be longer which as a result costs more money. Hence, comfort is in a relation with cost.

1.2 Problem definition and purpose

1.2.1 Model purpose

When making a model there should be three questions answered:
Is there something to choose?
Will the model output a number?
Should the model produce a value or knowledge?

The first question can be answered with *yes*, that is because there are different combinations for different sets of people, area ect.
The second question will also be answered with *yes* since the model should produce a number of escorts or wheelchairs needed so the cost can be calculated.
The answer to the last question should be a *value*, because the model brings an optimized solution rather than new knowlage.
From this we can conclude the model should be a *optimization*, it should produce the best solution possible for the owner.

[3]Compared to the case where no attention has been paid to optimized model where planes leave late with all financial consequences as result

1.2.2 Model dimensions

Now that the purpose of the model is known, the dimensions should be determined. This can be done using the following points.

1.2.2.1 Continue or discrete

The model should be a *discrete* model, since both input and output values will be both integers (real life objects like number of wheelchairs, escorts) and floats (salary, costs). Also most of the intermediate results will be discrete numbers.

1.2.2.2 Deterministic or stochastic

Since the owner of the model can decide almost all input variables, the assumption is that this model is *deterministic*. The owner has influence on most of the inputs, and also the number of wheelchairs and disabled people will be deterministic.

1.2.2.3 Black box or glass box

The model will be a *glass box* model, because there is insight in what happens, everything is known by the owner of the model, for instance the owner knows how many disabled people travel and where and when planes arrive and leave.

1.2.2.4 Static or dynamic

Because time does not matter -the model is, after all, just about one transfer- this is a *static* model. All input values are set before execution and are valid throughout the entire model.

1.2.2.5 Calculating or reasoning

The model will be a *calculating* model, because a number is the desired output of the model. Also all input values and quantities will be numbers.

1.2.2.6 Geometrical or non-geometrical

Even though an airport feels like a geometric setting the model is a *non-geometrical* model, this is because the airport will not be geographically defined, there are only distances used which are abstract numbers.

1.2.2.7 Numerical or symbolic

It is not entirely clear whether the model is numerical or symbolic since the model itself starts out using only symbols for the inputs in the formulas, but once executed the the model will replace these with concrete values, also the output will be numerical. This makes the model *both numerical and symbolic*.

1.2.2.8 Material or immaterial

The model will be *Immaterial*, because the model does not describe a real airport. There is just a concept in our mind that we project into this immaterial model. It will sort of look like modeling from scratch, but with a discrete model.

1.2.3 Conceptual definition of the problem

Given a description of the airport, incoming flights and departing flights: how many resources are required to get all flights of the ground with all immobile people on board?

1.3 Sub-questions

1. How will the number of wheelchairs influence the amount of time of a transfer between two flights?
2. How will the location of the wheelchair depot influence the time?
   (a) What will this mean for the distance between the gates?
   (b) What will this mean for the time required to travel between to gates?
   (c) What will this mean for the maintenance of the wheelchairs
      i. Who will do the maintenance of the wheelchairs?
      ii. How much service does each wheelchair require?
      iii. Where will those wheelchairs be bought?
   (d) How will this influence the amount of escorts?
      i. How many escorts do I need for one wheelchair?
   (e) Will the storing of the chairs at one location decrease the costs of guarding them?

i. Will hiring additional security to guard the wheelchairs result in less damage/stolen chairs?
ii. If the escorts guard the chairs, how will this influence security?
A. Do we have to hire more escorts if they handle security?

3. What kind of wheelchairs will be used?
   (a) Will the quality of the chair influence the amount of maintenance required?
   (b) Will the quality of the chair influence the amount of money asked for the service?
   (c) How will the quality of the wheelchair influence the customer satisfaction?
      i. How will this distinct KLM from other airliners?
      ii. Will this create an increase in customers?
   (d) Which wheelchair has the best price/quality rate?
      i. How much is the difference in price?
         A. How will the difference in price influence the total costs?
         B. What is the price of each wheelchair?

4. How will the amount of escorts influence the total costs?
   (a) What kind of people will escort the disabled?
      i. Will the use of students influence the amount of customers that want to use the service?
      ii. Will the use of athletes influence the average travel speed of an wheelchair?
      iii. What kind of education/degree do they need?
   (b) How much will the escorts be paid?
      i. Will the salary of the escorts influence how fast they run?
      ii. Will a bonus for fast deliveries increase the efficiency?
         A. Will this endanger the passengers?
   (c) Will the use of electric wheelchairs decrease the number the escorts?
      i. Can everyone use an electric wheelchair?

5. How does the distance between gates influence the cost of transfer flights?

6. How does the walking speed of escorts influence the cost of transfer flights?

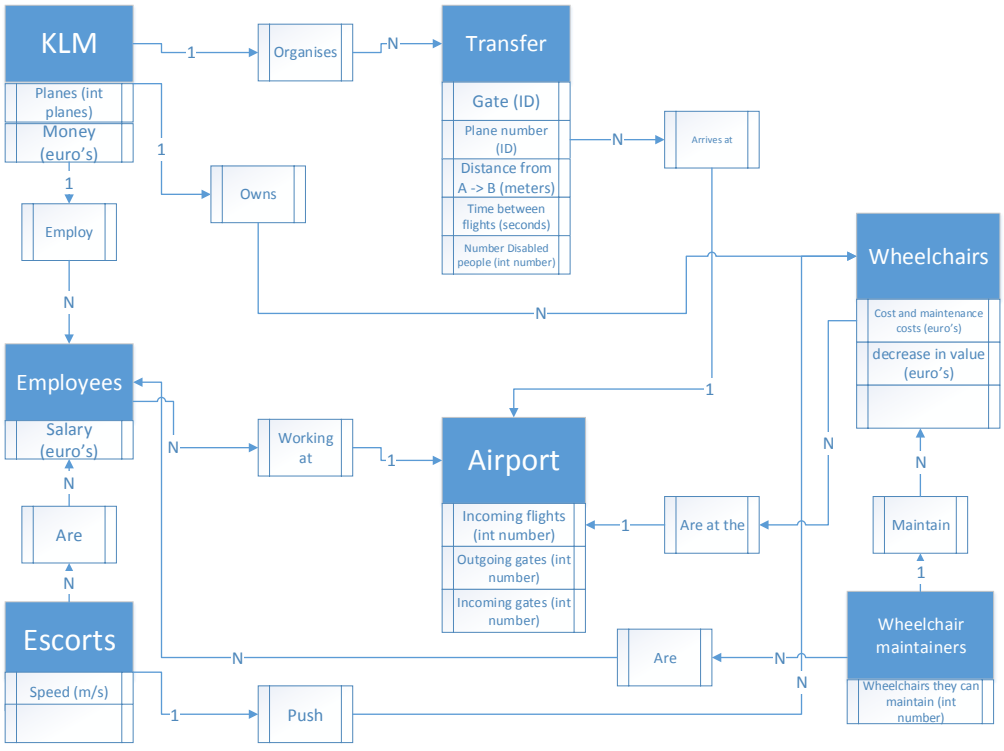
7. How does the cost depend on the time of travel between gates?

Chapter 2

Conceptualization phase

2.1 Concepts, properties,values and relations

2.1.1 The model



2.1.2 Explanation of

2.1.2.1 KLM

The "Money" property is the amount of money KLM has in this model.

2.1.2.2 N on N relations of employees, escorts and maintainers

These are very loose relations. In words this would be: some employees are escorts and some employees are maintainers.

2.1.2.3 Time

There are two values that are described in the unit "euro's/time". This time is not a predetermined value, because it is not known yet in what timeframe we would like to pay them.

2.1.2.4 Money

As one can see, all of the quantities are either usable to determine the eventual amount of money or are already quantified in money.

Chapter 3

Formalization phase

3.1 Quantities and their relationships

3.1.1 KLM

Property: Money

Unit: Euro's

Role:

3.1.2 Employees

Property: Salary

Unit: Euro's / hour

Role:

3.1.3 Transfer

Property: Distance from gate A to B

Unit: Meters

Role:

Property: Time between flights

Unit: Seconds

Role: To be chosen

Property: Disabled people

Unit: An integer number

Role: To be chosen

3.1.4 Escorts

Property: Speed

Unit: m/s

Role: Constant

3.1.5 Wheelchairs

Property: Cost and maintenance cost

Unit: Euros

Role: Constant

Property: Decrease in value

Unit: Euros/time

Role: Constant

3.1.6 Wheelchair maintainers

Property: Wheelchairs they can maintain

Unit: Integer

Role: Constant

3.2 Approximations and assumptions

3.3 Derivations

3.4 Special cases

3.5 Estimates

Chapter 4

Execution phase

4.1 Rephrased problem in formal terms